

# Burwell Center for Career Achievement



## Mass Timber at the University of Denver: An Authentic Expression of Sustainability

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DISCLAIMER: THIS PRESENTATION WAS DEVELOPED BY A THIRD PARTY AND IS NOT FUNDED BY WOODWORKS OR THE SOFTWOOD LUMBER BOARD



UNIVERSITY *of*  
DENVER



**CONSTRUCTION**

**NORDIC**  
STRUCTURES

LAKE | FLATO

**SA+R**  
SHEARS + ADKINS ROCKWOLD ARCHITECTS



didierdesignstudio  
LANDSCAPE ARCHITECTURE





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

# Course Description

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Set to open in the Fall of 2020, the University of Denver's Burwell Center for Career Achievement will present an authentic expression of the University's commitment to sustainability. This three-story, 23,000-square-foot facility provides a mix of classroom space, faculty and administrative offices, and indoor-outdoor forums. In this webinar, the architect and structural engineer will share specifics about the design approach for this project, which is the first in Denver to use cross-laminated timber shear walls and shaft walls. Topics will include detailing for constructability, fire resistance, acoustics, and structural connections, as well as permitting, plan reviews, on-site inspections, and other interactions with the City of Denver. The speakers will also share insights on the collaborative design process—which is critical to keeping mass timber projects streamlined and efficient.

# Learning Objectives

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WHY MASS  
TIMBER?



