AIA Conference on Architecture

WoodWorks Learning Lounge

Presented by WoodWorks

June 8 and 9, 2023

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Regional Directors: **One-on-One Project Support**

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Building Systems

- Light-Frame
- Mass Timber / CLT
- Off-Site / Panelized Construction
- Hybrid

Building Types

- Multi-Family / Mixed Use
- Education
- Office
- Commercial Low-Rise
- Industrial
- Civic / Recreational
- Institutional / Healthcare

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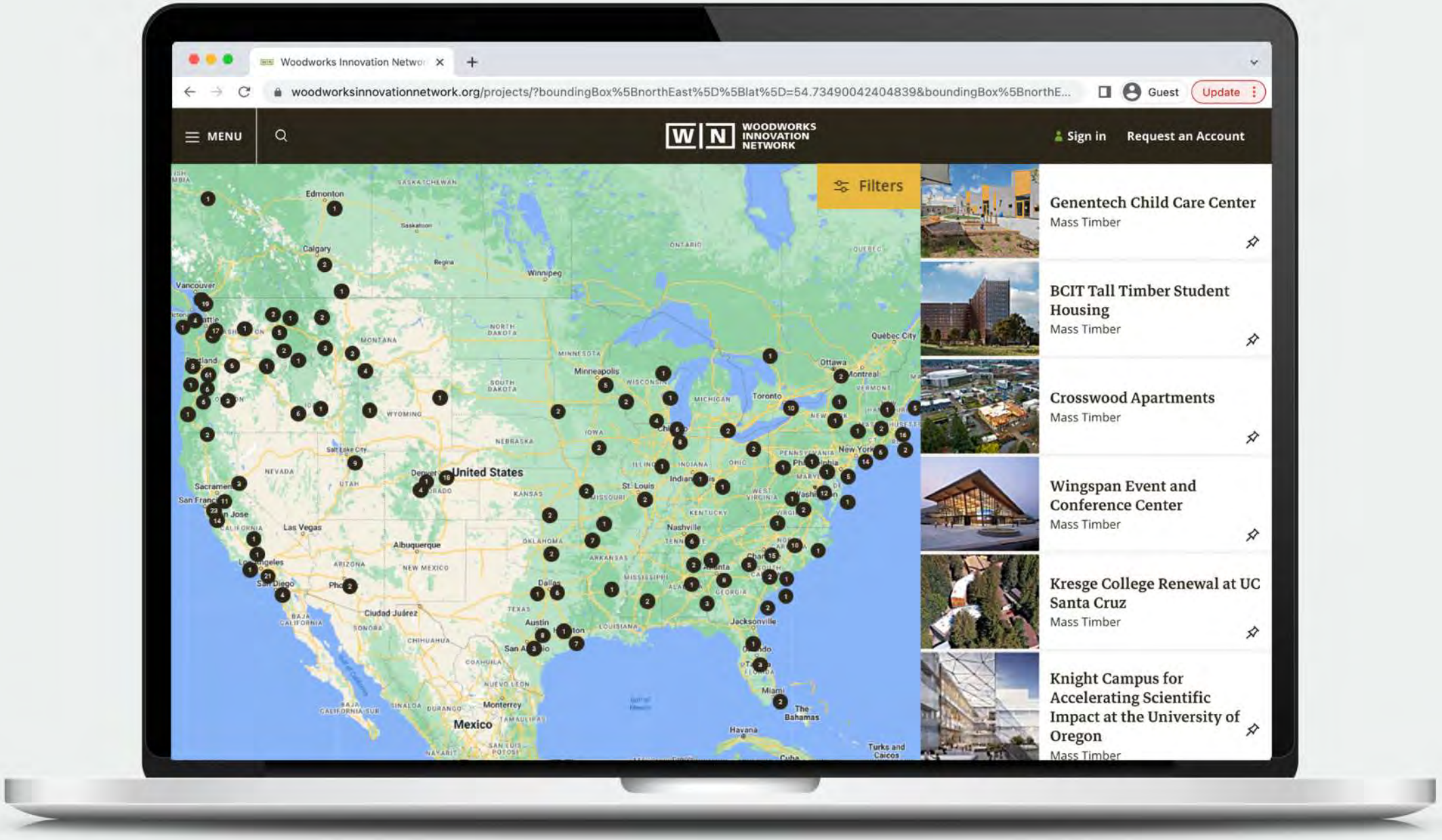
Discover mass timber projects across the US and connect with their teams.

Our experts can help—ask us anything. Get Free Project Support

WoodWorks is your go-to resource for commercial and multi-family wood building design, engineering, and construction. We're here to support you with free one-on-

woodworksinnovationnetwork.org



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- **Manufacturers & Suppliers** WoodWorks Partners 22

Industry

- Architect 0
- Contractor 0
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TIMBERLAB

Mass Timber: Making the Case to Developers and Owners for Mid-rise and Tall Wood

Course Number LL904

Thursday, June 8, 2023, 3:00pm - 4:00pm

Learning Units 1.00 LU/RIBA

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Questions related to specific products and services may be addressed at the conclusion of this presentation.

Course Description

Would you like to pitch sustainable mass timber to a client? If so, attend this session to learn how to complete the value proposition for developers and owners. The aesthetic differentiation and biophilic benefits of mass timber have broad appeal to a wide range of stakeholders, from end users to ESG-investors. Architects hoping to influence decisions to use mass timber will learn how this appeal can translate to return on investment in an overview of initial findings from WoodWorks' Mass Timber Business Case Study series, written for the developer/ owner/ investor audience. Then we'll take a deep dive on Ascent, the world's tallest timber tower, and discuss the challenges, lessons learned, and successes the team experienced taking timber innovations to a new height in the US. Leading engineers, Thornton Tomasetti will share some insight from their explorations of mass timber and tall wood.

Learning Objectives

1. Understand how the biophilic benefits of wood can contribute to occupant health, tenant appeal and the financial value of a real estate development.
2. Discuss the environmental benefits of mass timber and how they resonate with a wide range of stakeholders from occupants to project teams, investors and communities.
3. Through case study examples, explore code-compliant design of mass timber structures, including those pushing beyond the code-prescribed tall wood building height and exposure allowances.
4. Explore the engineering considerations for tall wood buildings as they relate to developer/ owner concerns such as cost, sustainability and impact on floor plans.

Mass Timber: Making the Case to Developers and Owners for Mid-rise and Tall Wood

Chelsea Drenick, PE, SE
WoodWorks Regional Director

Jordan Komp, PE, SE
Thornton Tomasetti Associate Principal

Photo: Kat Doughty

Resources for Developers/Owners

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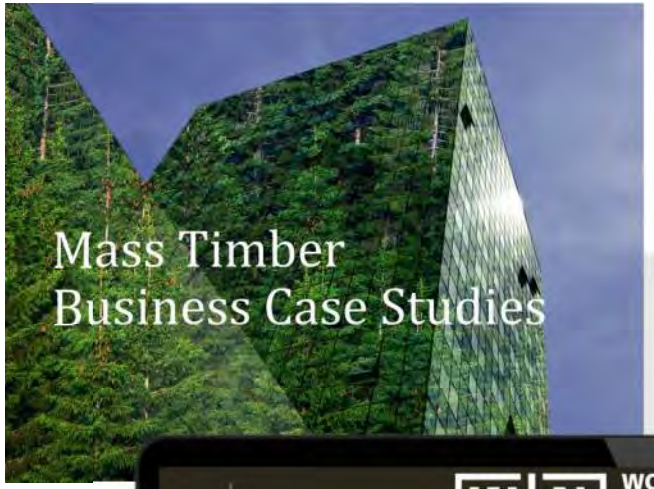
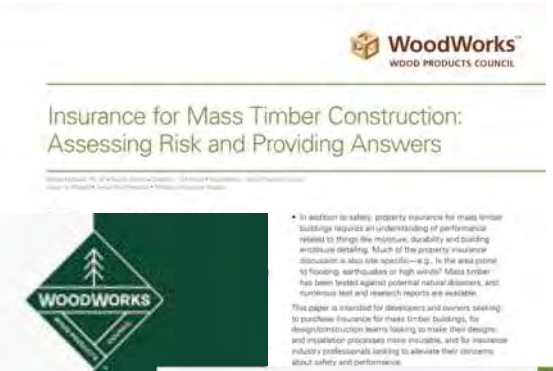
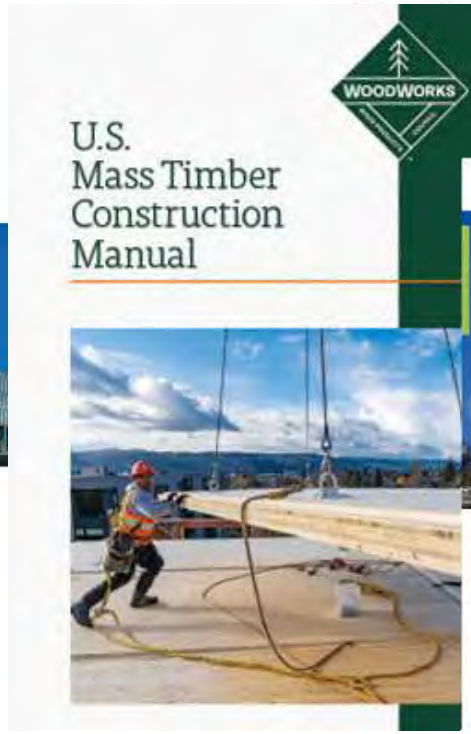
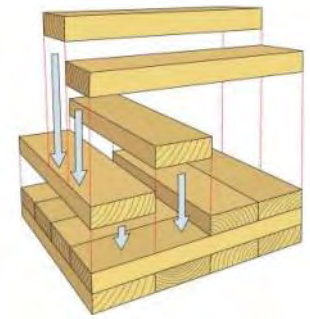
www.woodworks.org/learn/mass-timber-clt/mass-timber-business-case/







WHAT IS MASS TIMBER?



Structuremag

"Mass timber is a category of framing styles typically characterized by the use of large solid wood panels for wall, floor, and roof construction."

American Wood Council (AWC)

Light-Frame Wood
Photo: WoodWorks

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)

Plank orientation

Photo: StructureCraft

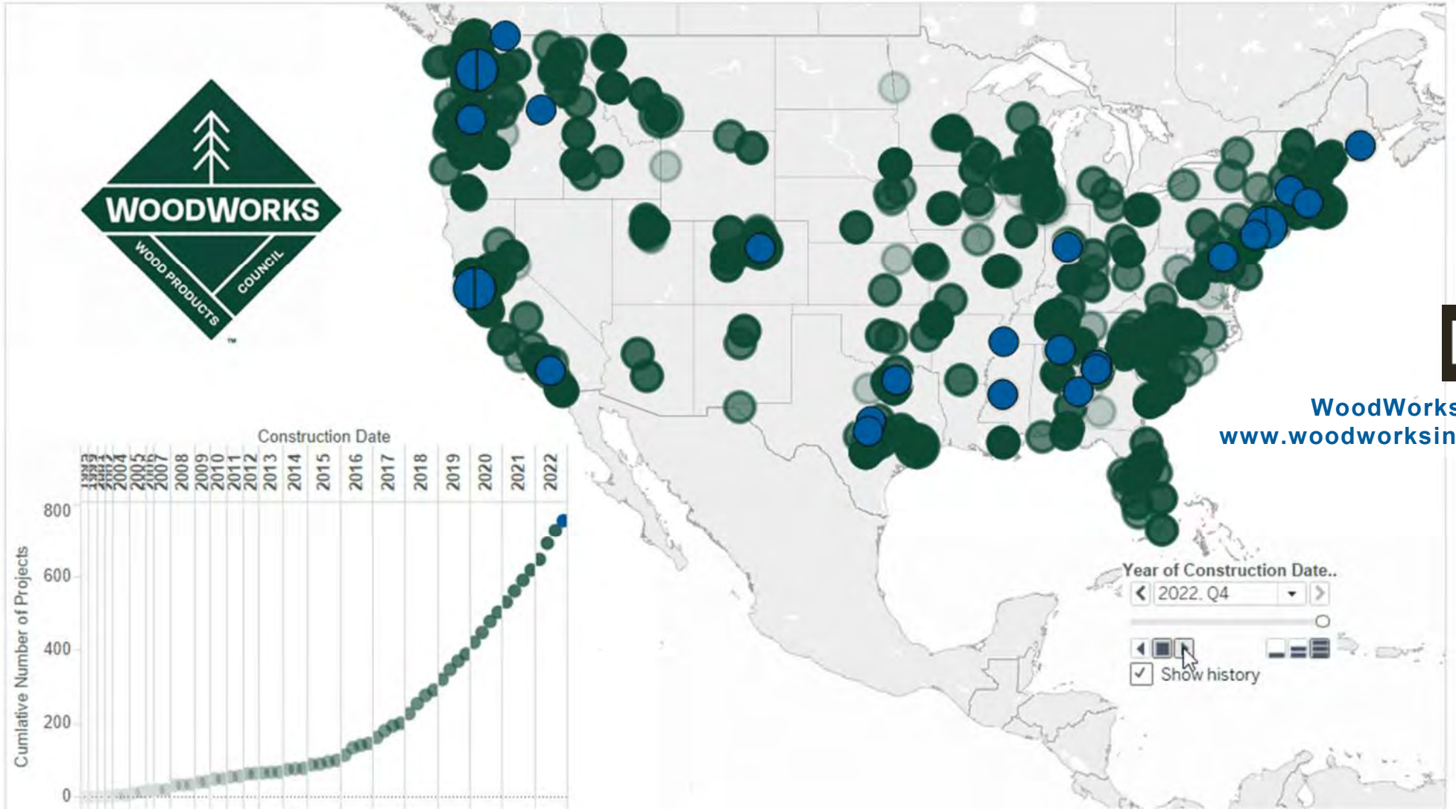
Photo: StructureCraft

Photo: Ema Peter

Photo: Manasc Isaac Architects/Fast + Epp

Current State of Mass Timber Projects

As of December 2022, in the US, **1,667** multi-family, commercial, or institutional projects have been constructed with, or are in design with, mass timber.



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WoodWorks Innovation Network
www.woodworksinnovationnetwork.org

11 tall wood projects already under construction or built.

Carbon 12
Portland, OR
8 stories mass timber

Heartwood
Seattle, WA
8 stories mass timber

Minnesota Places
Portland, OR
8 stories – 7 mass timber

TimberView
Portland, OR
8 stories mass timber

1510 Webster
Oakland, CA
18 stories – 16 mass timber

Ascent
Milwaukee, WI
25 stories – 19 mass timber

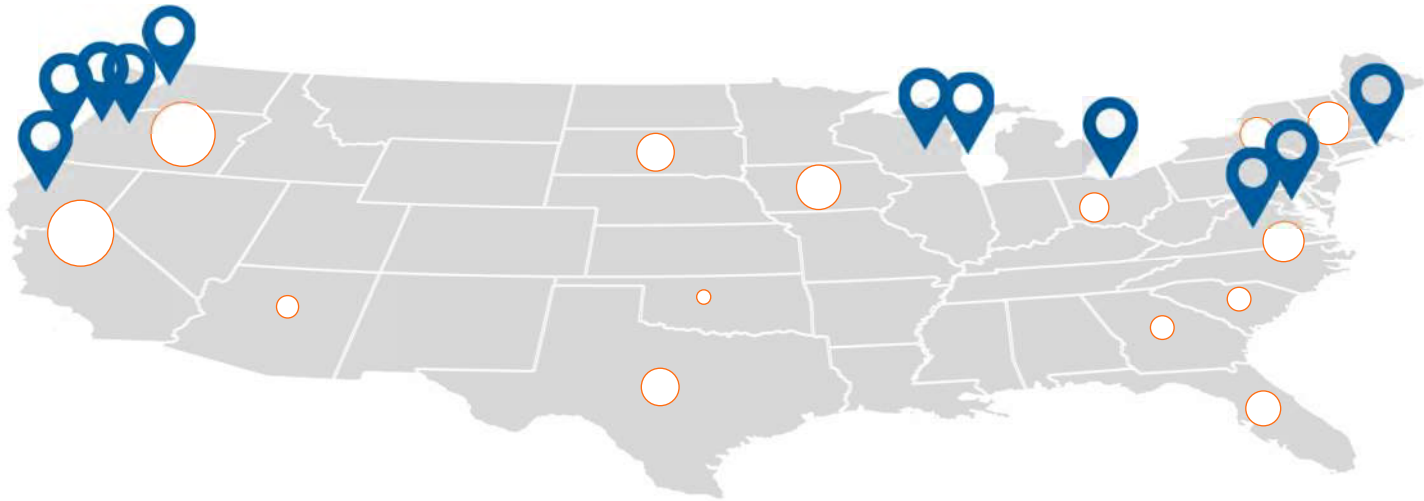
Bakers Place
Madison, WI
15 stories – 12 mass timber

INTRO
Cleveland, OH
9 stories – 8 mass timber

11 E Lenox
Boston, MA
7 stories mass timber

80 M Street
Washington DC
10 stories – 3-story mass timber vertical addition

Apex Plaza
Charlottesville, VA
8 stories – 6 mass timber



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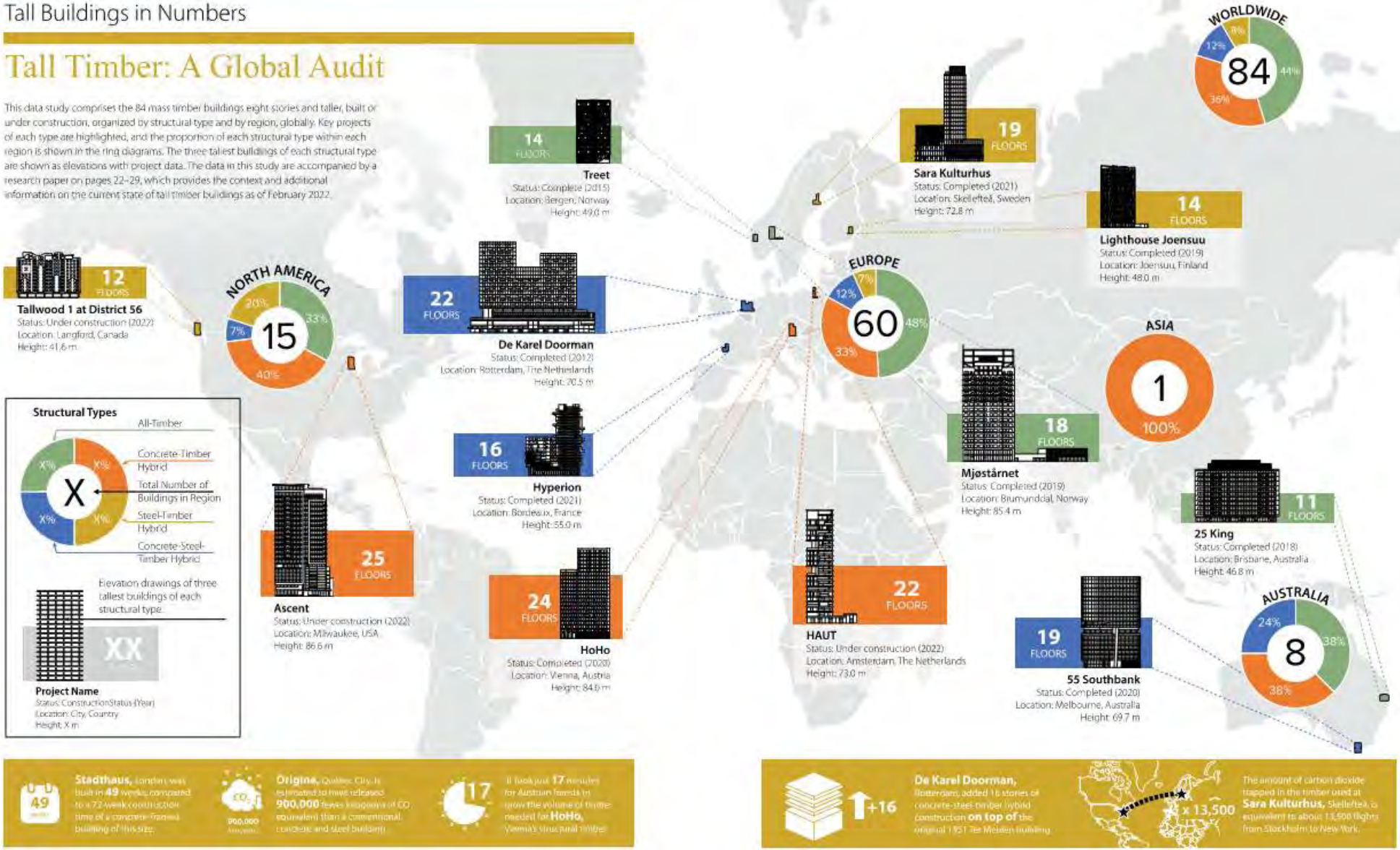
TALL WOOD

= 20 in-design tall wood projects

= tall wood project in construction or completed

WoodWorks is supporting 208 tall wood projects


Tall Buildings in Numbers
Tall Timber: A Global Audit
This data study comprises the 84 mass timber buildings eight stories and taller, built or under construction, organized by structural type and by region, globally. Key projects of each type are highlighted, and the proportion of each structural type within each region is shown in the ring diagrams. The three tallest buildings of each structural type are shown as elevations with project data. The data in this study are accompanied by a research paper on pages 22–29, which provides the context and additional information on the current state of tall timber buildings as of February 2022.
WORLDWIDE
84
12%
8%
44%
36%
14 FLOORS
Treet
Status: Complete (2015)
Location: Bergen, Norway
Height: 49.0 m
19 FLOORS
Sara Kulturhus
Status: Completed (2021)
Location: Skellefteå, Sweden
Height: 72.8 m
14 FLOORS
Lighthouse Joensuu
Status: Completed (2019)
Location: Joensuu, Finland
Height: 48.0 m
12 FLOORS
Tallwood 1 at District 56
Status: Under construction (2022)
Location: Langford, Canada
Height: 41.6 m
NORTH AMERICA
15
20%
33%
7%
40%
22 FLOORS
De Karel Doorman
Status: Completed (2012)
Location: Rotterdam, The Netherlands
Height: 70.5 m
EUROPE
60
7%
12%
48%
33%
ASIA
1
100%
16 FLOORS
Hyperion
Status: Completed (2021)
Location: Bordeaux, France
Height: 55.0 m
18 FLOORS
Mjøstårnet
Status: Completed (2019)
Location: Brumunddal, Norway
Height: 85.4 m
11 FLOORS
25 King
Status: Completed (2018)
Location: Brisbane, Australia
Height: 46.8 m
Structural Types
All-Timber
Concrete-Timber Hybrid
Total Number of Buildings in Region
Steel-Timber Hybrid
Concrete-Steel-Timber Hybrid
X
X%
Elevation drawings of three tallest buildings of each structural type
XX
Project Name
Status: Construction Status (Year)
Location: City, Country
Height: X m
25 FLOORS
Ascent
Status: Under construction (2022)
Location: Milwaukee, USA
Height: 86.6 m
24 FLOORS
HoHo
Status: Completed (2020)
Location: Vienna, Austria
Height: 84.0 m
22 FLOORS
HAUT
Status: Under construction (2022)
Location: Amsterdam, The Netherlands
Height: 73.0 m
19 FLOORS
55 Southbank
Status: Completed (2020)
Location: Melbourne, Australia
Height: 69.7 m
AUSTRALIA
8
24%
38%
38%
49
Stadthaus, London, was built in 49 weeks, compared to a 72-week construction time of a concrete-framed building of this size.
900,000
Origine, Quebec City, is estimated to have released 900,000 fewer kilograms of CO2 equivalent than a conventional, concrete and steel building.
17
It took just 17 minutes for Austrian forests to grow the volume of timber needed for HoHo, Vienna's tallest timber building.
+16
De Karel Doorman, Rotterdam, added 16 stories of concrete-steel-timber hybrid construction on top of the original 1951 Tee Mealen building.
x 13,500
The amount of carbon dioxide trapped in the timber used at Sara Kulturhus, Skellefteå, is equivalent to about 13,500 flights from Stockholm to New York.

TALL MASS TIMBER UNDERSTANDING THE WHY

Brock Commons, Vancouver, BC | Architect: Acton Ostry | Image Courtesy naturallywood

New Buildings & Greenhouse Gases

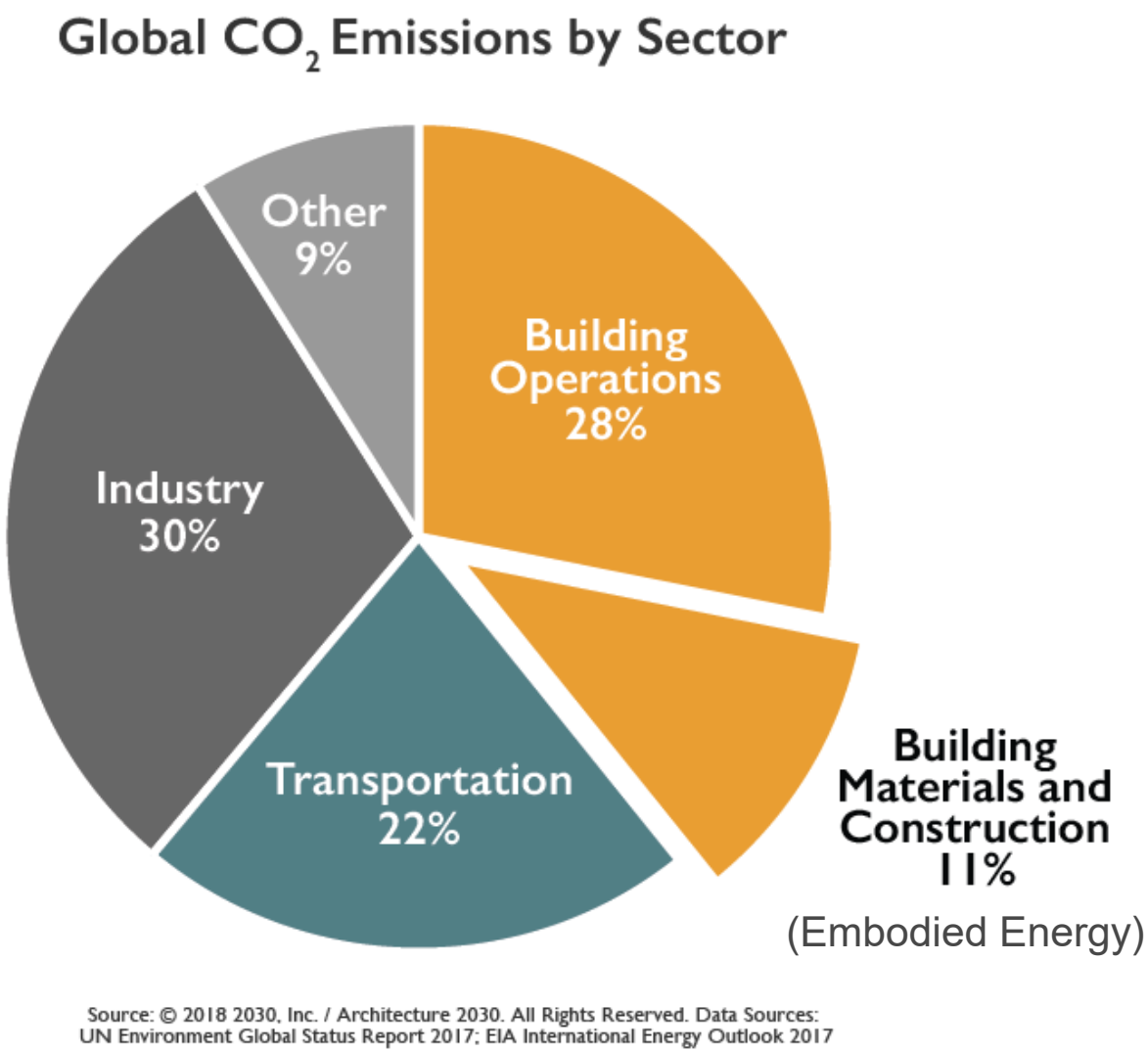


Image: Architecture 2030

Buildings generate nearly 40% of annual global greenhouse gas emissions (*building operations + embodied energy*)

Embodied Energy (11%): Concrete, iron + steel produce approximately 9% of this (Architecture 2030)

Embodied vs. Operational Energy

Traditional Non-Wood Building

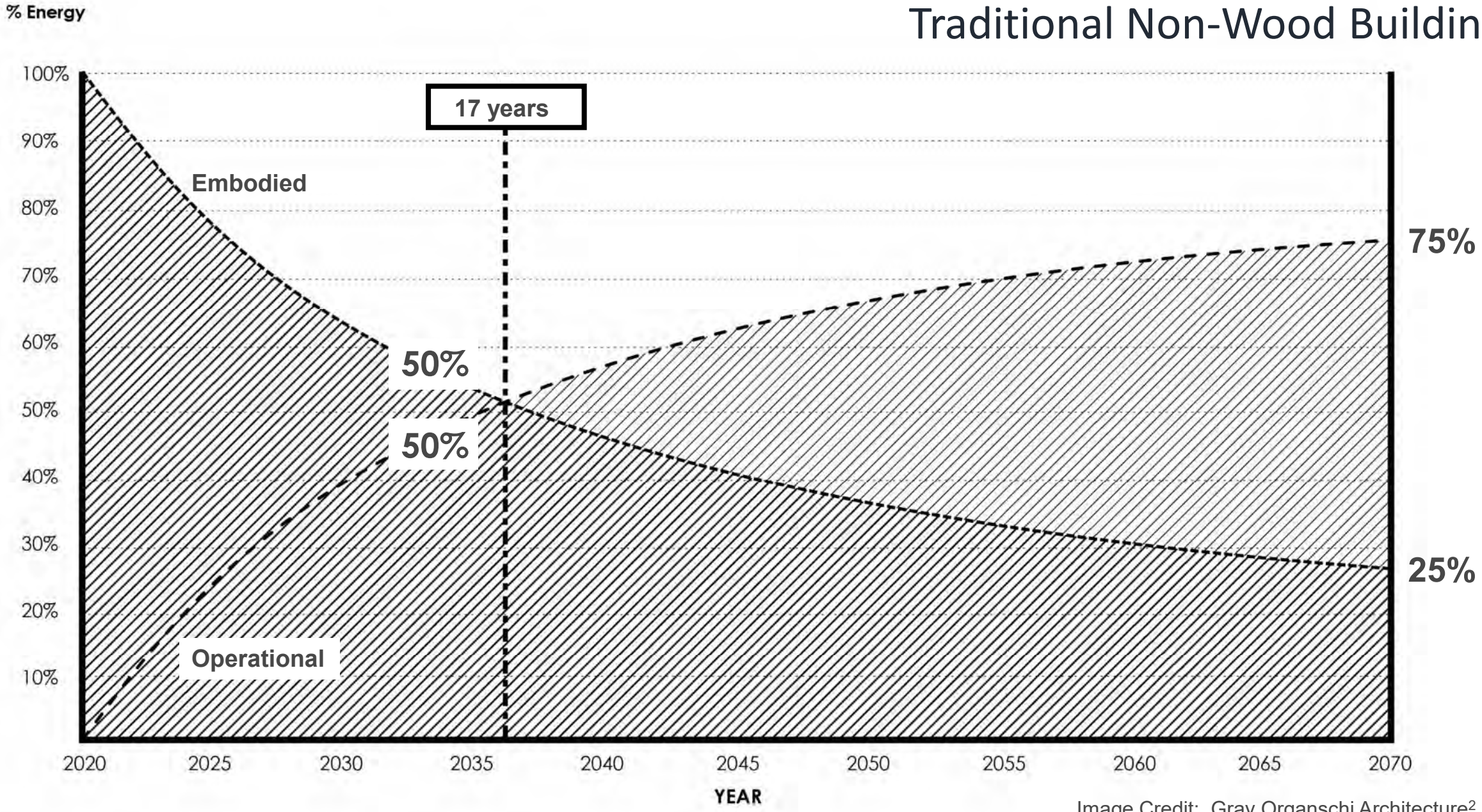


Image Credit: Gray Organschi Architecture[2]

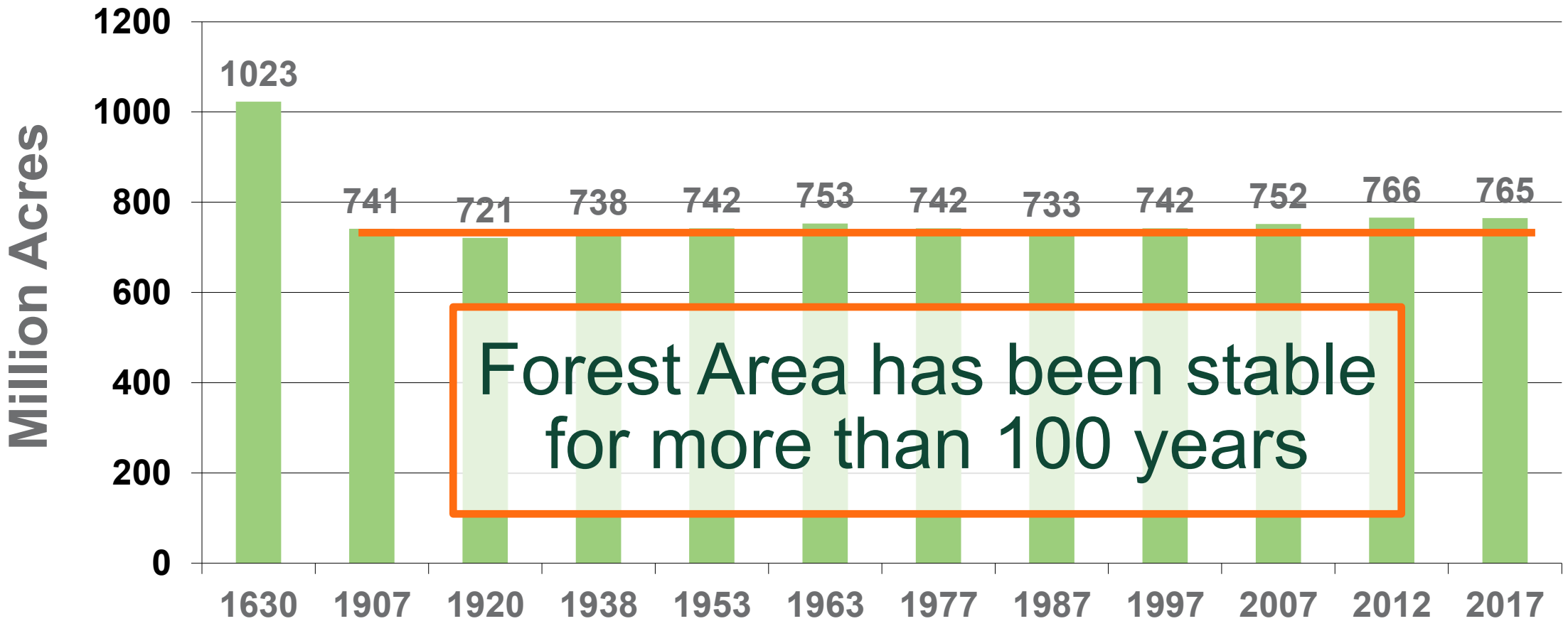
Carbon Storage

Wood ≈ 50% Carbon (dry weight)

Image: Kaiser + Path

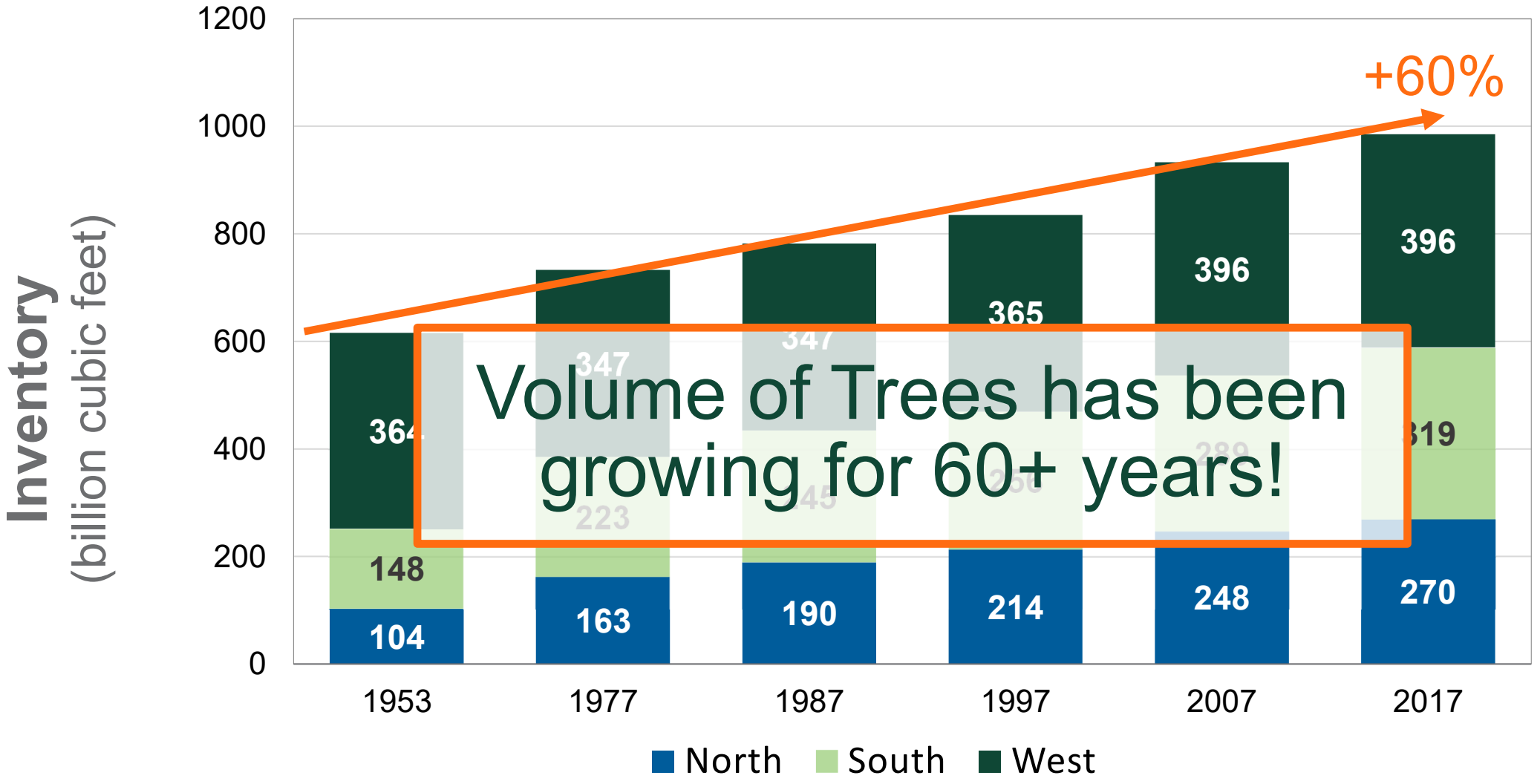
Image: Lever Architecture

U.S. Forest Land:
Forest **Area** in the United States 1630 – 2017



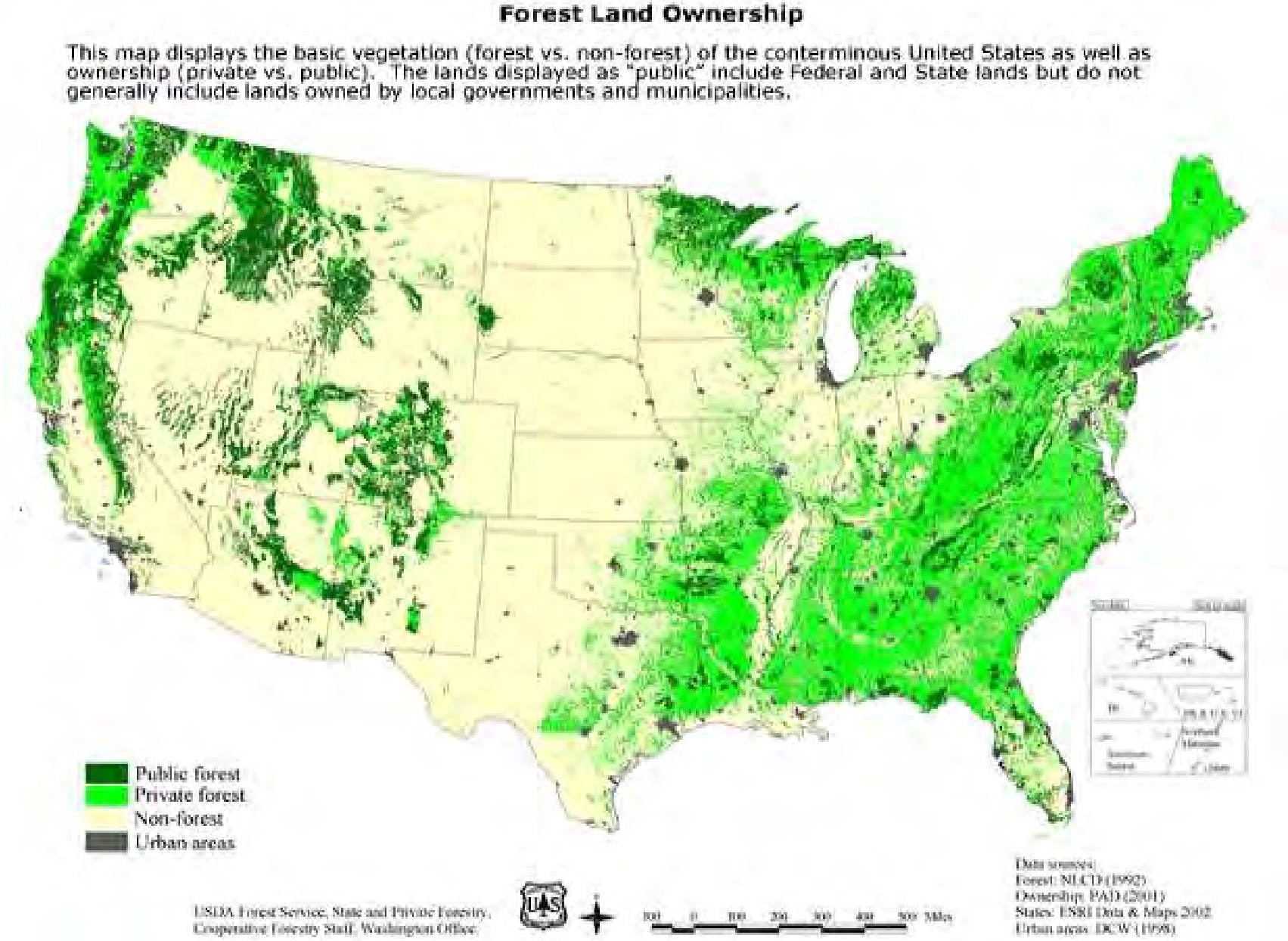
Source: USDA-Forest Service, Forest Resources of the United States, 2017 (2018)

State of our Forests: US Timber Volume on Timberland



Source: USDA-Forest Service, Forest Resources of the United States, 2017 (2018)

US Forest Lands



Biophilia - Structural Warmth is a Value-Add

TMBR (unbuilt) Minneapolis, MN | Images: D/O Architects

Study of Wood vs. Non-wood Finishes

Wood and Human Health

- Univ. of British Colombia & FP Innovations study
- 4 rooms: white furnishings vs. wood furnishings; plants vs. no plants

"Stress, as measured by sympathetic nervous system activation, was lower in the wood room in all periods of the study."