STRUCTURAL  
DESIGN



CITY REVIEW  
PROCESS



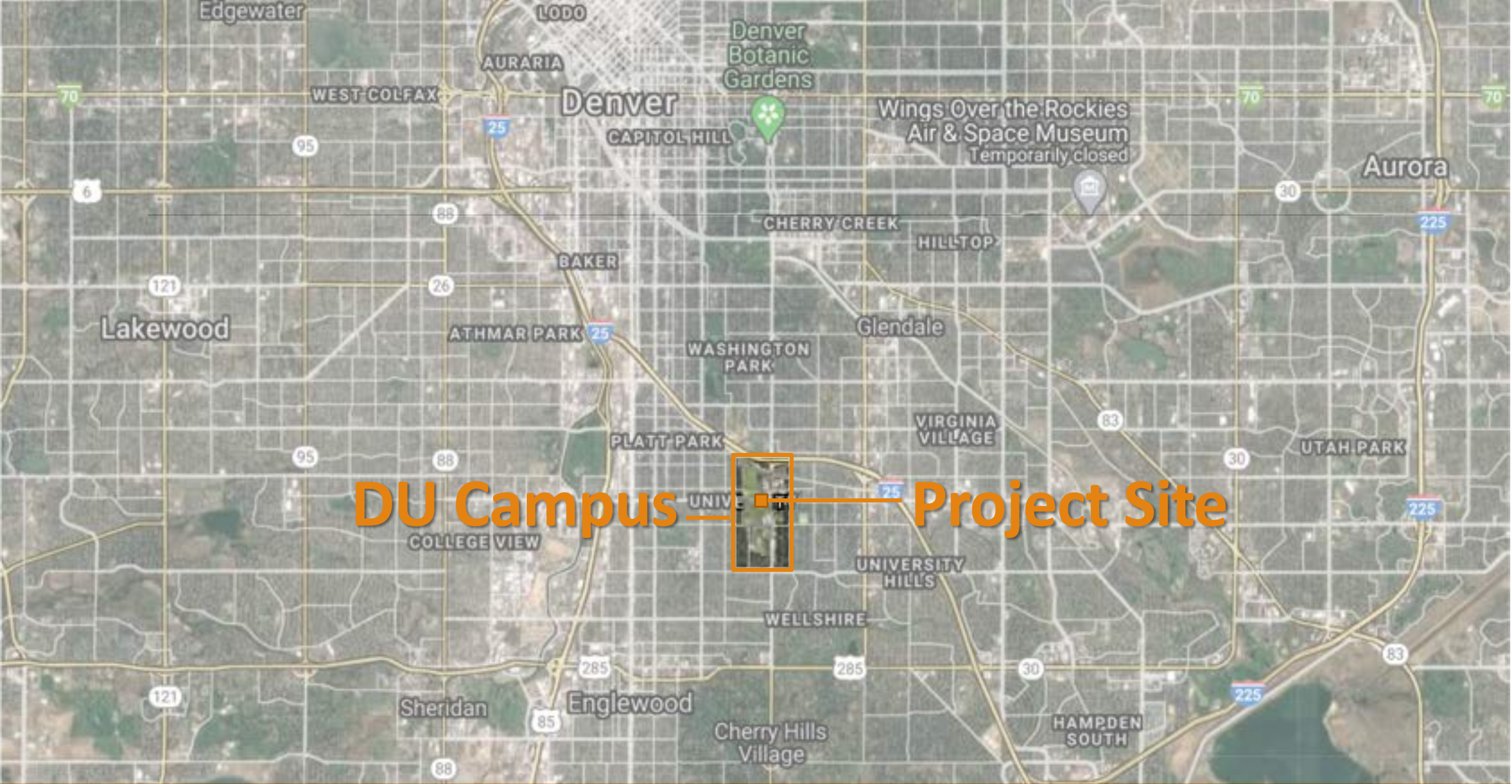
LESSONS  
LEARNED



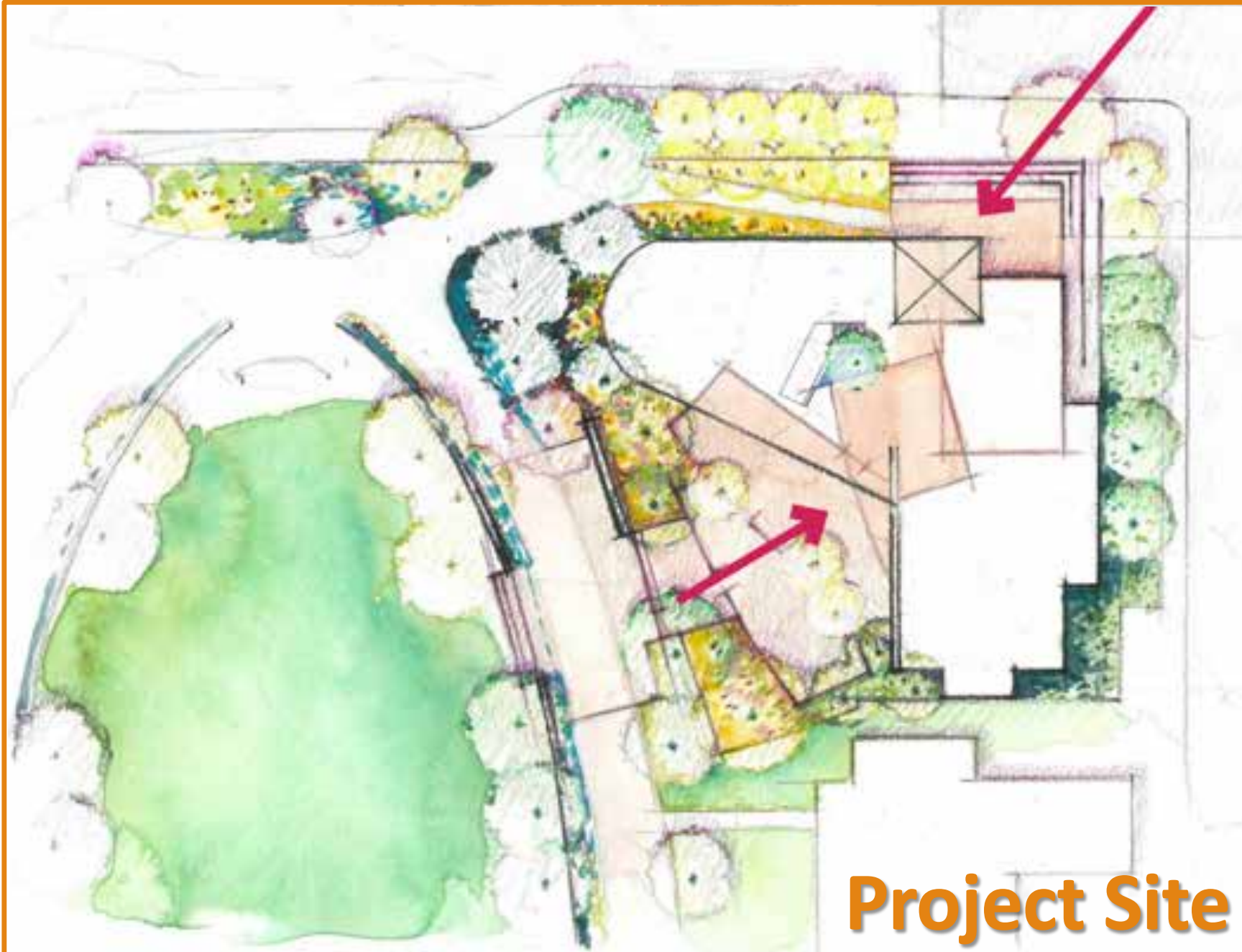
WHY MASS  
TIMBER?