Source: *Wood and Human Health* https://www.woodworks.org/wp-content/uploads/2014-SE-WSF-Fell-Healthy-Buildings.pdf

Workplaces: Wellness + Wood = Productivity
Healthy Buildings/ Biophilia

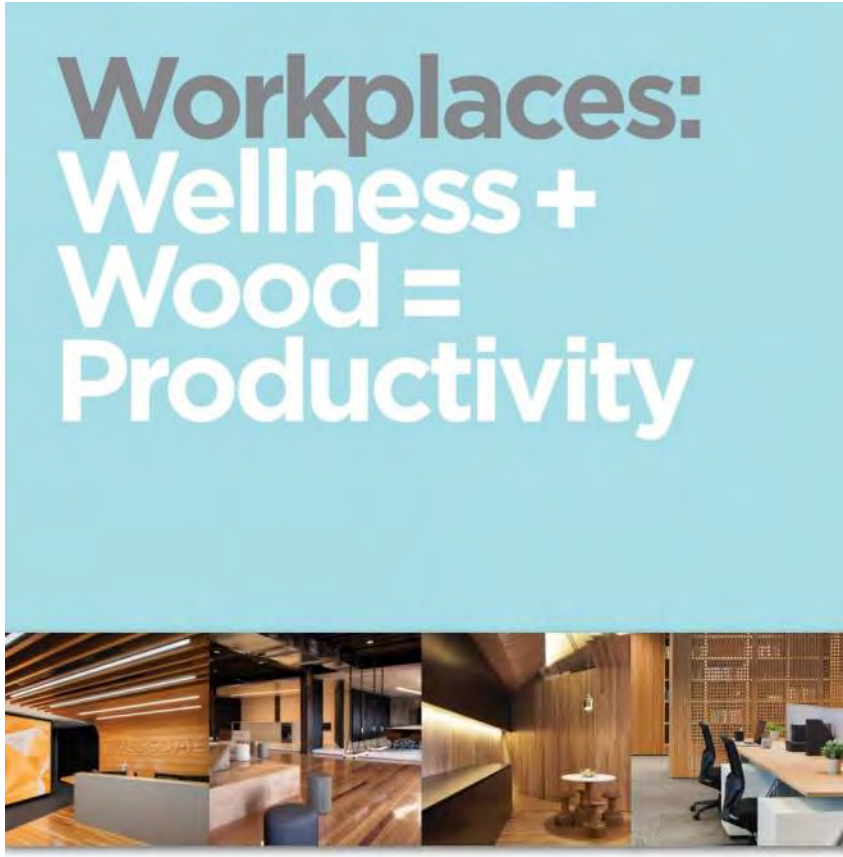
"Those in workplaces with a higher proportion of **visible wood** **feel more connected to nature** and rate their working environment far more positively."

These people report:

- lower stress levels
- higher concentration
- improved overall mood

"Wood in the workplace is associated with **higher productivity** and **reduced sick leave**."

Report based on survey of 1,000 typical Australians working indoors



George Fox University – Canyon Commons
Hacker | Photo: Jeremy Bittermann

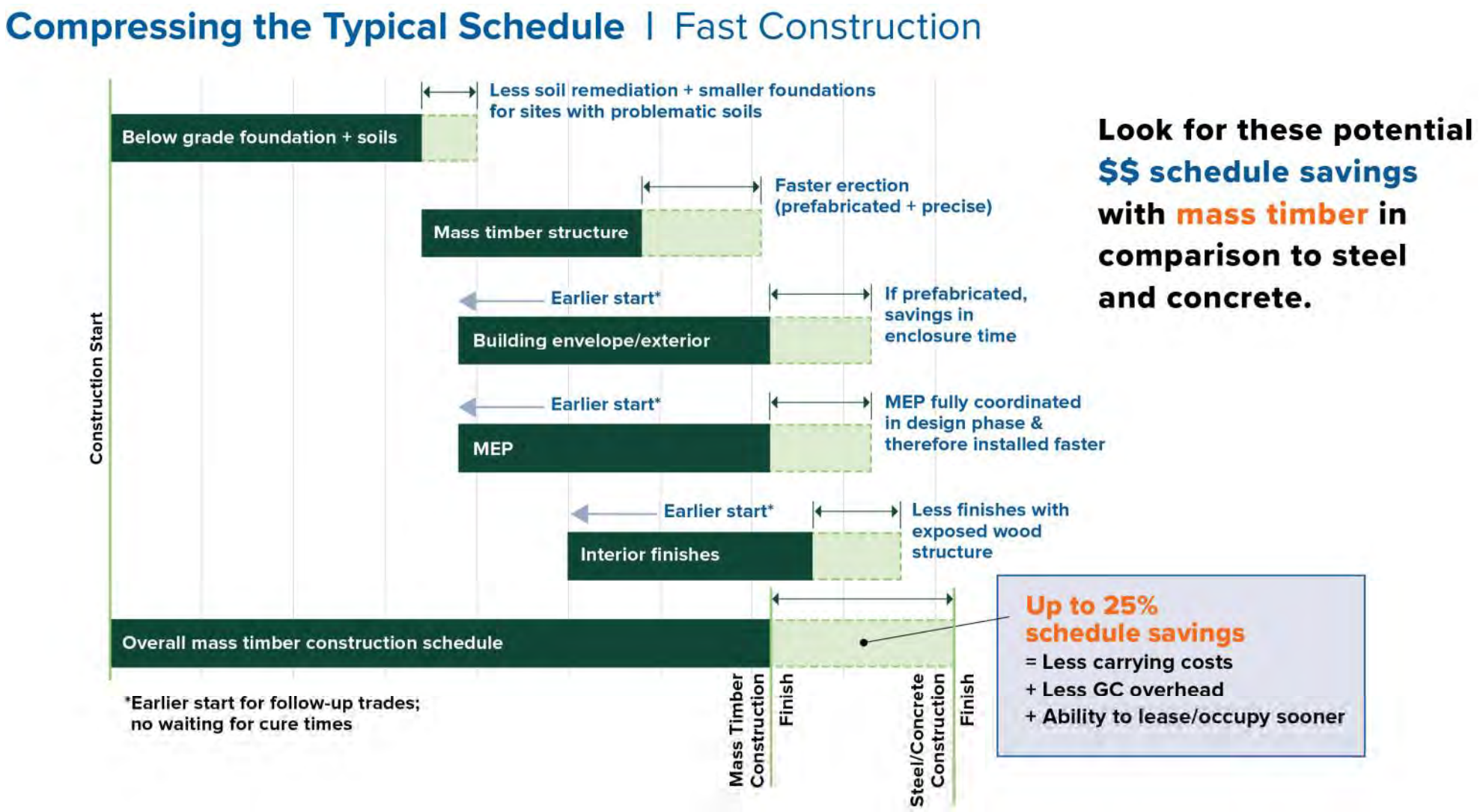
Material Mass
75% Lighter weight than concrete

- smaller cranes
- more efficient seismic systems

Construction Impacts: Labor Availability

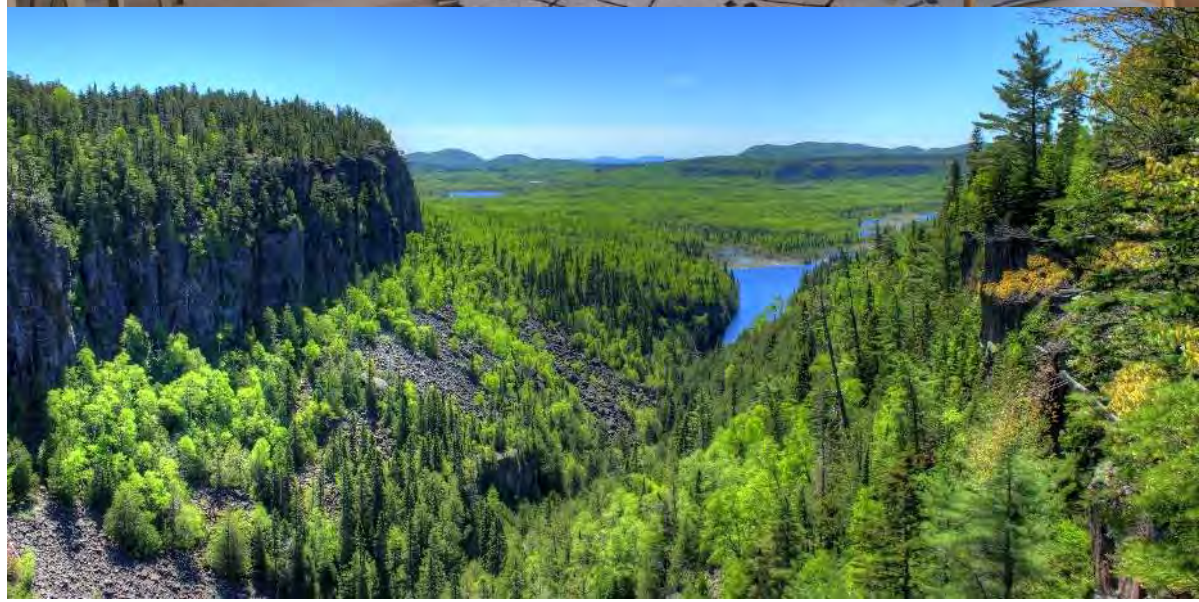
Construction Impacts: Schedule

Up to 25% Faster

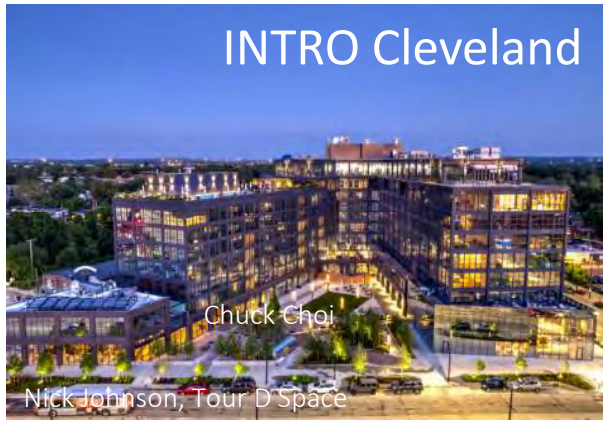


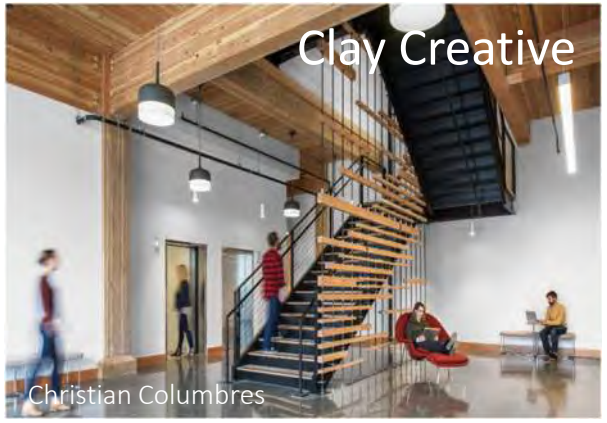
WHY MASS TIMBER?

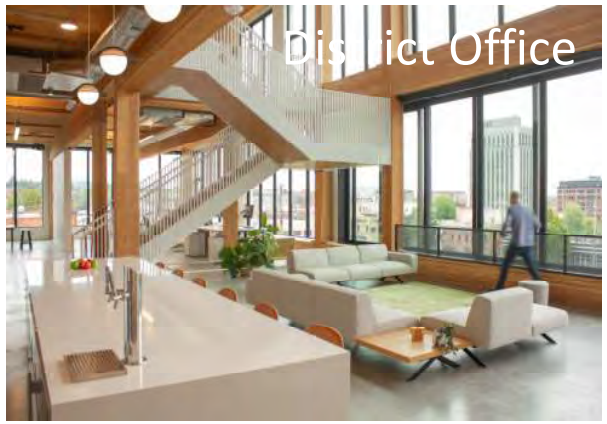
- Sustainability
  - Renewable resource
  - Low Fabrication Emissions
- Aesthetics
  - Connection to nature / biophilia
  - Intrinsic Beauty and Appeal
- Construction
  - Increased Speed of Construction
  - Prefabrication
  - Fit-Out
  - Smaller Crew Sizes
  - Reduced Weight
  - Lighter Foundations



Mass Timber Business Case Studies: Value Creation Analysis







Scan to download

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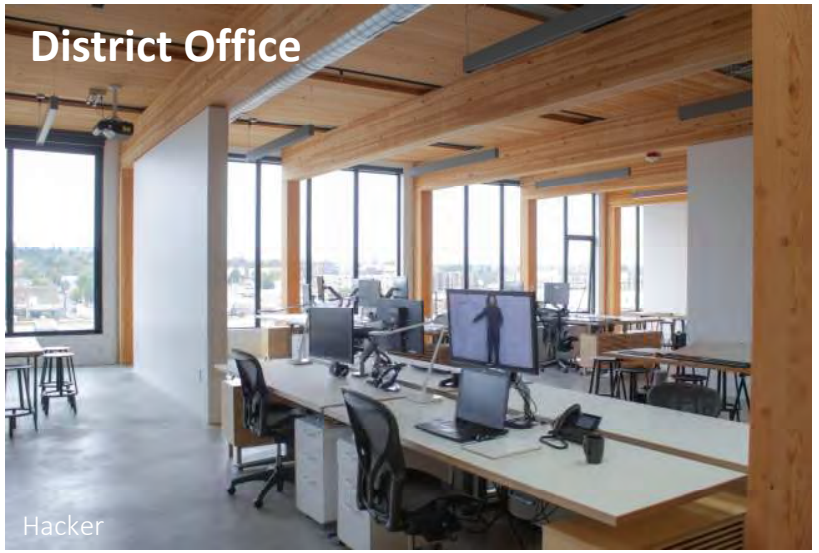
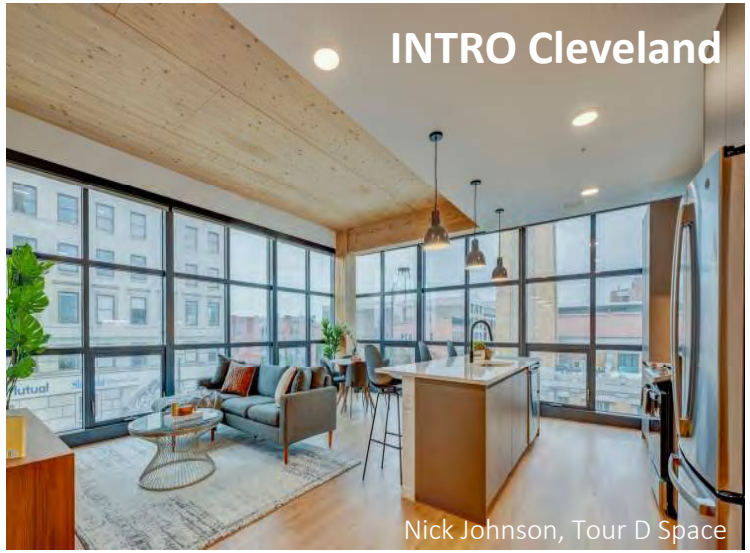
Mass Timber Business Case Studies: Value Creation Analysis

Development Overview
- Property Information
- Product Strategy
- Investment Highlights

Qualitative Discussion
- Challenges
- Lessons Learned
- Successes

Quantitative Overview
- Development Timeline
- Costs
- Rents
- Lease up





Comparative Return Analysis

	Market	Pro Forma	Realized
Yield on cost	6.25%	7.00%	7.35%
Cap rate	4.75%	4.50%	TBD
Value/rentable SF	$550/ RSF	$717/ RSF	TBD ($800+/ RSF)
Leverage	65%	65%	N/A

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CONRAD INVESTMENT MANAGEMENT

Multifamily | Office | Industrial | Student Housing

Contributors

Contributing Developers/Owners & Investors

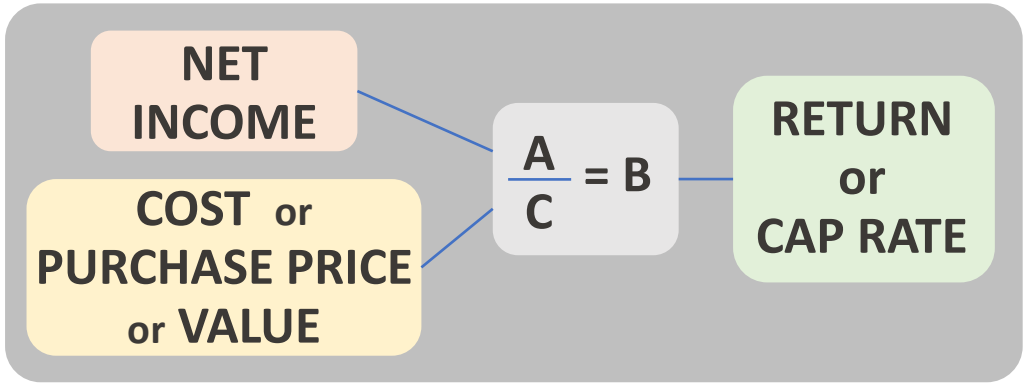
Lead Analysis Team

We are grateful to the developers, owners and investors who have publicly shared their stories and financial data in these case studies.

The study uses simple, industry standard means of understanding economic viability

- Net Income (cashflows)
- Cost to develop (purchase price)
- Cap rate (initial return, excluding loans)

Levers for Value Creation



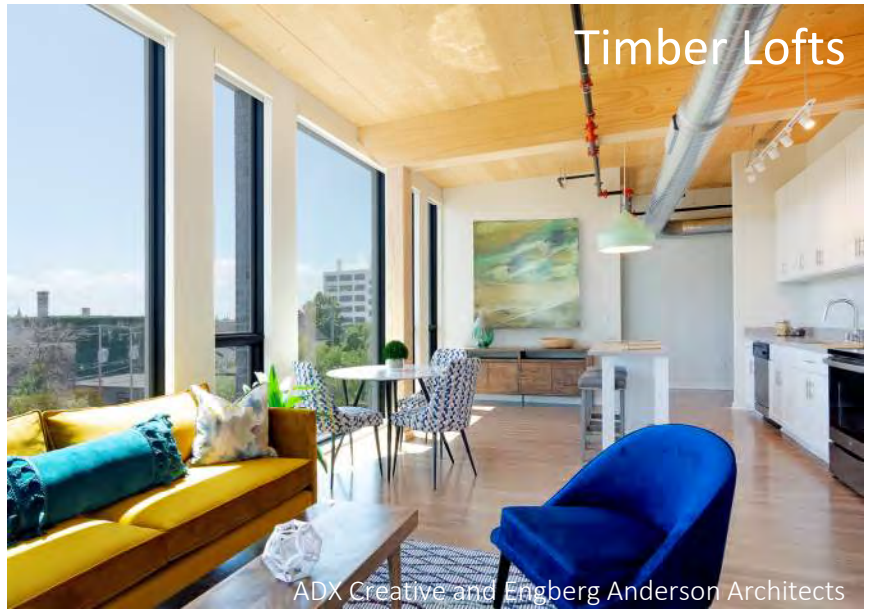
Office & Multifamily Tend to:

Lease up faster than submarket norms; which translates to:

- Higher net income
- Lower income volatility
- Better IRR
- Lower risk via quicker to refinance/ sell

Attract quality tenants; which translates to:

- Better rent collection
- Better (lower) cap rates
- Better (stable) occupancy

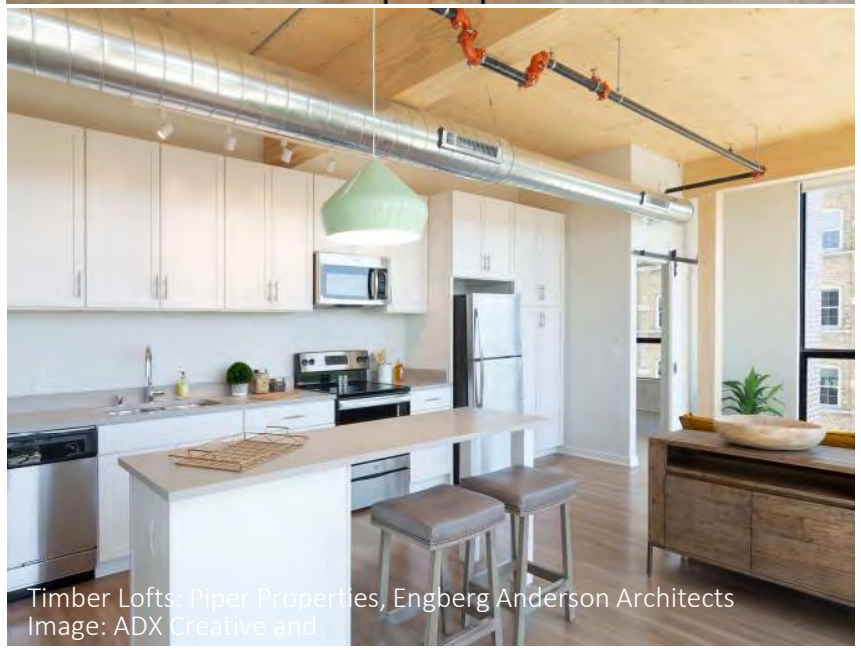


Ascent: New Land Enterprises, Weichmann Enterprises
Image: C.D. Smith Construction

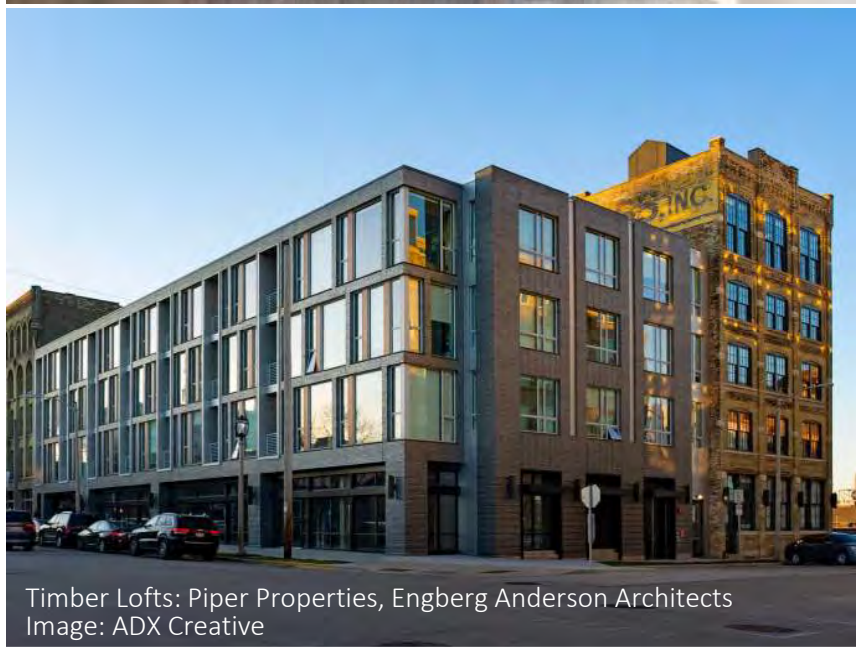
INTRO Cleveland: Harbor Bay Ventures
Image: Nick Johnson, Tour D Space

The Canyons: Kaiser Group
Image: Jeremy Bittermann

Adohi Hall, University of Arkansas
Image: Timothy Hursley



Timber Lofts: Piper Properties, Engberg Anderson Architects
Image: ADX Creative and



Timber Lofts: Piper Properties, Engberg Anderson Architects
Image: ADX Creative

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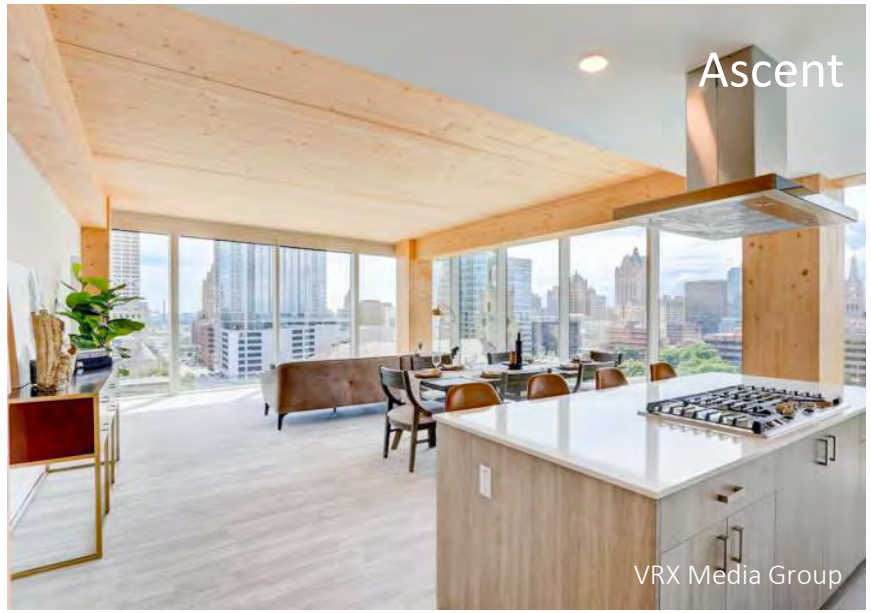
INVESTMENT MANAGEMENT

Mass Timber Business Case Studies

December 2022

Residents respond to "look & feel"

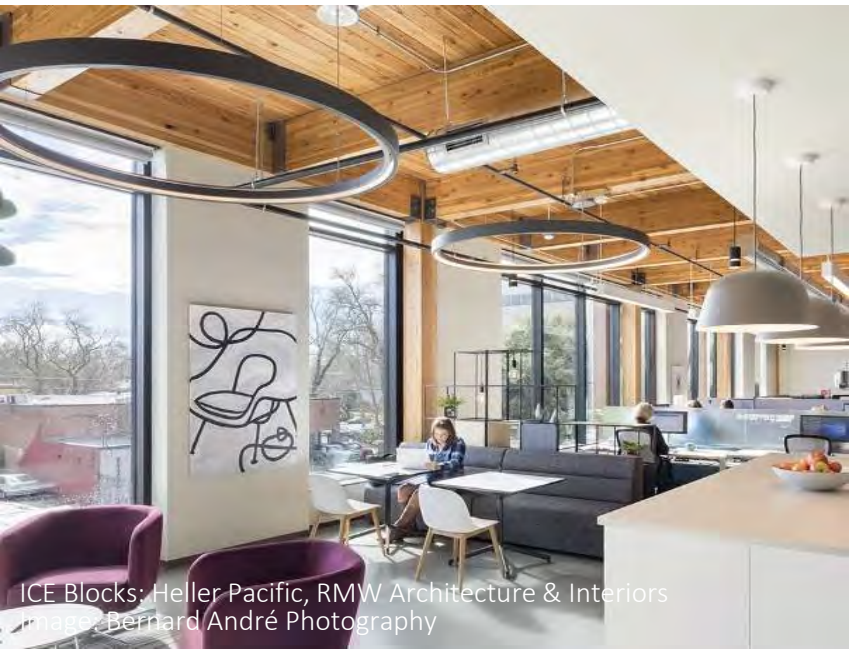
- Aesthetics seem to be broadly appealing; wider target markets = better market demand
- Robust pre-leasing = lower costs & risks
  - More income sooner = lowers operating & interest budgets
  - Faster to stabilization = faster to refinance
- Tangible distinction = mitigates future supply risk
- Tangible realization of desired brand identities



1 De Haro: SKS Partners, Perkins & Will
Image: David Wakely

Clay Creative
Image: Christian Columbres

Platte Fifteen: Crescent Real Estate, Oz Architecture
Image: Arch Angle Media



ICE Blocks: Heller Pacific, RMW Architecture & Interiors
Image: Bernard André Photography

District Office: UD+P, Beam Development, Hacker
Image: Hacker

Boulder Industrial Warehouse: Mojo Partners
Image: WoodWorks

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INVESTMENT MANAGEMENT

Mass Timber Business Case Studies

December 2022

Firms Attracted for Myriad Reasons

- Most tenants are "creditworthy"
- Desire intangible stakeholder benefits
  - Workforce Desires
  - Regulatory Perceptions
  - Brand Position
- Tend to see impressive pre-leasing
  - Enables better construction debt
  - Sets perceptions of desirable development
- Seeing sustained occupancy via subleasing
  - Tested by COVID disruptions

WOODWORKS
WOOD PRODUCTS COUNCIL

Mass Timber Business Case Study

Ascent: Project Team

Development Team:
New Land Enterprises
Wiechmann Enterprises

Lenders
Mezzanine: **Hines Realty Income Fund**
Senior: **Bank OZK**

Investors:
Local high net worth + Crowd funding (Realty Mogul)

Architect
Korb + Associates Architects

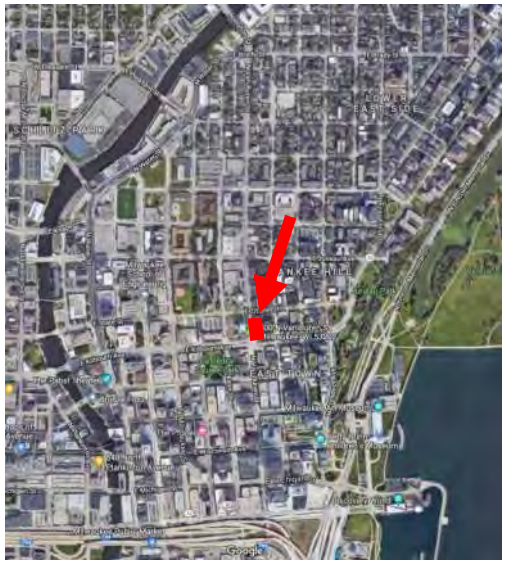
Structural Engineer
Thornton Tomasetti

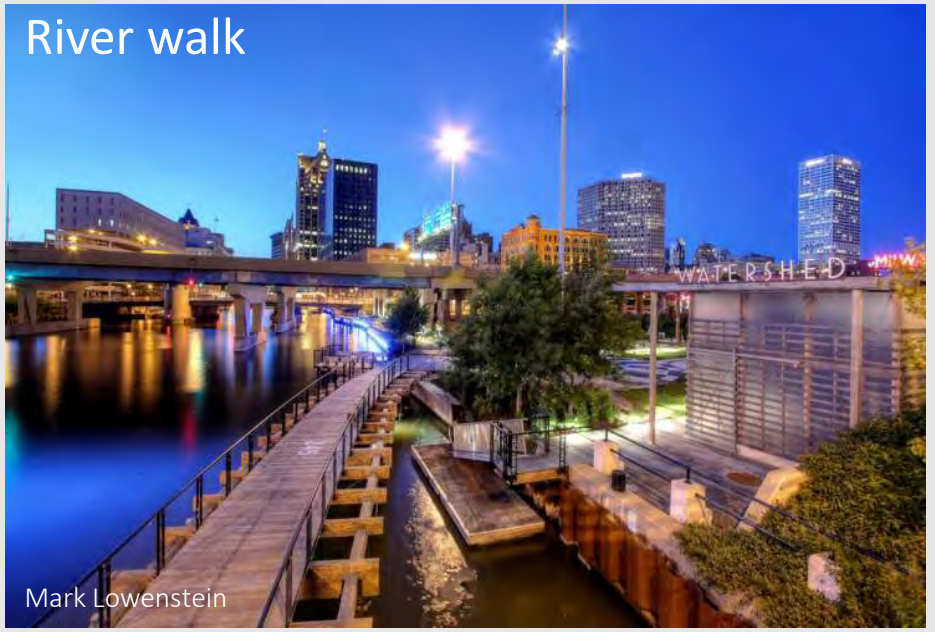
Contractors
C.D. Smith Construction
Catalyst Construction

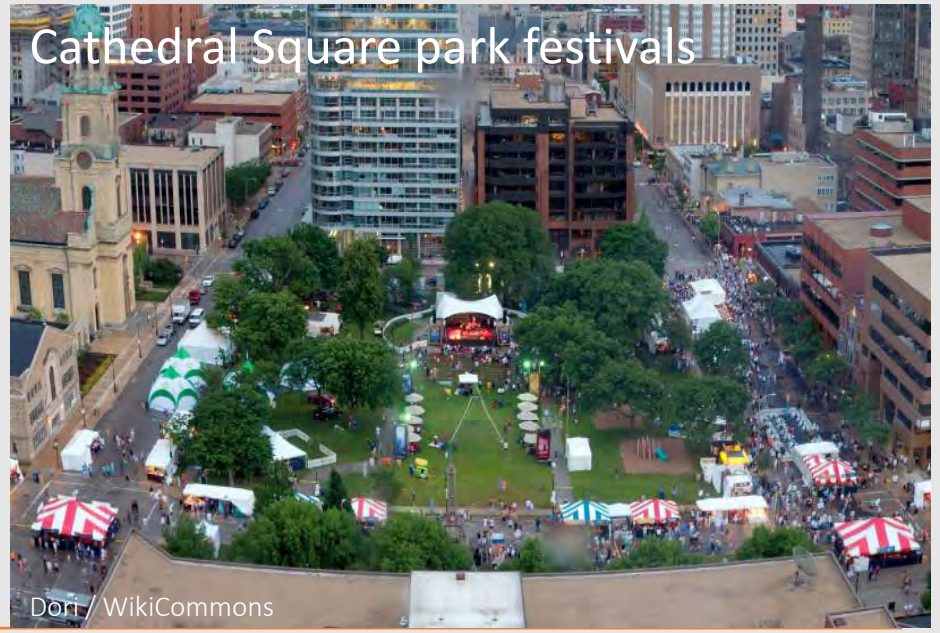

Kat Doughty

Milwaukee's East Town Market

- **East Town:** Revitalizing the northern edge of downtown, where cultural institutions, lakefront parks and water access bridge to desired residential areas
- **Neighborhood:** Large corporations and healthcare drive employment for Milwaukee.







ASCENT:
The building will sequester approximately 7,200 metric tons of CO_2.

It will take approximately 25 minutes to grow this volume of wood in North American forests.

This CO_2 benefit is also equivalent to taking approximately 2400 cars off the road for a year or the energy to operate over 1100 homes for a year.

Development Overview

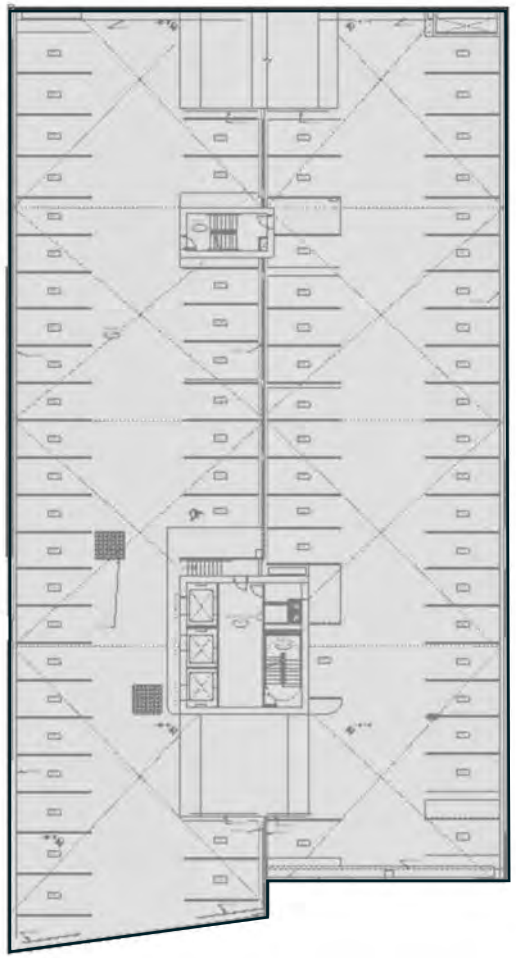
- 284’ tall, 25-story apartment tower; world’s tallest timber structure at the time of construction
- 19 stories of mass timber over 6 story parking podium
- Strategy: reset Milwaukee standard for luxury high-rise living while appealing to a broad market segment
- Approval pursued under WBCB Section 361 (similar to 2015 IBC’s “Alternate Materials, Design and Methods”)
- ~50% of Mass Timber Exposed

Property Information	
Property timing	Delivered July & August 2022
Submarket	Milwaukee’s East Town
Construction Type	4 (w/ fire ratings for high-rise)
Site size	28,504 SF /.65 acres
Gross building area	493,000 SF 273,000 SF mass timber
Net rentable/saleable area	279,475 SF

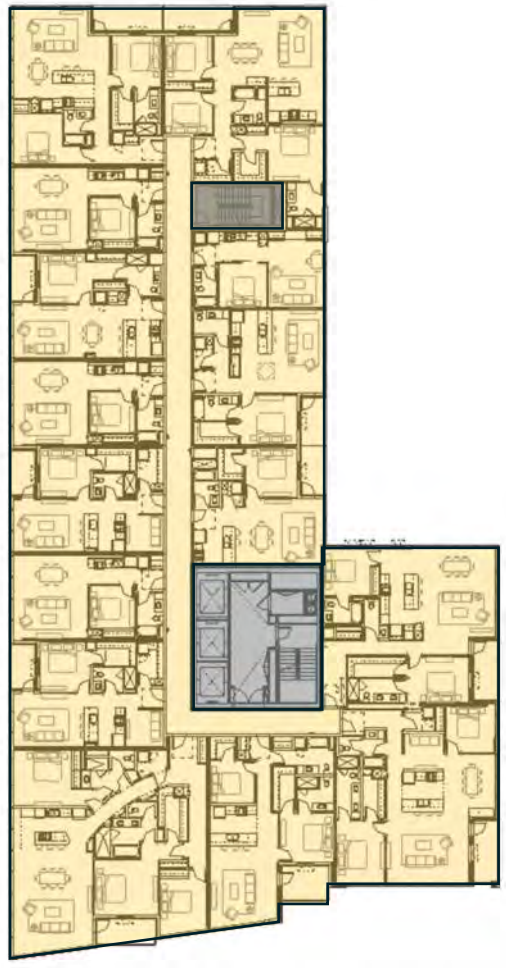
VRX Media Group

ASCENT:

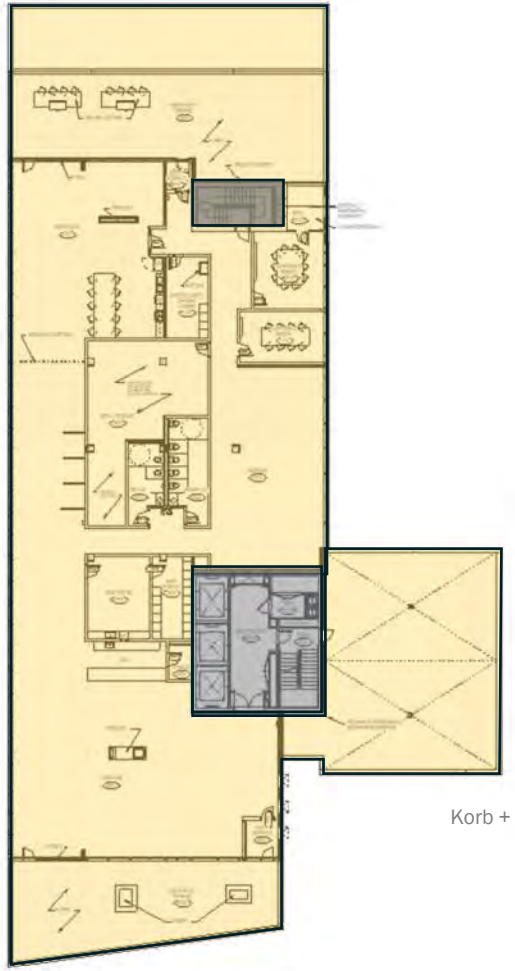
Typical Floor Plans:



TYPICAL PARKING LEVEL



TYPICAL RESIDENTIAL LEVEL



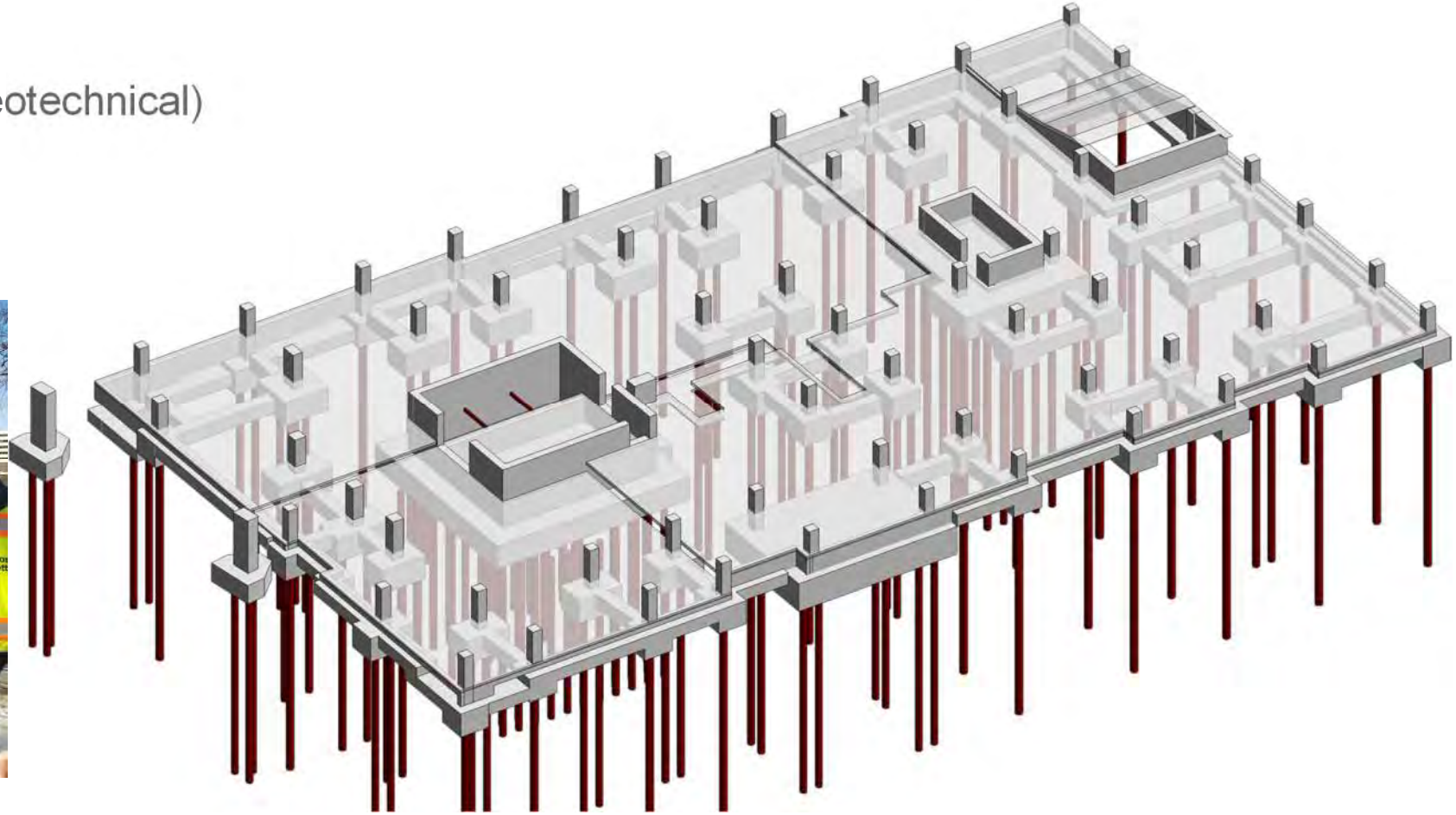
AMENITIES LEVEL (L25)