1. Review code provisions applicable to a three-story mass timber structure, including construction type and fire-resistance ratings.
2. Highlight structural design processes associated with the use of CLT shear walls and diaphragms.
3. Discuss local jurisdictional approvals relative to a first-of-its-kind mass timber structure in Denver.
4. Explore lessons learned relative to code compliance, detailing best practices, and material procurement for a CLT structure.

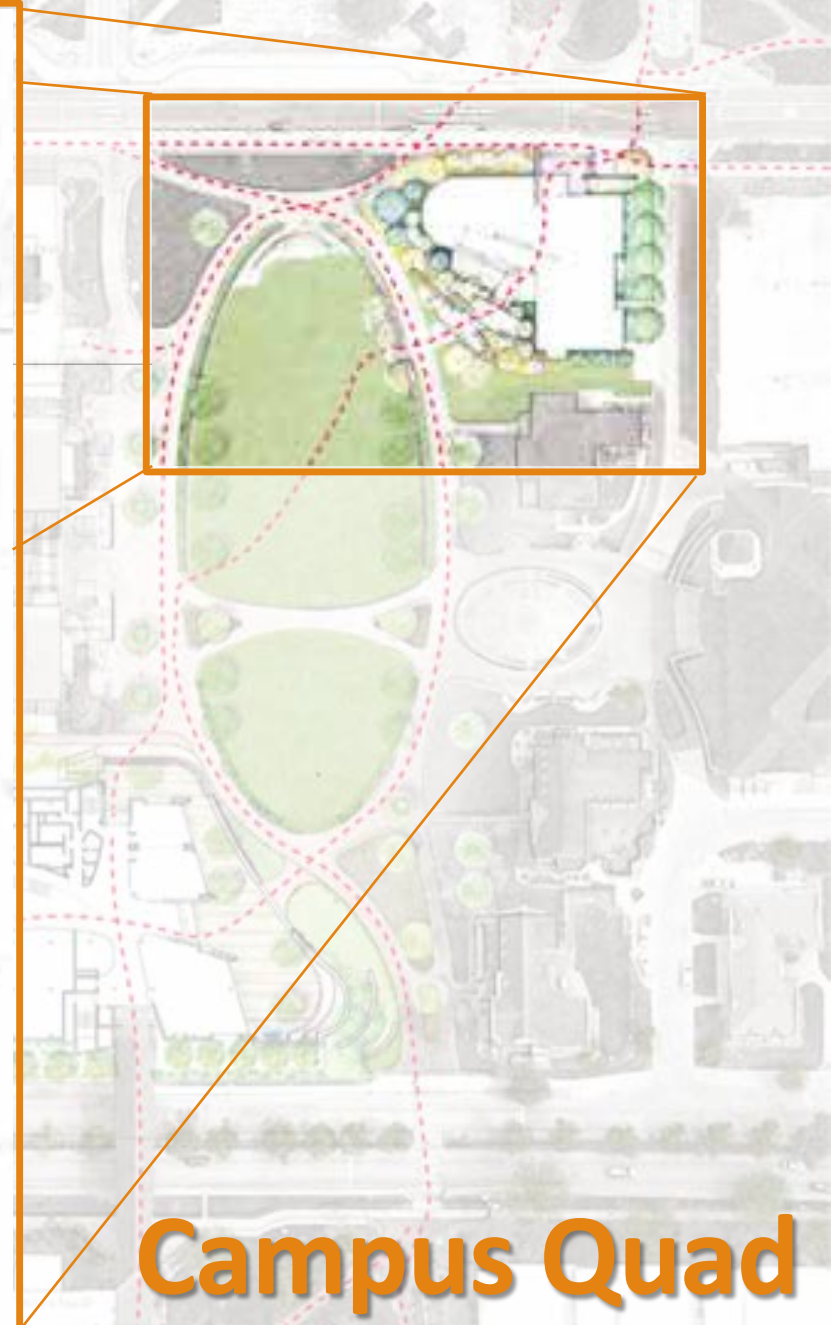