Korb + Associates

ASCENT STRUCTURE

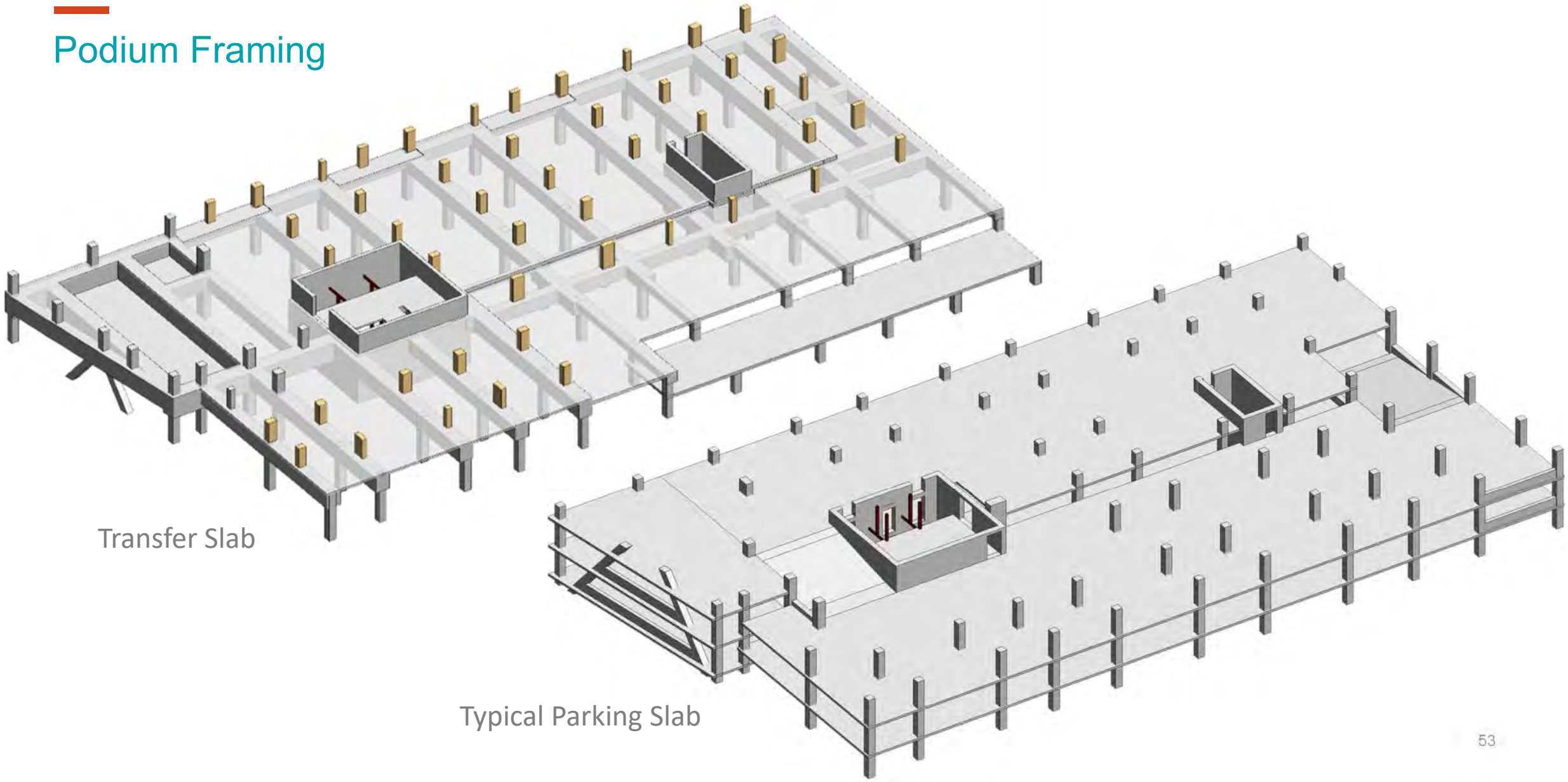
Foundation

- Light weight superstructure
- Static Load Test: 450 Tons (Geotechnical)
    - Limited by reaction frame!



ASCENT STRUCTURE

Podium Framing

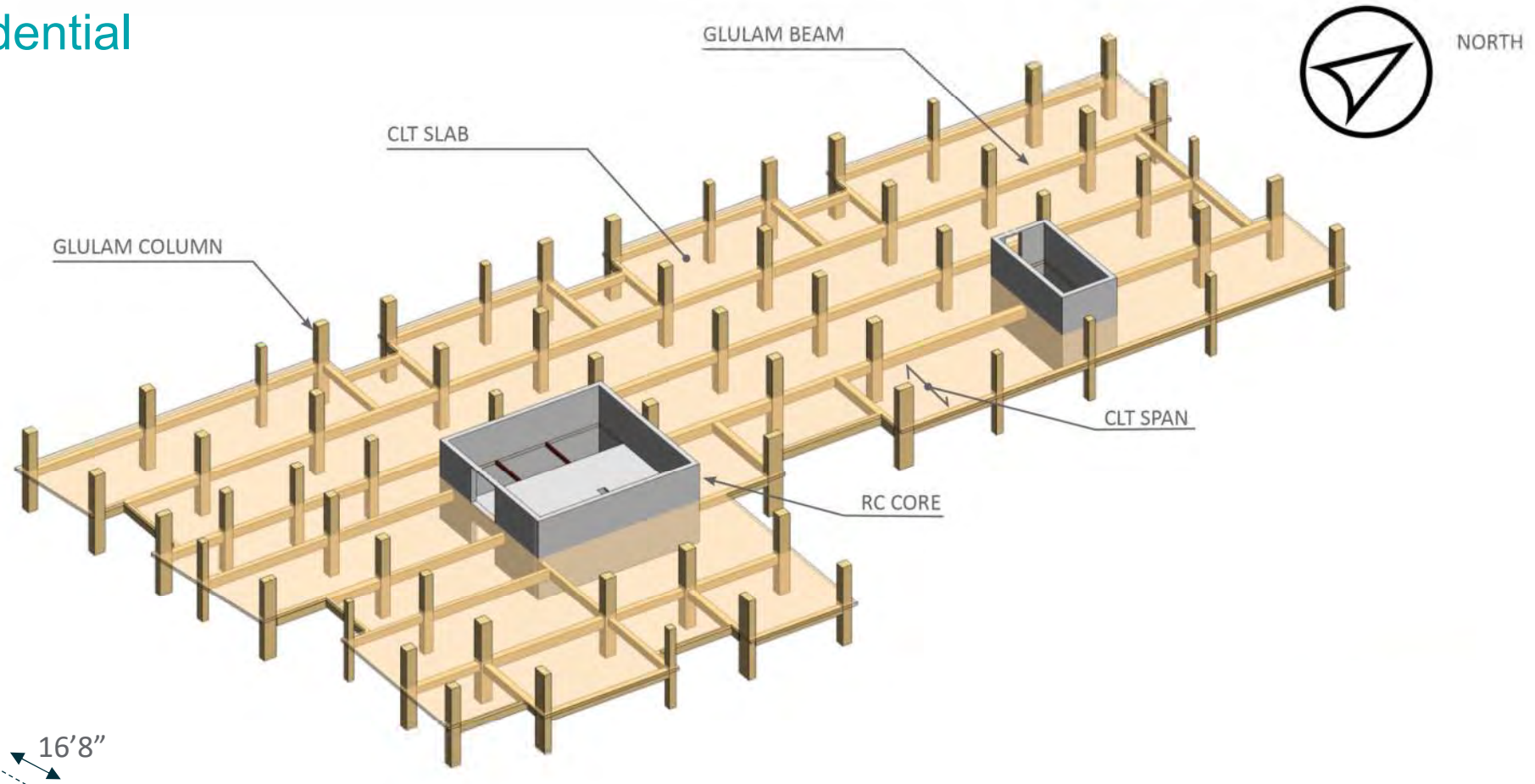


Transfer Slab

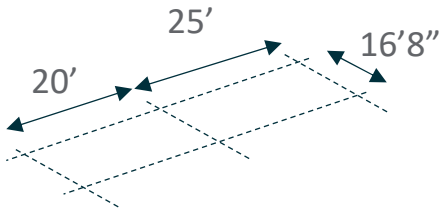
Typical Parking Slab

ASCENT STRUCTURE

Typical Residential

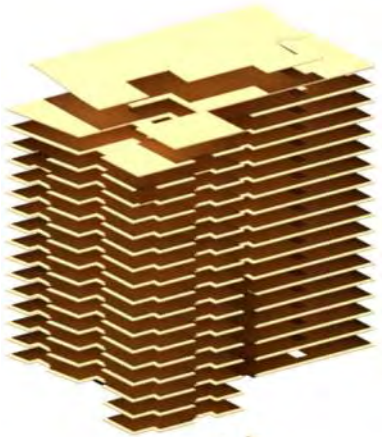


TYPICAL GRID



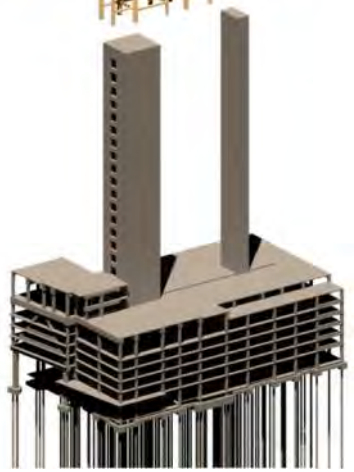
ASCENT STRUCTURE

Systems



SLABS (CLT)

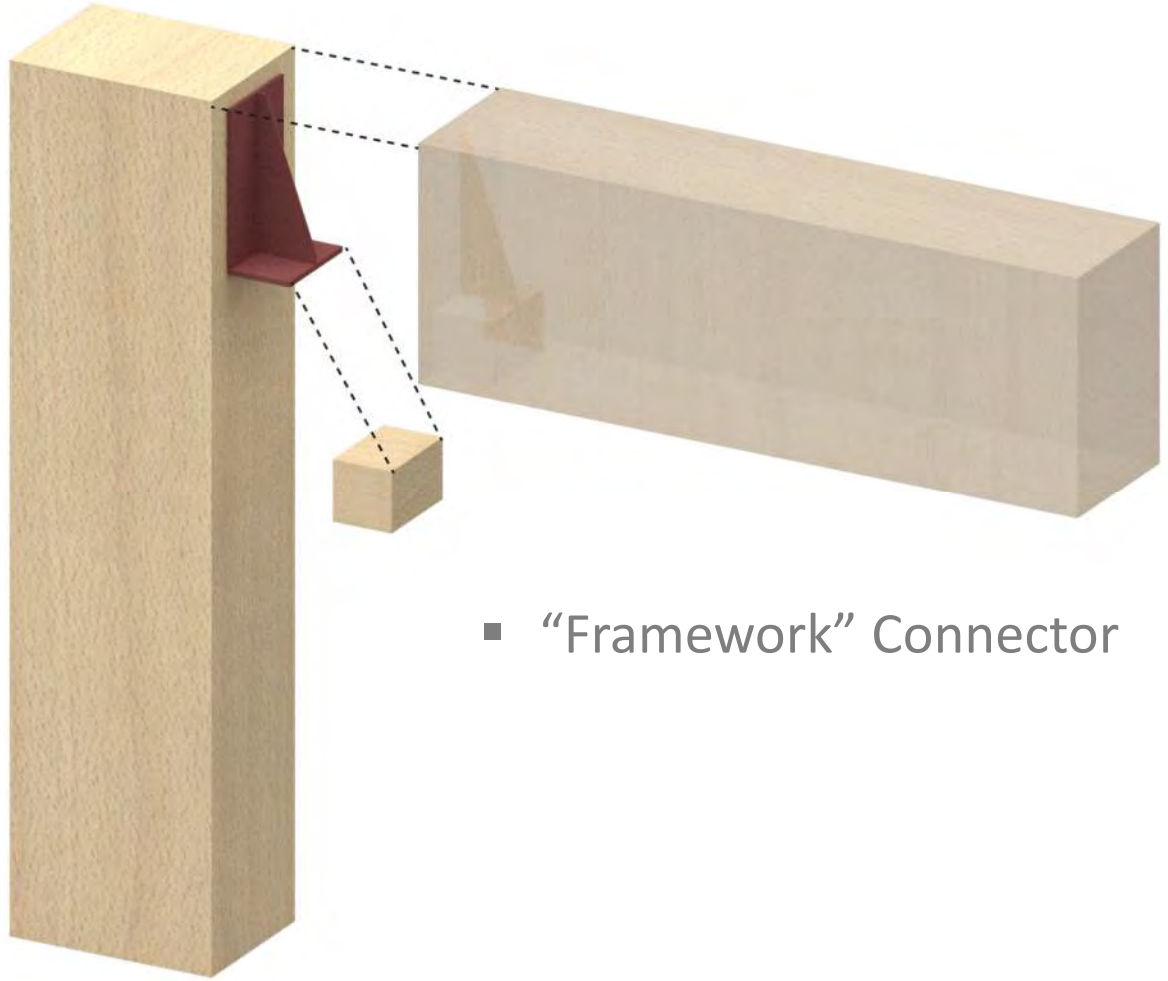
BEAMS + COLUMNS (GLULAM)



PODIUM AND LATERAL SYSTEM (CONCRETE)

ASCENT CONNECTIONS

Exposed



- “Framework” Connector

ASCENT CONNECTIONS

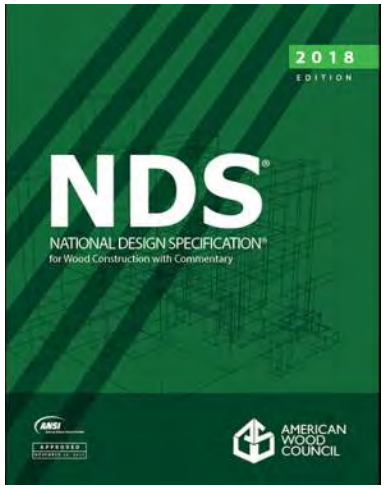
Concealed

- Wood-Wood Bearing

MASS TIMBER

Material Considerations

- Visual Appearance vs. Material Properties
- Design Methodology
- Code Compliance (NDS vs. Eurocode)



Spruce

Douglas Fir

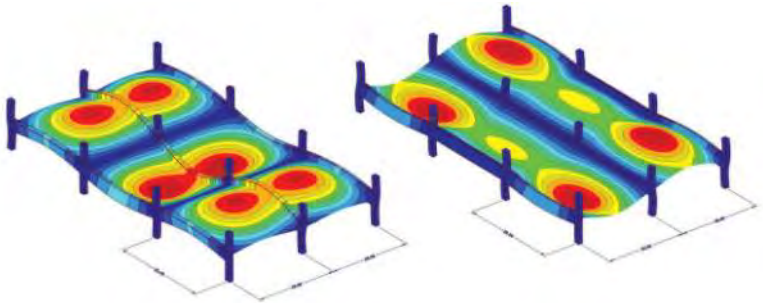
Yellow Pine

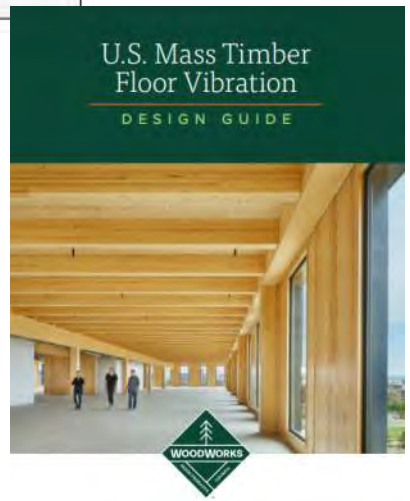
Smartlam

MASS TIMBER

Sound and Vibration Considerations

Category	Range of Damping ζ (% critical)	Discussion
Lightly damped	1-2%	The lower end includes bare floors without topping and with minimal furnishing. The higher end includes floors with concrete topping and furnishings.
Moderately damped	2-4%	Lower values include bare timber-concrete composite floors, or timber floors with a floating concrete layer and full furnishings. The higher values include floors with floating floor layers, raised floors, full furnishings and mechanical systems. Floors with both furnishings and permanent partitions, not otherwise accounted for, could also be represented at the higher end of this damping range.
Heavily damped	4-5%	Floors in this range represent the upper limit of inherent damping. These floors likely include floating toppings, raised floors, suspended ceilings, furnishings, fixtures and/or permanent partitions not otherwise taken into account.
Explicit damping control	5%+	Generally, mass timber floors do not have more than 5% damping unless explicit damping control (e.g., a tuned mass damper) is added. These systems are beyond the scope of this guide.