**Project Site**



**Campus Quad**



# Why Mass Timber?

Rendering courtesy of Lake Flato



# Sustainability Goals

Total Potential Carbon  
Benefit: 579 metric tons of  
CO<sup>2</sup>

Amount of Carbon stored in  
the wood: 417 metric tons  
of CO<sup>2</sup>



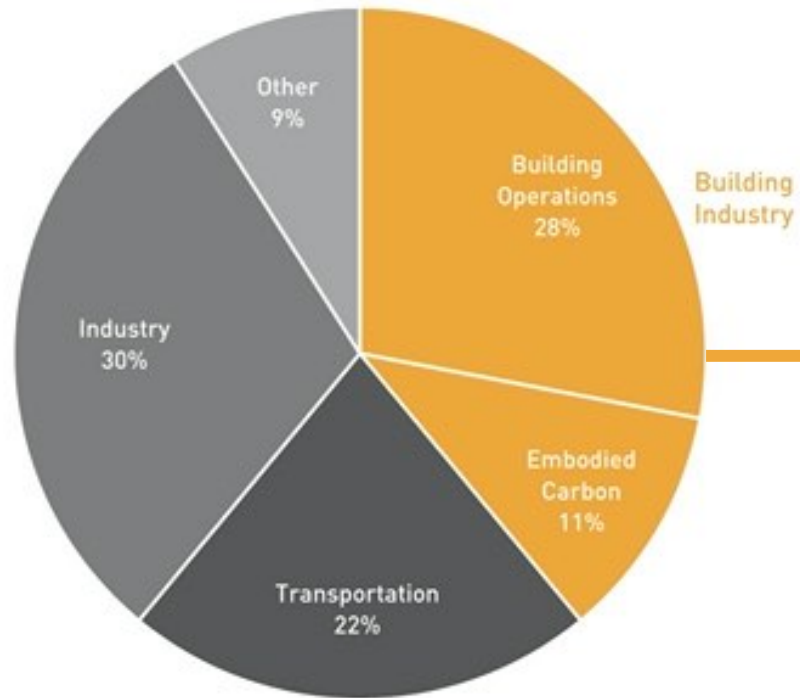
SUSTAINABILITY AND HONEST EXPRESSION ARE UNIVERSITY PRIORITIES

# Sustainability Metrics

Total Potential Carbon Benefit: 579 metric tons of CO<sub>2</sub>

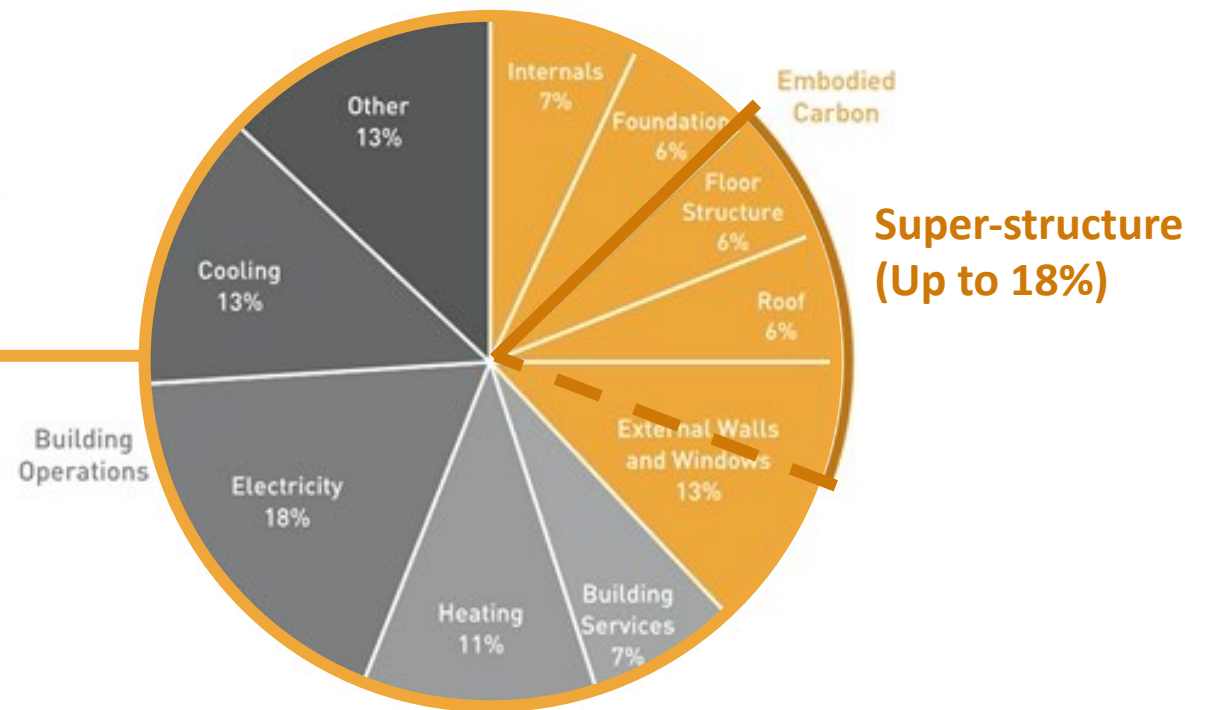
Amount of Carbon stored in the wood: 417 metric tons of CO<sub>2</sub>

Global CO<sub>2</sub> Emissions by Sector



Source: Architecture 2030,  
UN Environment Global Status Report 2017.

Typical Building Sector Lifetime CO<sub>2</sub>



Source: Sturgis Associates LLP  
Indicative Whole Life Carbon Emissions.



# Structural System

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MASS TIMBER STRUCTURE CAPTURES CARBON

# Architectural Expression



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EXPRESSION OF MASS TIMBER IS HONEST



# Architecture + Structure = **Authenticity**

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STRUCTURE AND ARCHITECTURE COMBINE TO TELL A STORY OF SUSTAINABILITY

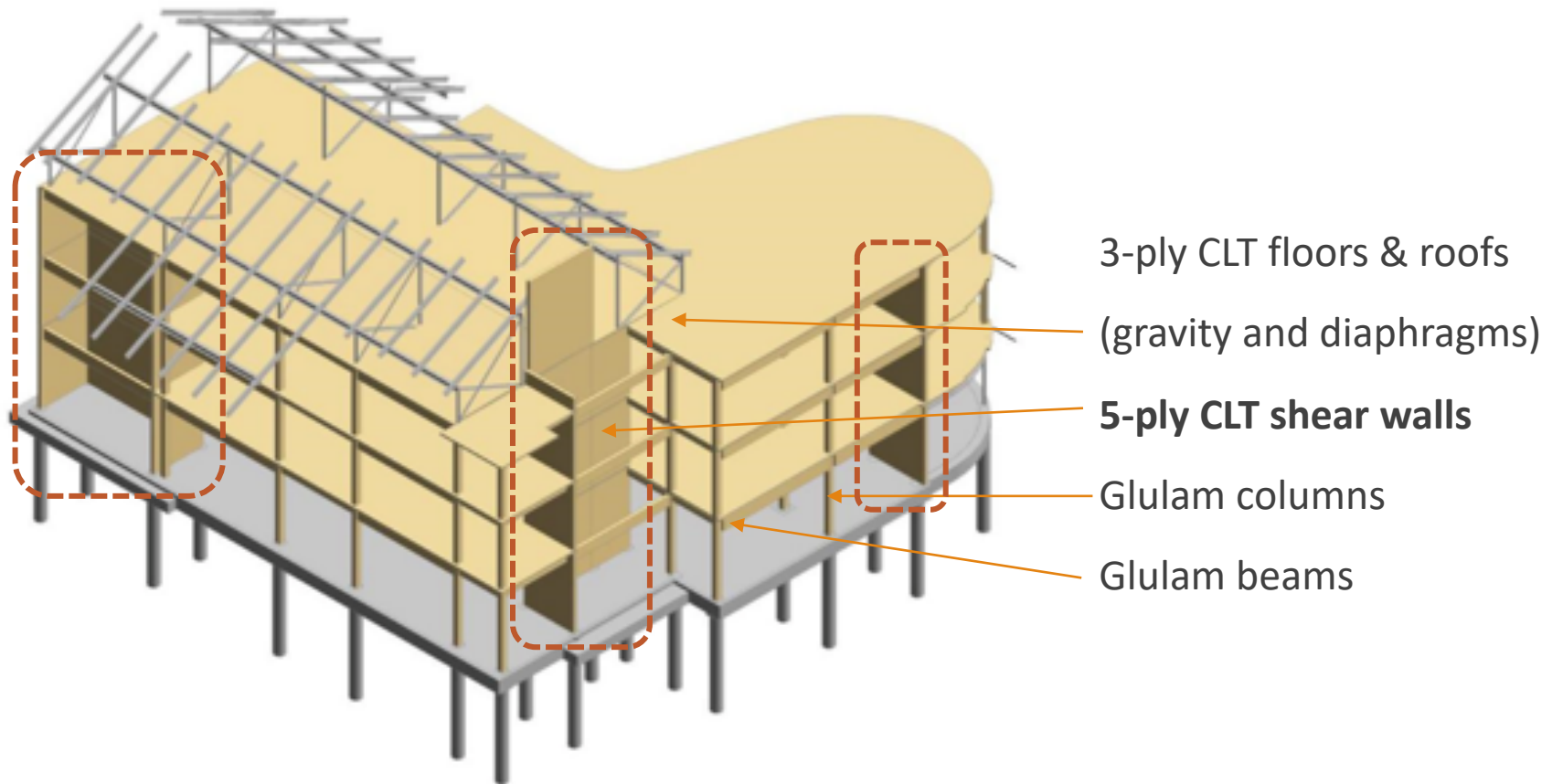


# Structural Design

Rendering courtesy of Lake Flato



# Structural Elements



3-ply



5-ply

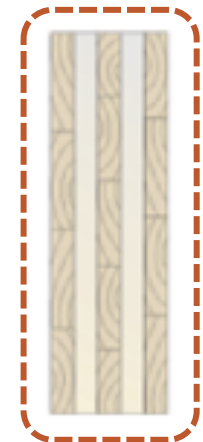


Image courtesy of KL&A

GLU-LAM COLUMNS & BEAMS, 3-PLY CLT FLOOR DECKING, AND 5-PLY CLT SHEAR WALLS

# 3-Ply CLT Decking

3-ply

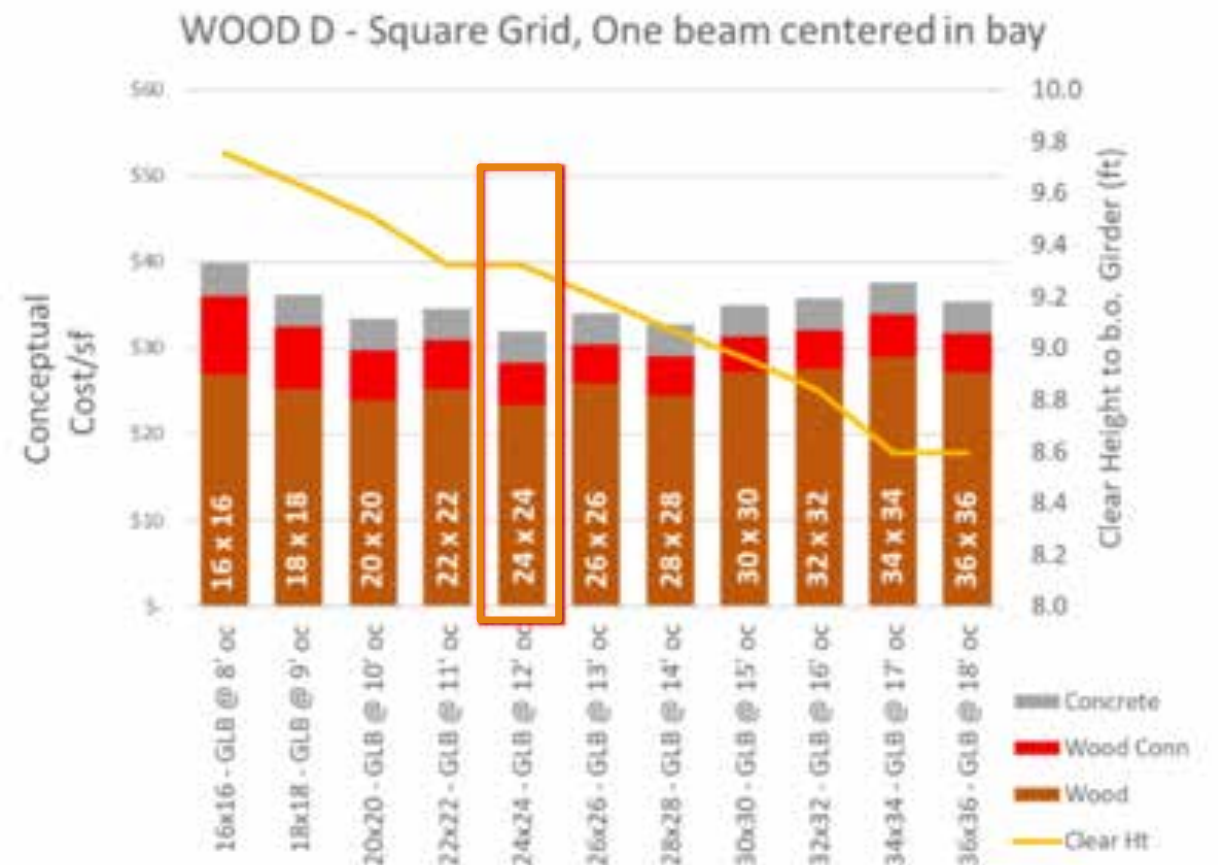


Image courtesy of KL&A

GRID SPACING, VOLUME OF WOOD, and \$/SF