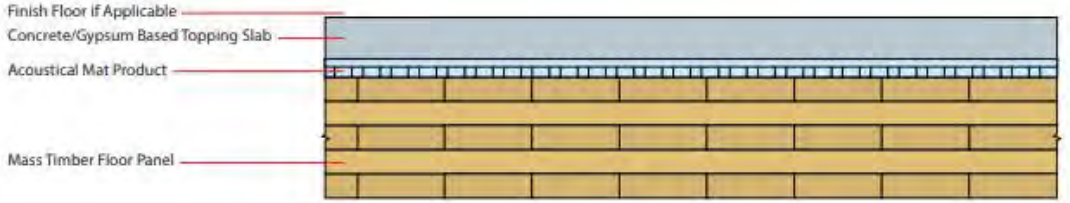


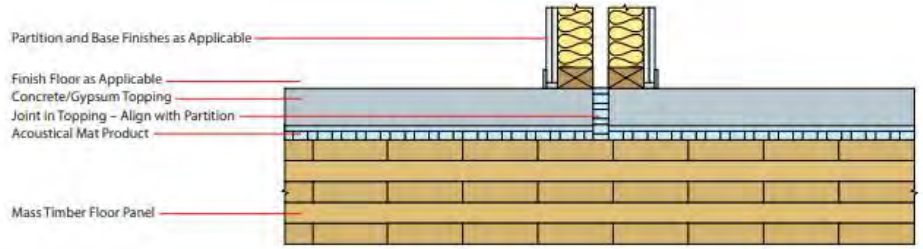


Acoustical floor underlayments

Typical Mass Timber Floor Assembly

Section View

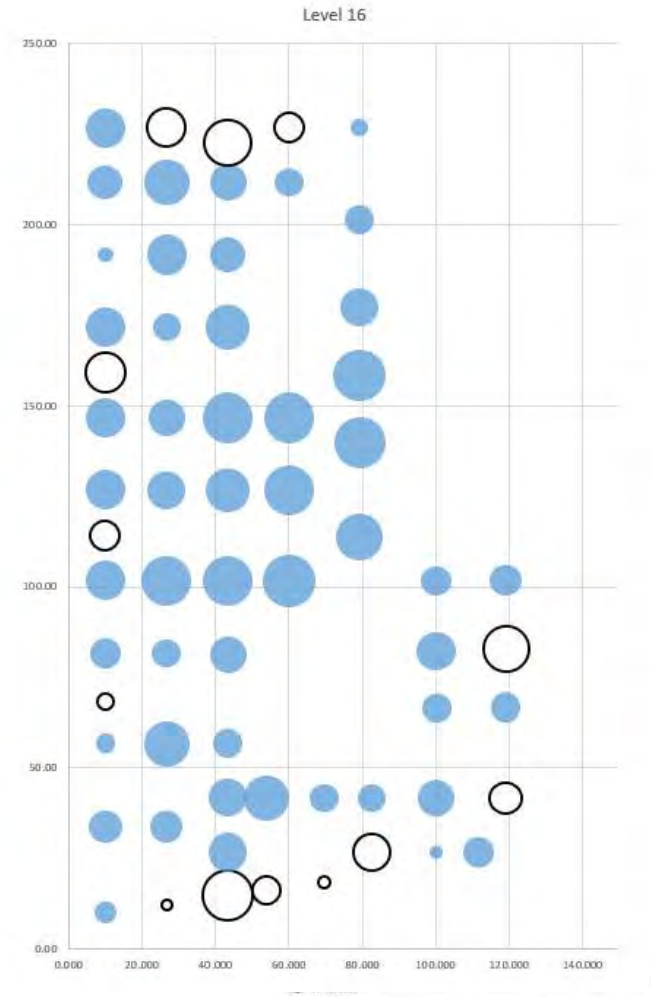


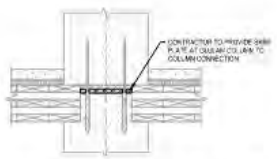


Richard McLain - Woodworks

MASS TIMBER

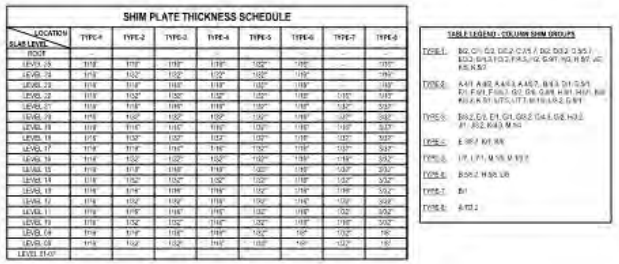
Vertical Compensation and Surveying

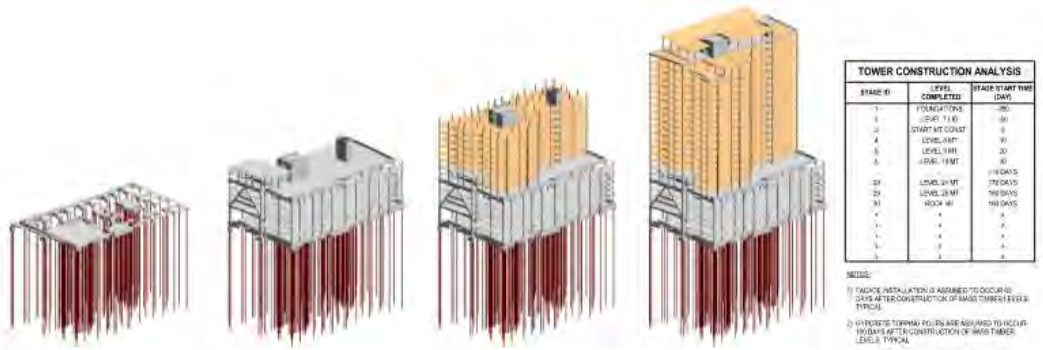




SHIM PLATE FOR VERTICAL ELEVATION ADJUSTMENT

SHIM PLATE THICKNESS SCHEDULE



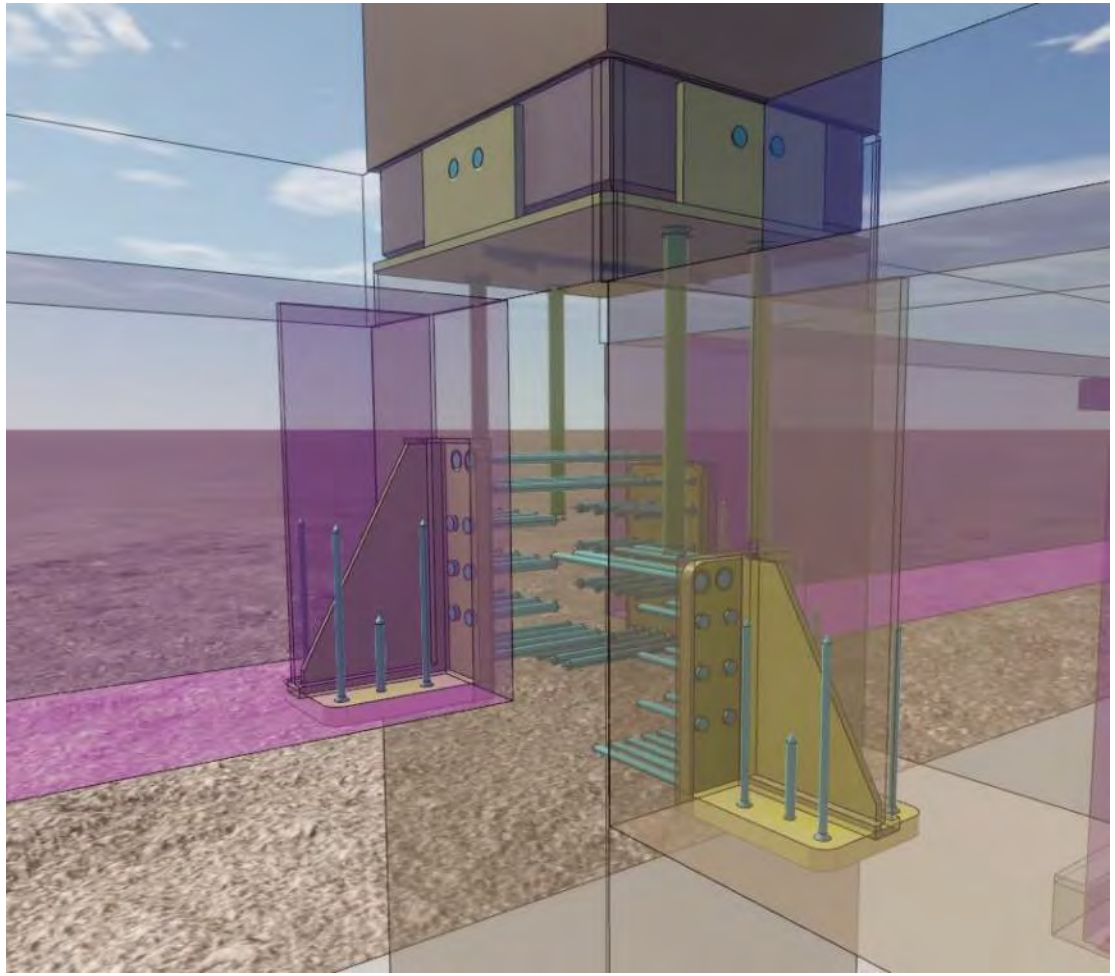


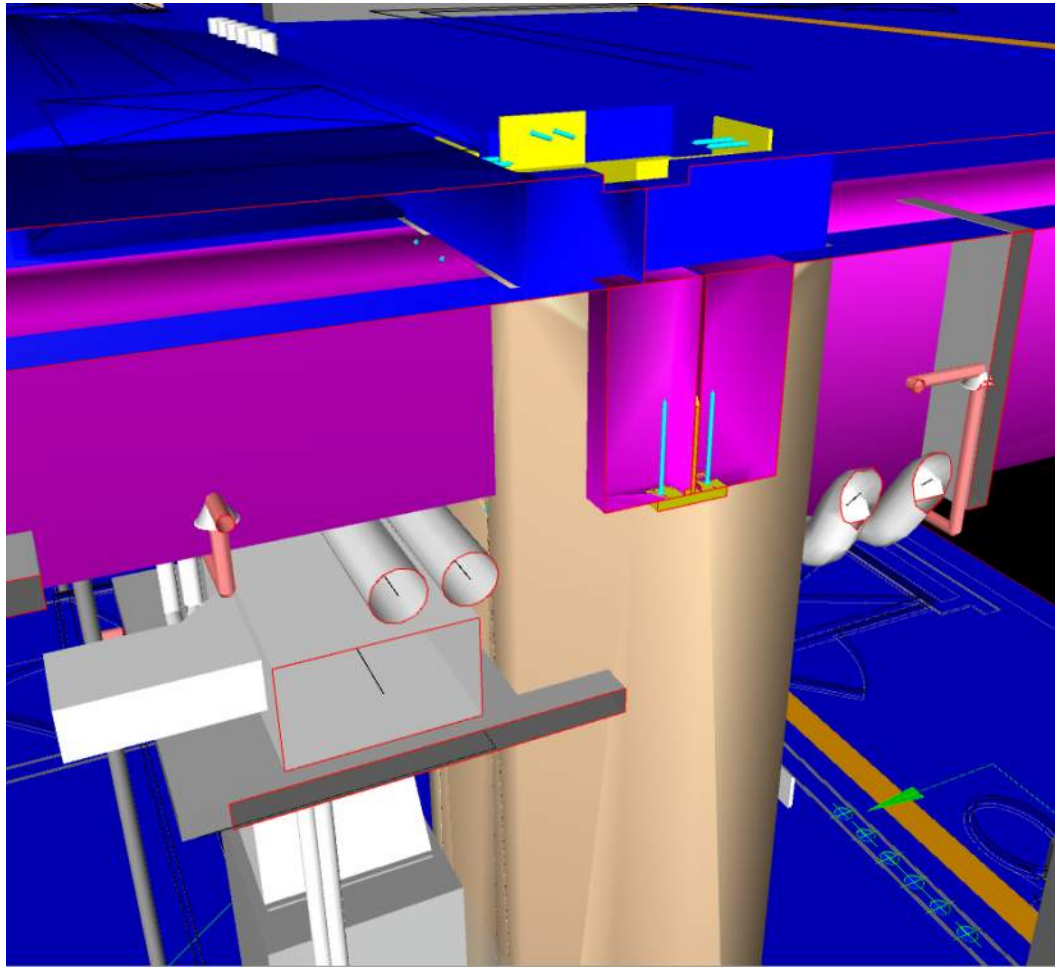
ASSUMED CONSTRUCTION SCHEDULE FOR PRECONSTRUCTION ANALYTICAL PREDICTION OF ELASTIC AND LONG-TERM CREEP ADN SHRINKAGE EFFECTS

TOWER CONSTRUCTION ANALYSIS

MASS TIMBER

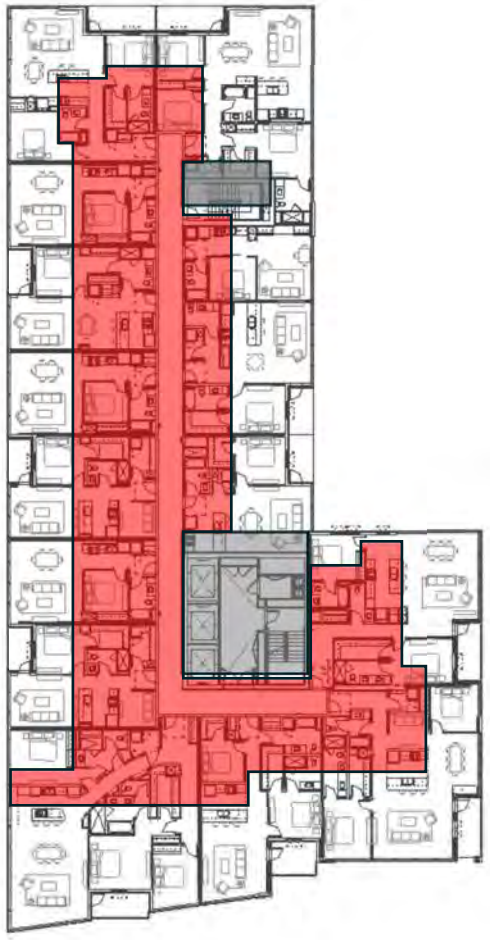
Modeling



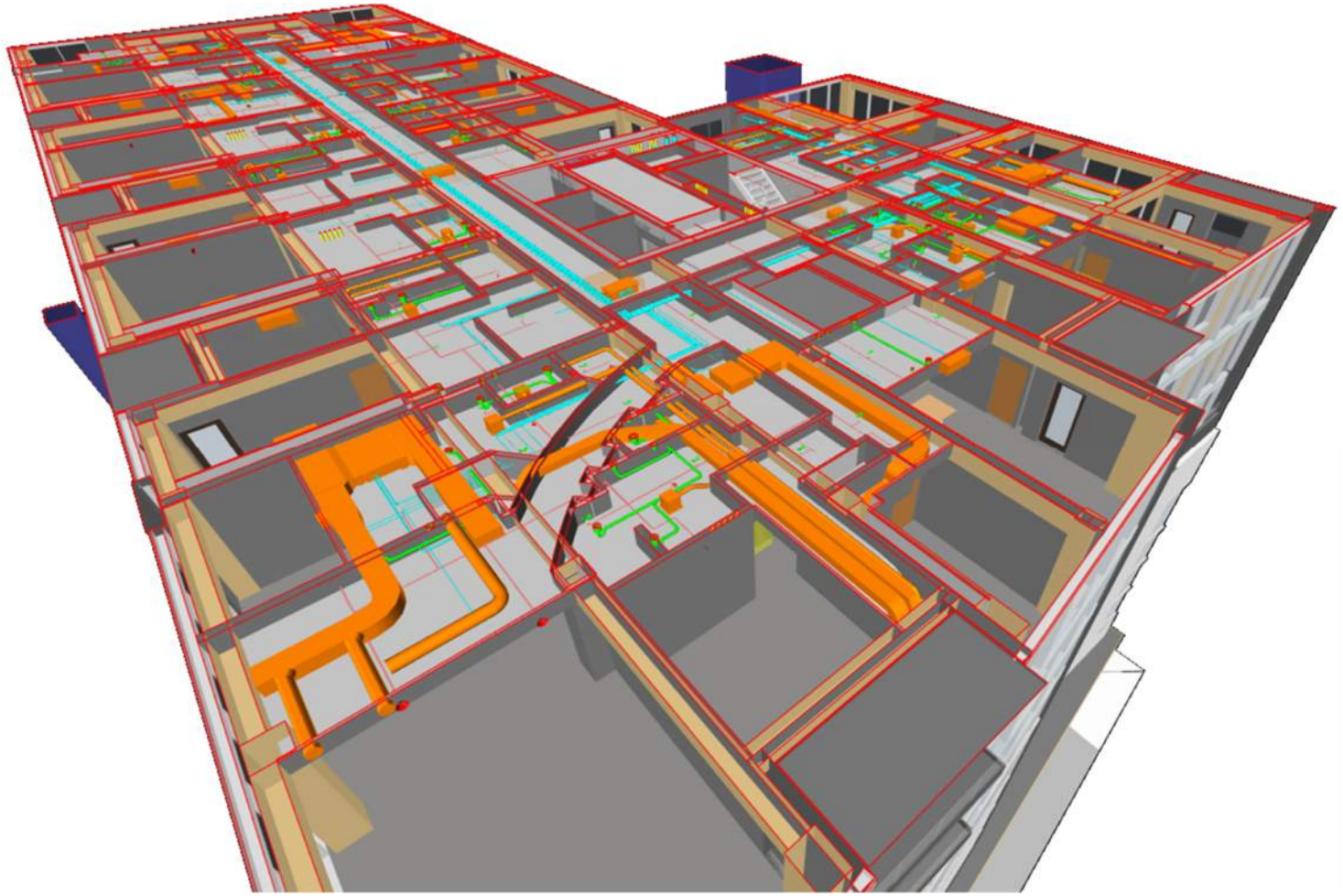


MASS TIMBER

Coordination



TYPICAL RESIDENTIAL LEVEL



MASS TIMBER

Fire Rating

- Char
  - Calculations (Char Method)
  - Full Scale (Global) Testing
  - Element (Member) Testing
  - Connection Testing
- Product Certificates
- Concealment
- Intumescent Paint (connections only)

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

Required Fire Endurance (hr.)	Effective Char Rate, β_{eff} (in./hr.)	Effective Char Depth, a_{char} (in.)
1-Hour	1.8	1.8
1½-Hour	1.67	2.5
2-Hour	1.58	3.2

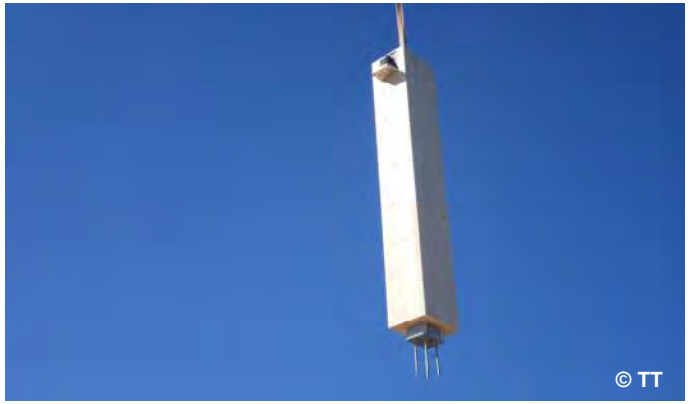
Table 16.2.2 Adjustment Factors for Fire Design[1]

			ASD					
			Design Stress to Member Strength Factor	Size Factor [2]	Volume Factor [2]	Flat Use Factor [2]	Beam Stability Factor [3]	Column Stability Factor [3]
Bending Strength	F_b	x	2.85	C_F	C_V	C_{fu}	C_L	-
Beam Buckling Strength	F_{bE}	x	2.03	-	-	-	-	-
Tensile Strength	F_t	x	2.85	C_F	-	-	-	-
Compressive Strength	F_c	x	2.58	C_F	-	-	-	C_P
Column Buckling Strength	F_{cE}	x	2.03	-	-	-	-	-

1. See 4.3, 5.3, 8.3, and 10.3 for applicability of adjustment factors for specific products.
2. Factor shall be based on initial cross-section dimensions.
3. Factor shall be based on reduced cross-section dimensions.

MASS TIMBER

Fire Performance



BEAMS

COLUMNS

CLT

PERMITTING

IBC 2015-2018

602.2 Types I and II. Types I and II construction are those types of construction in which the building elements listed in Table 601 are of noncombustible materials except as permitted in Section 603 and elsewhere in this code.

602.3 Type III. Type III construction is that type of construction in which the exterior walls are of noncombustible materials and the interior building elements are of any material permitted by this code. *Fire-retardant-treated wood* framing complying with Section 2303.2 shall be permitted within *exterior wall* assemblies of a 2-hour rating or less.

602.4 Type IV. Type IV construction (Heavy Timber, HT) is that type of construction in which the exterior walls are of noncombustible materials and the interior building elements are of solid or laminated wood without concealed spaces. The details of Type IV construction shall comply with the provisions of this section and Section 2304.11. Exterior walls complying with Section 602.4.1 or 602.4.2 shall be permitted.

602.5 Type V. Type V construction is that type of construction in which the structural elements, *exterior walls* and interior walls are of any materials permitted by this code.

IBC 2015

Type	Interior Material	Exterior Material	Façade exceptions
Types I & II	Non Combustible	Non Combustible	None
Type III	Any	Non Combustible	Fire-retardant-treated wood (FRTW)
Type IV	Solid or laminated wood	Non Combustible	FRTW CLT
Type V	Any	Any	N/A

PERMITTING

IBC 2015-2018

TABLE 504.3[a]
ALLOWABLE BUILDING HEIGHT IN FEET ABOVE GRADE PLANE

OCCUPANCY CLASSIFICATION	TYPE OF CONSTRUCTION									
	SEE FOOTNOTES	TYPE I		TYPE II		TYPE III		TYPE IV	TYPE V	
		A	B	A	B	A	B	HT	A	B
A, B, E, F, M, S, U	NS[b]	UL	160	65	55	65	55	65	50	40
	S	UL	180	85	75	85	75	85	70	60
H-1, H-2, H-3, H-5	NS[c, d]	UL	160	65	55	65	55	65	50	40
	S									
H-4	NS[c, d]	UL	160	65	55	65	55	65	50	40
	S	UL	180	85	75	85	75	85	70	60
I-1 Condition 1, I-3	NS[d, e]	UL	160	65	55	65	55	65	50	40
	S	UL	180	85	75	85	75	85	70	60
I-1 Condition 2, I-2	NS[d, f, e]	UL	160	65	55	65	55	65	50	40
	S	UL	180	85						
I-4	NS[d, g]	UL	160	65	55	65	55	65	50	40
	S	UL	180	85	75	85	75	85	70	60
R	NS[d, h]	UL	160	65	55	65	55	65	50	40
	S13R	60	60	60	60	60	60	60	60	60
	S	UL	180	85	75	85	75	85	70	60

OFFICE

RESIDENTIAL

IBC 2015

PERMITTING

IBC 2015-2018

TABLE 504.4[a, b]—continued
ALLOWABLE NUMBER OF STORIES ABOVE GRADE PLANE

OCCUPANCY CLASSIFICATION	SEE FOOTNOTES	TYPE OF CONSTRUCTION								
		TYPE I		TYPE II		TYPE III		TYPE IV	TYPE V	
		A	B	A	B	A	B	HT	A	B
B	NS	UL	11	5	3	5	3	5	3	2
	S	UL	12	6	4	6	4	6	4	3
R-1	NS[d, h]	UL	11	4	4	4	4	4	3	2
	S13R	4	4						4	3
	S	UL	12	5	5	5	5	5	4	3
R-2	NS[d, h]	UL	11	4	4	4	4	4	3	2
	S13R	4	4	4					4	3
	S	UL	12	5	5	5	5	5	4	3
R-3	NS[d, h]	UL	11	4	4	4	4	4	3	3
	S13R	4	4						4	4
	S	UL	12	5	5	5	5	5	4	4
R-4	NS[d, h]	UL	11	4	4	4	4	4	3	2
	S13R	4	4						4	3
	S	UL	12	5	5	5	5	5	4	3

OFFICE

RESIDENTIAL

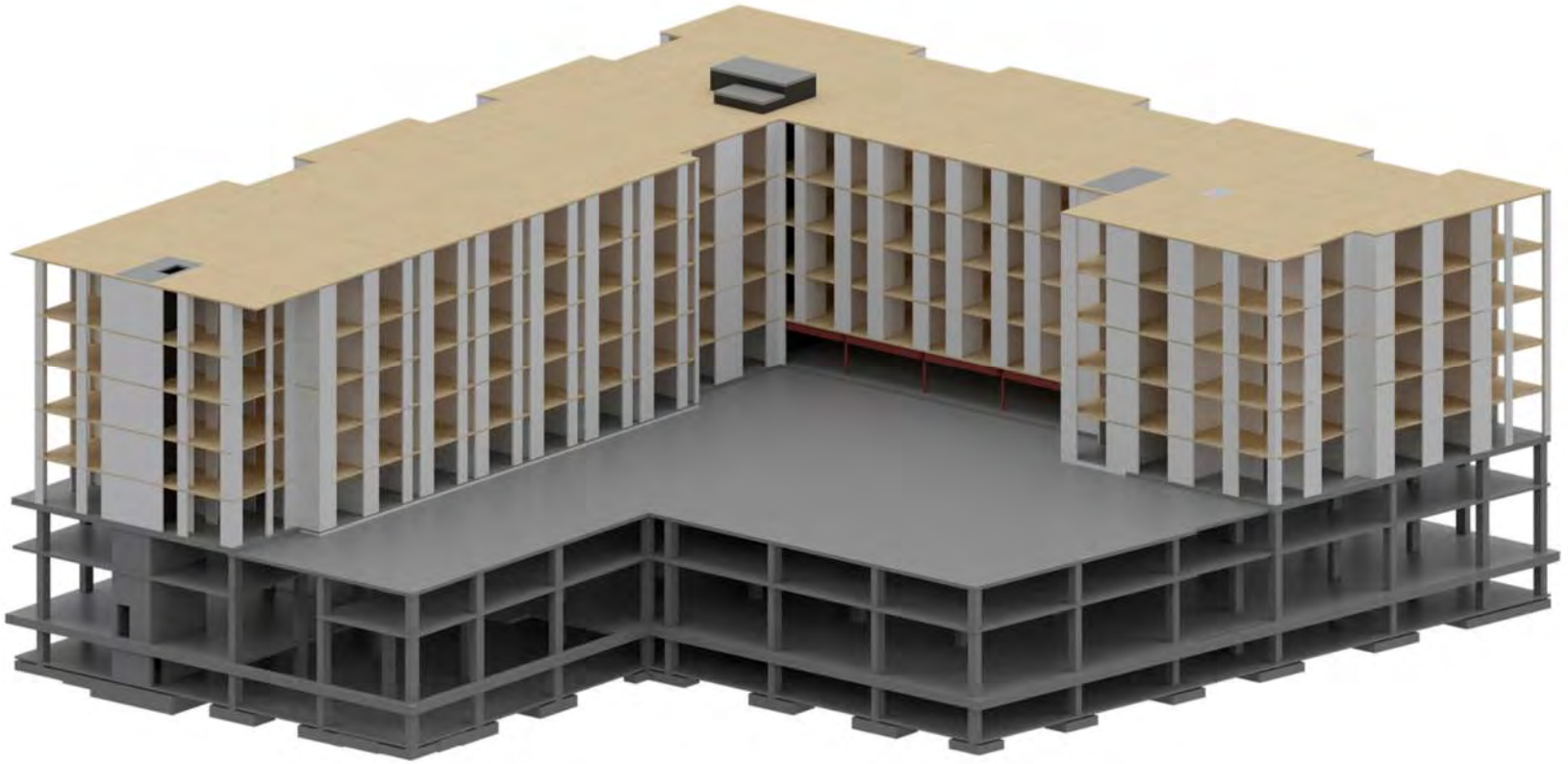
IBC 2015

PERMITTING

IBC 2015-2018

PERMITTING

IBC 2015-2018



STICK FRAMING
WALLS + CLT
SLABS

CONCRETE
PODIUM

CONCRETE
BASEMENT

PERMITTING

UNITED STATES APPROVALS

12 stories

25 stories

Framework (2017)
Portland, OR

Ascent (2020)
Milwaukee, WI

CODE DEVELOPMENT

IBC (2021 and Beyond)

IBC 2024 currently approving 100% exposed ceilings

- 6 Stories
- Fully Exposed

IBC 2015

TYPE IV-C

- 9 Stories
- Fully Exposed

TYPE IV-B

- 12 Stories
- Limited exposure (20% ceilings, 40% walls)

TYPE IV-A

- 18 Stories
- Fully Concealed

IBC 2021 (approved)

?

FUTURE CODES ?

Images From American Wood Council (https://awc.org/tallmasstimber)

PERMITTING

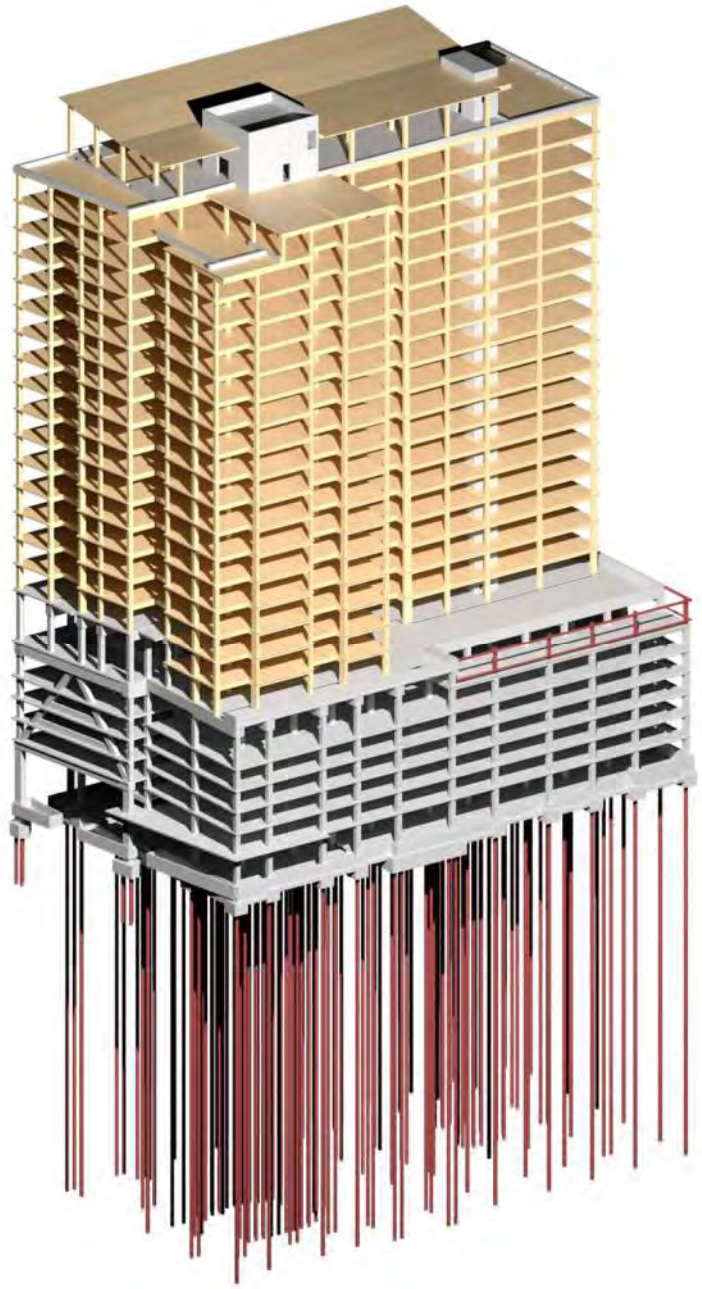
Alternate Materials

[A] 104.11 Alternative materials, design and methods of construction and equipment. The provisions of this code are not intended to prevent the installation of any material or to prohibit any design or method of construction not specifically prescribed by this code, provided that any such alternative has been *approved*. An alternative material, design or method of construction shall be *approved* where the *building official* finds that the proposed design is satisfactory and complies with the intent of the provisions of this code, and that the material, method or work offered is, for the purpose intended, not less than the equivalent of that prescribed in this code in quality, strength, effectiveness, *fire resistance*, durability and safety. Where the alternative material, design or method of construction is not *approved*, the *building official* shall respond in writing, stating the reasons why the alternative was not *approved*.

[A] 104.11.1 Research reports. Supporting data, where necessary to assist in the approval of materials or assemblies not specifically provided for in this code, shall consist of valid research reports from *approved* sources.

[A] 104.11.2 Tests. Whenever there is insufficient evidence of compliance with the provisions of this code, or evidence that a material or method does not conform to the requirements of this code, or in order to substantiate claims for alternative materials or methods, the *building official* shall have the authority to require tests as evidence of compliance to be made at no expense to the jurisdiction. Test methods shall be as specified in this code or by other recognized test standards. In the absence of recognized and accepted test methods, the *building official* shall approve the testing procedures. Tests shall be performed by an *approved agency*. Reports of such tests shall be retained by the *building official* for the period required for retention of public records.

IBC 2015



PERMITTING

IBC and the Wisconsin Commercial Building Code

TABLE 601
FIRE-RESISTANCE RATING REQUIREMENTS FOR BUILDING ELEMENTS (HOURS)

BUILDING ELEMENT	TYPE I		TYPE II		TYPE III		TYPE IV	TYPE V	
	A	B	A	B	A	B	HT	A	B
Primary structural frame[f] (see Section 202)	3[a]	2[a]	1	0	1	0	HT	1	0
Bearing walls Exterior[e, f] Interior	3 3[a]	2 2[a]	1 1	0 0	2 1	2 0	2 1/HT	1 1	0 0
Nonbearing walls and partitions Exterior	See Table 602								
Nonbearing walls and partitions Interior[d]	0	0	0	0	0	0	See Section 602.4.6	0	0
Floor construction and associated secondary members (see Section 202)	2	2	1	0	1	0	HT	1	0
Roof construction and associated secondary members (see Section 202)	1½[b]	1[b,c]	1[b,c]	0[c]	1[b,c]	0	HT	1[b,c]	0

For SI: 1 foot = 304.8 mm.

a. Roof supports: Fire-resistance ratings of primary structural frame and bearing walls are permitted to be reduced by 1 hour where supporting a roof only.

b. Except in Group F-1, H, M and S-1 occupancies, fire protection of structural members shall not be required, including protection of roof framing and decking where every part of the roof construction is 20 feet or more above any floor immediately below. Fire-retardant-treated wood members shall be allowed to be used for such unprotected members.

c. In all occupancies, heavy timber shall be allowed where a 1-hour or less fire-resistance rating is required.

d. Not less than the fire-resistance rating required by other sections of this code.

e. Not less than the fire-resistance rating based on fire separation distance (see Table 602).

f. Not less than the fire-resistance rating as referenced in Section 704.10.

IBC 2015

Chapter SPS 361
ADMINISTRATION AND ENFORCEMENT

Subchapter I — Scope and Application

(6) Alternatives. Nothing in chs. SPS 361 to 366 is intended to prohibit or discourage the design and utilization of new building products, systems, components, or alternate practices, provided written approval from the department is obtained first.
Note: Chapter SPS 361, subch. VI contains requirements for approval of building products and alternate standards.

Subchapter VI — Product and Standard Review and Approval

SPS 361.50 Building product approvals.
(1) Voluntary approval.
(a) Materials, equipment, and products regulated under chs. SPS 361 to 366 may receive a written approval from the department indicating code compliance.
(b)
1. Approval of materials, equipment, and products shall be based on sufficient data, tests, and other evidence that prove the material, equipment, or product is in compliance with the standards specified in chs. SPS 361 to 366.
2. Tests, compilation of data, and calculations shall be conducted by a qualified independent third party.
(2) Alternate approval.
(a) Materials, equipment, and products that meet the intent of chs. SPS 361 to 366 and which are not approved under sub. (1) shall be permitted if approved in writing by the department.
(b)
1. Approval of materials, equipment, and products shall be based on sufficient data, tests, and other evidence that prove the material, equipment, or product meets the intent of the standards specified in chs. SPS 361 to 366.
2. Tests, compilation of data, and calculations shall be conducted by a qualified independent third party.

WISCONSIN COMMERCIAL BUILDING CODE

PERMITTING

Fire Rating

- Char
  - **Calculations (Char Method)**
  - **Element (Member) Testing**
    - **1st Ever 3 Hour Test!**
  - **Connection Testing**

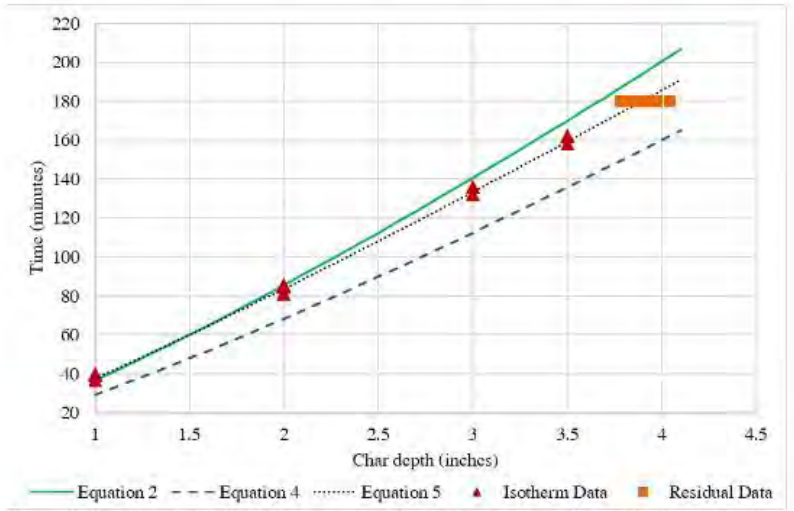
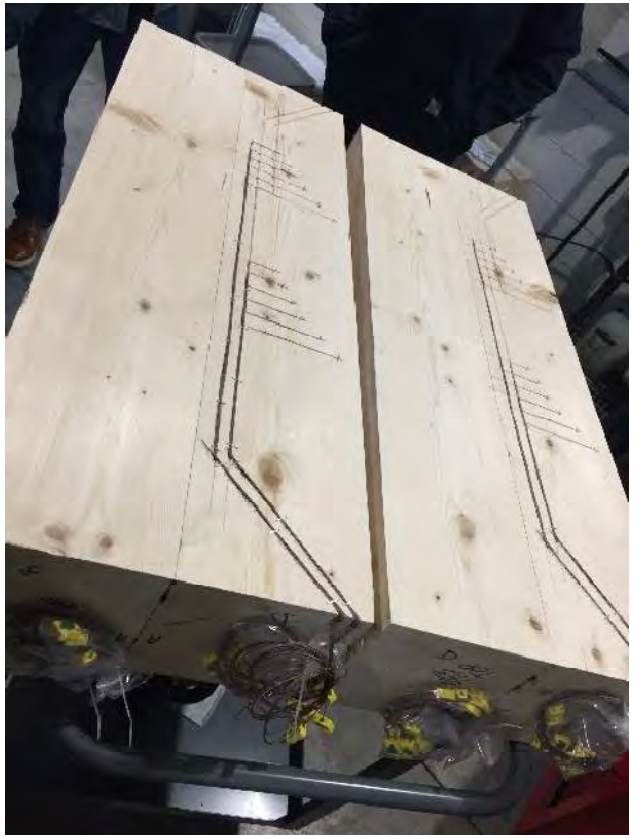


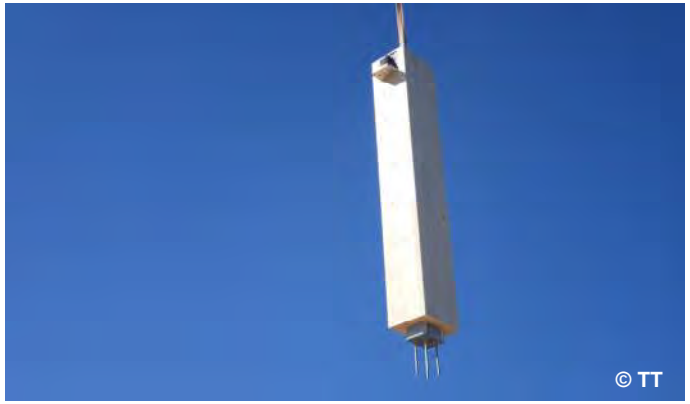
Figure 8: Data from the 300°C Isotherm combined with data from the residual cross sections compared with 3 models.

USDA FOREST PRODUCTS LABORATORY



PERMITTING

Fire Rating (Members)



BEAMS

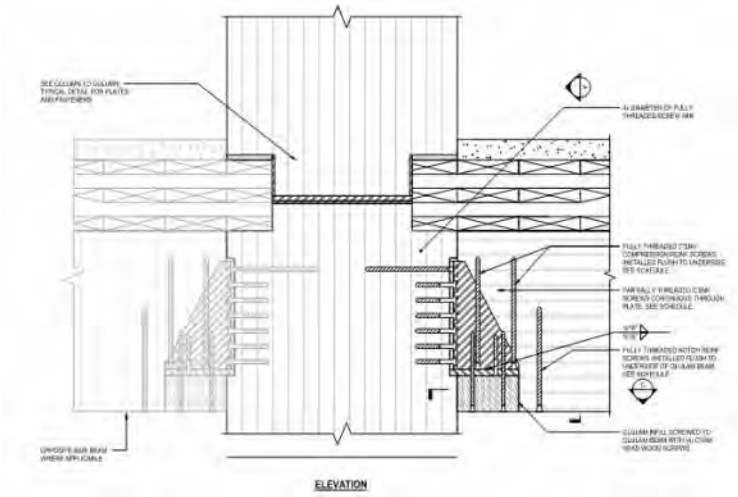
COLUMNS

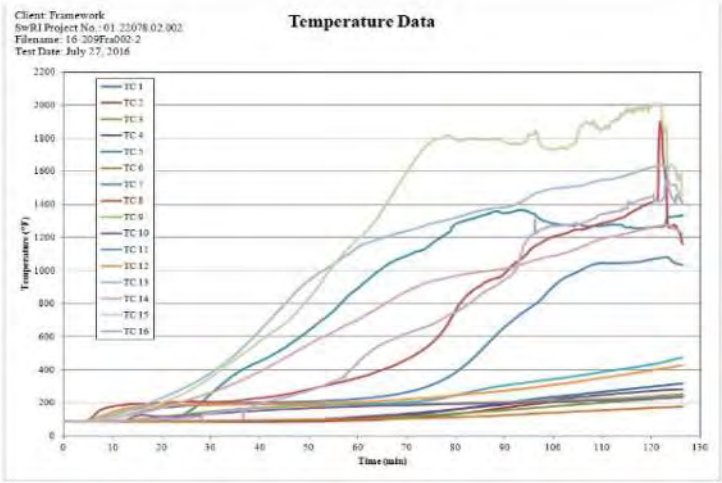
CLT

PERMITTING

Fire Rating (Connections)

- “Framework Connector”
- Encapsulation

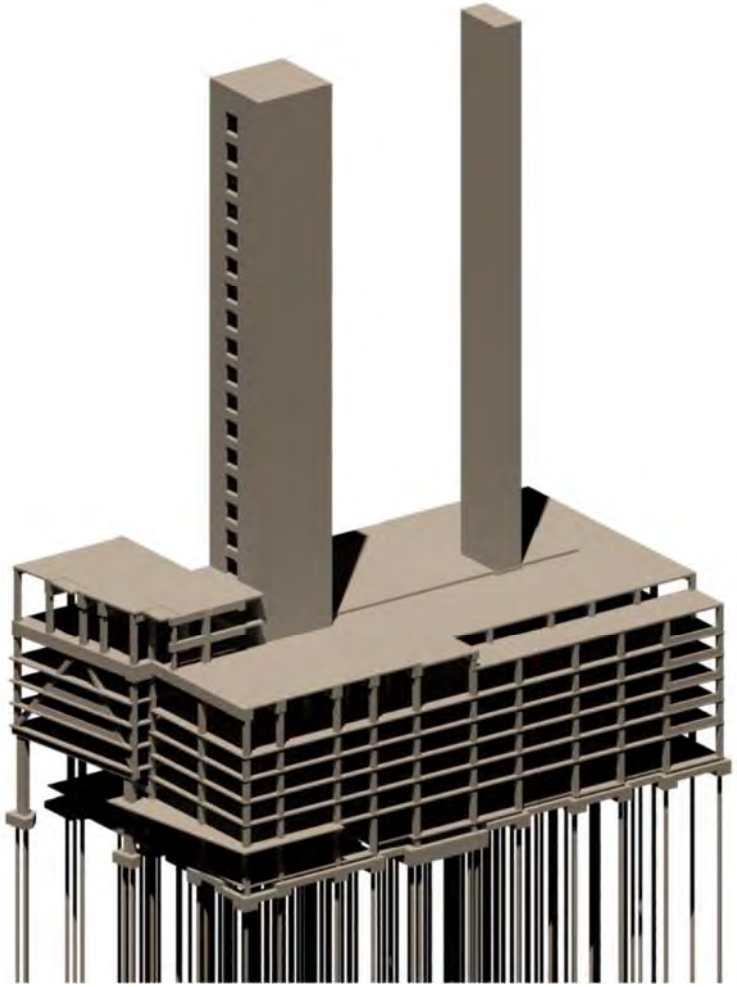




“FRAMWORK CONNECTOR”

PERMITTING

Ascent – AHJ Agreements

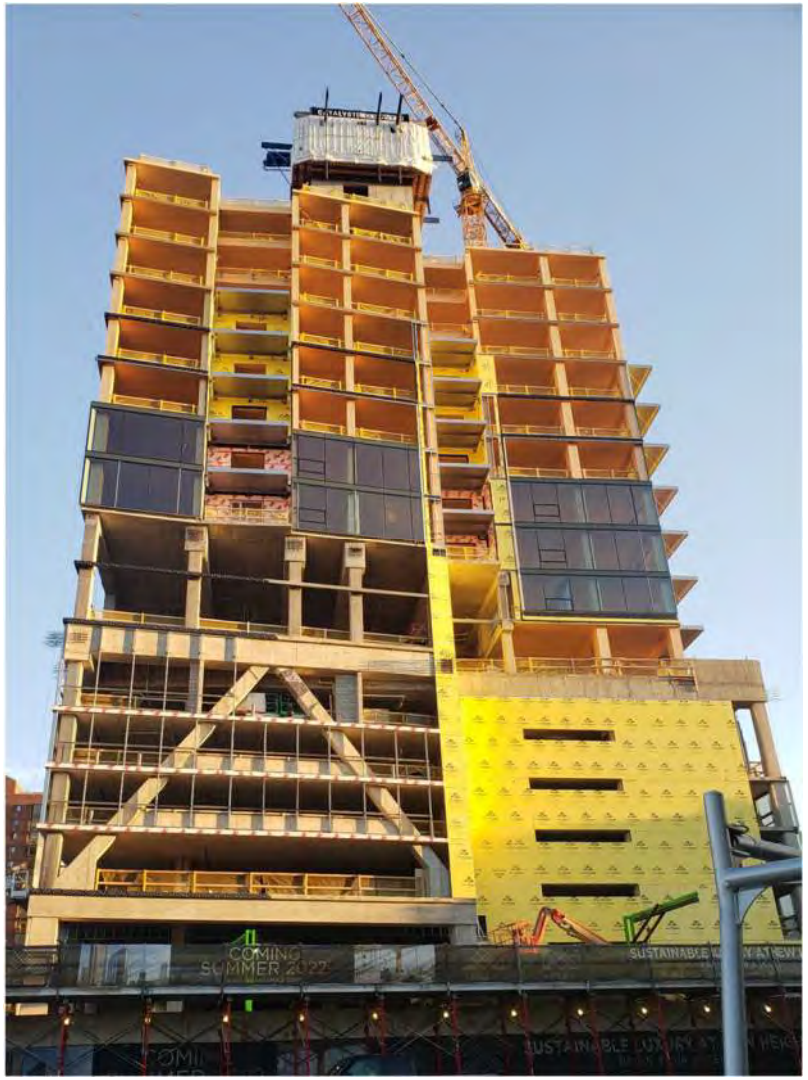


- **SPECIAL INSPECTIONS**
  - (not required in WI)
- Concrete cores
- Automatic sprinkler system
- Dual Water Supply to Fire Pump
- Standpipe in Each Stair
- Smoke detection
- FD Vehicle Access on Two Roads
- Electronically Supervised Valves
- Fire Command Center
- Fire Dept Communications Support
- Voice Communications
- Stair Pressurization

ASCENT

Construction Progress

Start of Timber Construction
(June 2021)



Level 17 Complete
(September 2021)

Level 26 (Roof) Topped Out
(December 2021)