# Acoustics

**Table 1: CLT Floor Assemblies with Concrete/Gypsum Topping, Ceiling Side Exposed**



CLT Panel	Concrete/Gypsum Topping	Acoustical Mat Product Between CLT and Topping	Finish Floor	STC <sup>1</sup>	IIC <sup>1</sup>	Source
CLT 3-ply (3.5")	3" concrete	Maxxon Acousti-Mat® 3/4	None	53 <sup>2</sup> ASTC	45 <sup>2</sup> FIIC	72



# Columns + Beams + Connections

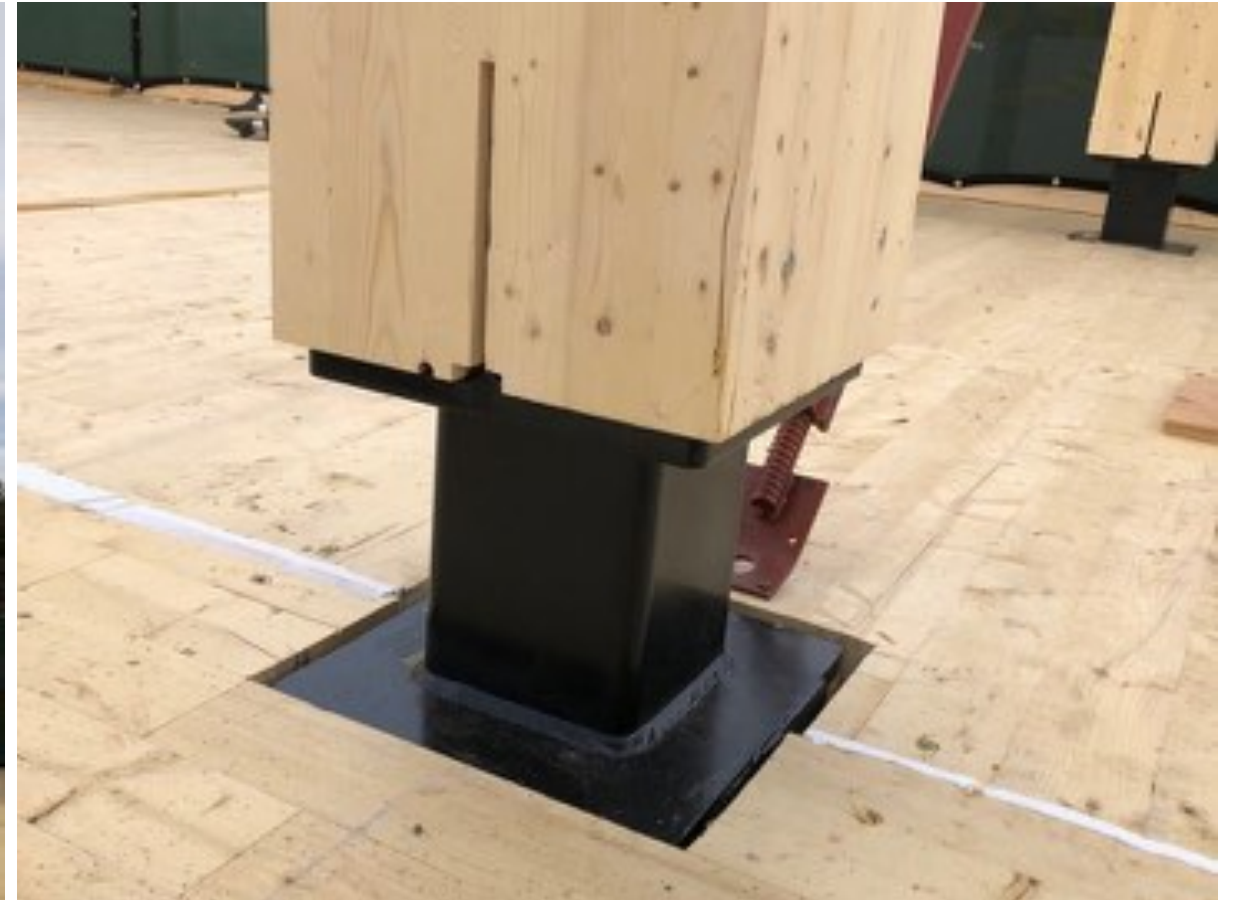
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GLU-LAM BEAMS AND COLUMNS (NOTE SNOW IN FOREGROUND AND COLUMN BASE CONNECTION)