ASCENT

Primary Mass Timber Structural Components

GLULAM COLUMNS

GLULAM BEAMS

CLT PANELS

TIMBER SCREWS

ASCENT

Primary Mass Timber Connections

CORE-CLT/GLB

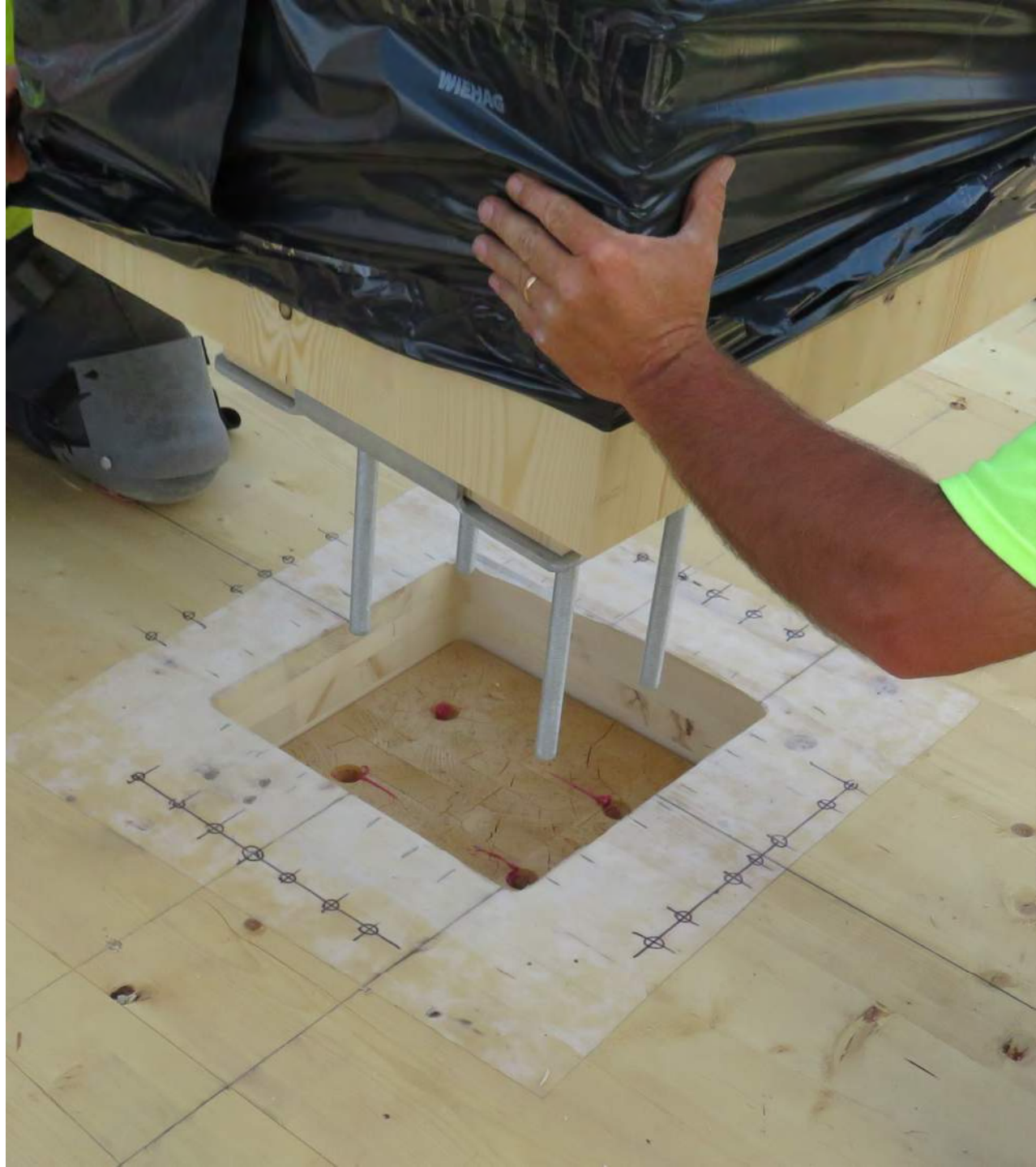
COL-COL (EPOXY)

COL-COL (INTERIOR)

BEAM-COL (HANGER)

BEAM-COL (BEARING)


F-1833



ASCENT

ASCENT

Quantitative Overview

Costs				
Total project cost		$130,000,000 $501,930/ unit		
Land		$6,250,000	@ appraised value	
		Market Standard*	**Pro Forma****	**Realized*****
Construction costs (normalized wo/COVID)		$200 / GSF	$190 / GSF	$190 / GSF****

NOI				
Apartment		**Market**	**Realized*** **	
Rental rates				
	1-BR	$1,850	$2,046	~11%% higher
	2-BR	$3,500	$3,956	~13% higher
	3-BR	$5,500	$8,551	~55% higher
Occupancy at stabilization		95%	54%	Property still in lease up
Parking Revenue		**Market**	**Pro Forma****	**Realized*****
In addition to lease		$175	$185	$175

Retail	Market	Pro Forma**	Realized***
Retail rental rates	$25 / RSF/YR	$21 / RSF/YR	$TBD/ COVID
Rent type (e.g., NNN)	Modified Gross	NNN	TBD
Tenant improvement allowance	Varies	$86 / SF	$TBD / SF
Occupancy after 12 months	Varies	100%	TBD%

Market rental rates for apartments sourced from a CoStar report dated September 2022

**Market standard costs refer to normal cost to build for subject's use, irrespective of structural approach*
***Pro forma dated early 2020*
****Realized metrics as of October 2022*
*****Average unit size is larger than the market contributing to lower cost per square foot. Mass timber was a slight premium. A longer iterative design process proved beneficial in maximizing efficiencies, thereby driving down costs to make mass timber competitive.*

Return Performance	Market	Pro Forma**	Realized***
Yield on cost – untrended	6.00%	5.85%	TBD / on track
Cap rate (mkt vs. appraisal subject conclusion)	5.00%	4.70%	TBD
Value per unit	$500,000	$594,000	TBD / on track
Leverage	65%	70%	50%
Mezzanine leverage	15%	15%	20%

Timeline	Date	Context/Comment
Date of conception (first dollar spent)	April 2018	Mid cycle
Date underwriting finalized (go/no-go decision)	May 2020	Mid cycle
Date equity capital secured	June 2020	Late cycle
Permitting duration	6 months	Longer (started early & ran concurrent w/design)
GMP in place	July 2020	
Construction start	Aug 2020	
Duration of construction (anticipated without delays)	22 months	Faster (by 4 months)
Duration of construction (realized w/ delays)	24 months	Delays due to COVID + Suez Canal obstruction
Construction completed	Aug 2022	Two phases of completion: July 15 & Aug 31
Date stabilized (80% occupancy, NOI, or at pro forma or refinanced)	TBD	Projected June 2023

Project Context

Economic case made by demand

- Lease up velocity averaging 20 units/month is better than the market's typical average of 14 units/month (per the appraisal) and better than the pro forma expectations
- Superior luxury product with minimal comps in Milwaukee market

Above-market absorption

Good Design is a Good Investment for all Stakeholders

Lessons Learned

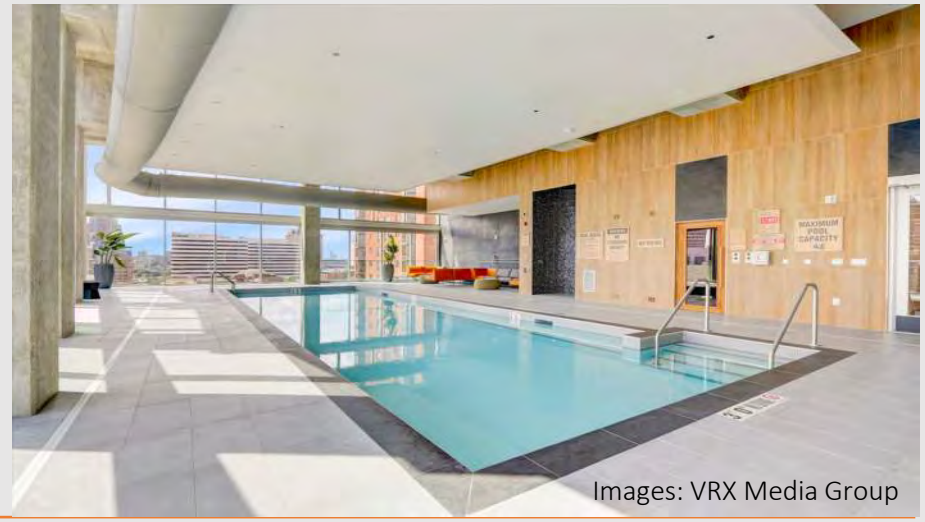
- Intensive coordination: Bldg scale and performance-based code approach required extraordinary coordination + precise MEPF design
- Fire Testing: AHJ required fire ratings for a high-rise; glulam columns passed 3-hr fire-resistance ratings

Challenges

- Insurance: More costly, (3x) standard rate
- Extra considerations: For developers on a variety of technical A/E/C topics

Successes

- Cost: Slight premium for optimized mass timber system over market rates for similar apartment towers
- Lease-up: Amazing pre-leasing w/ ~45% pre-leased at construction completion



Images: VRX Media Group

CODE DEVELOPMENT

IBC (2021 and Beyond)

IBC 2024 currently approving 100% exposed ceilings

- 6 Stories
- Fully Exposed

IBC 2015

TYPE IV-C

- 9 Stories
- Fully Exposed

TYPE IV-B

- 12 Stories
- Limited exposure (20% ceilings, 40% walls)

TYPE IV-A

- 18 Stories
- Fully Concealed

IBC 2021 (approved)

?

FUTURE CODES ?

Images From American Wood Council (https://awc.org/tallmasstimber)

FIRE TESTING

IBC 2021 - 2024

COMPOSITE MASS TIMBER

Panel Composite Action

CONNECTIONS

2-hour Fire Rating

MTC

Double Ricon/Megan: 16.6 kips

(1.5 hours)

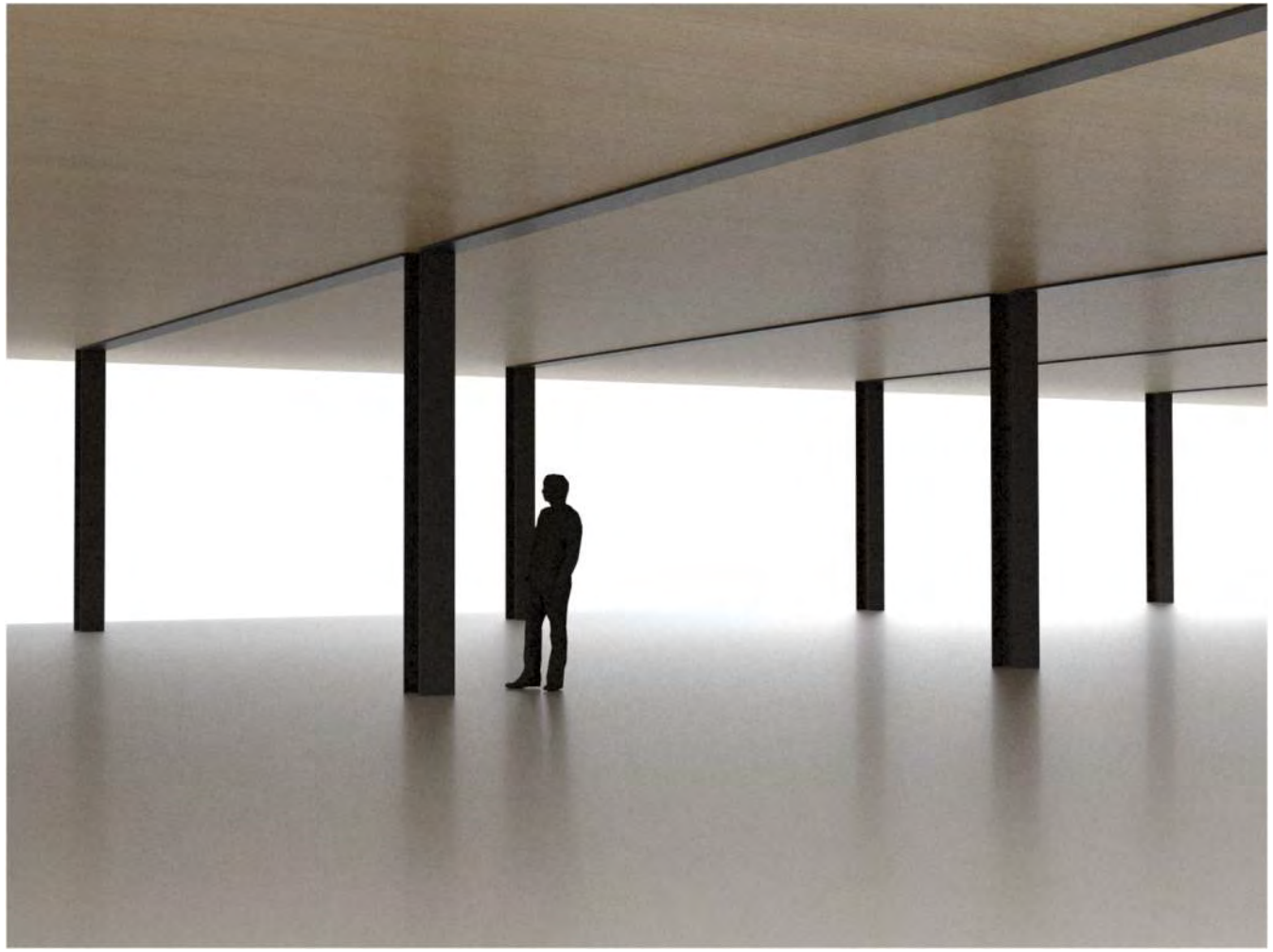
Simpson Strong-Tie

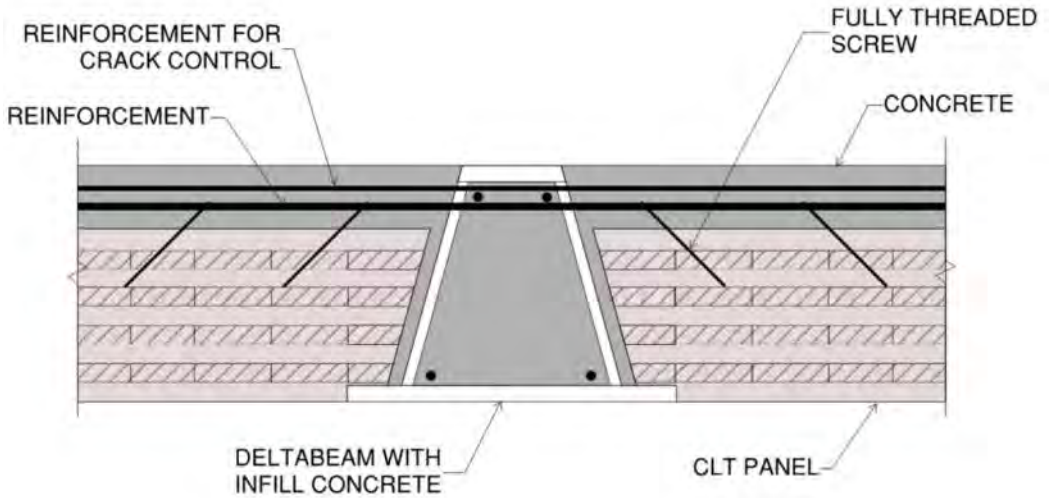
CBH2.37x9.97: 36kips

(2 hours)

HYBRID STRUCTURES

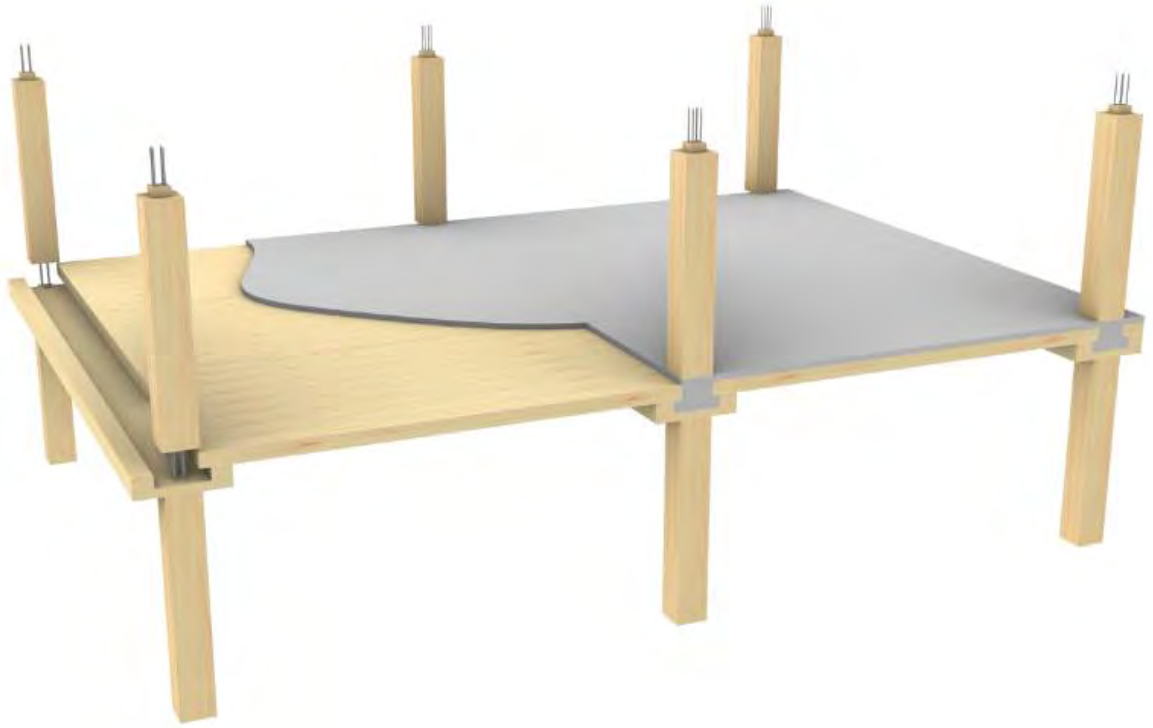
Mass Timber - Steel

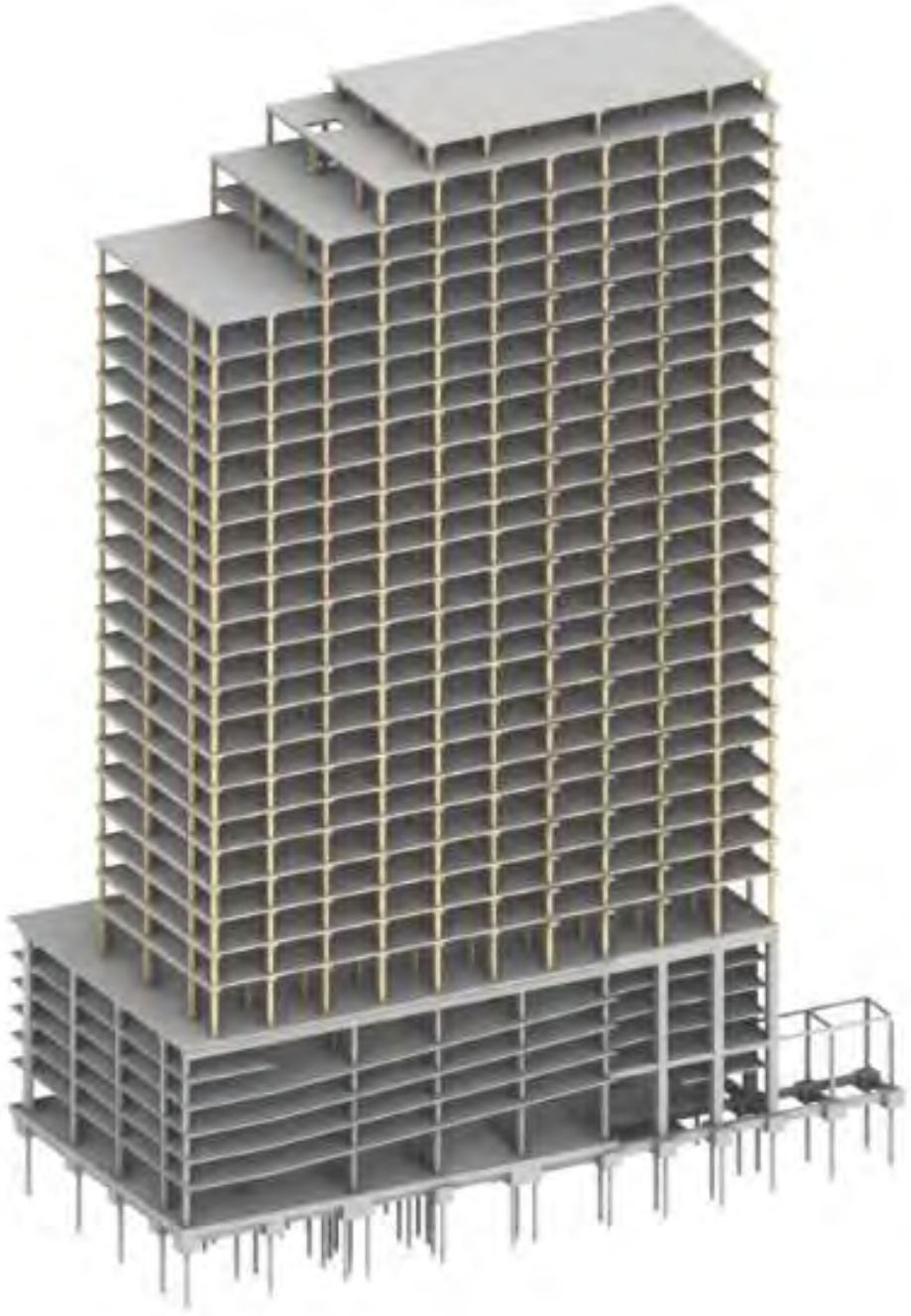




HYBRID STRUCTURES

Mass Timber - Concrete





Tall Wood Takeaways

1. Benefits of mass timber – sustainability, aesthetics, construction speed and efficiency. Contribute to tenant appeal and financial value
2. Advancement in codes and permitting allow for tall timber, with more advances on the horizon
3. Advances in engineering – additional research and testing, hybrid structures and composite structures.
4. WoodWorks Resources are available for free to assist architects, engineers and developers. Scan code to right to download business case studies!

Scan to download business case studies

QUESTIONS?

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This concludes The American Institute of Architects Continuing Education Systems Course

Ask us anything!

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