# Columns + Beams + Connections

14,000 individual  
connectors (screws, dowels,  
bolts, etc. Excluding nails  
for plywood, by PCL)



DETAILING AT BOTTOM OF COLUMNS AND SADDLES AT TOPS/BEAMS (EXPRESSION MEETS DURABILITY)



Volume of Wood  
Products: 482 m<sup>3</sup>  
(17,004 ft<sup>3</sup>)

# Shear Walls + Shaft Walls



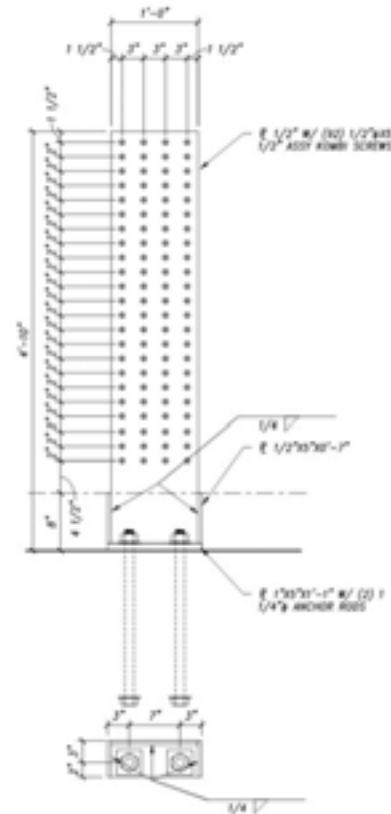
5-ply



5-PLY CLT SHEAR AND SHAFT WALLS – UL-LISTED (UL V329)

Volume of Wood  
Products: 482 m<sup>3</sup>  
(17,004 ft<sup>3</sup>)

# Shear Walls & Hold-downs



5-ply



## FORCES IN CLT SHEAR WALLS TRANSFERRED TO DRILLED PIERS THROUGH HOLD-DOWNS





TYPE III-B  
CONSTRUCTION

ADMINISTRATIVE  
MODIFICATION 1

PERMITTING

EJ #1

GROUND-BREAKING

EJ #2

EJ #3

AM #2

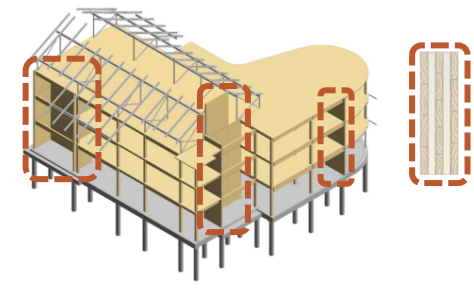
COMPLETE

RATED SHAFT  
ASSEMBLY (5-PLYCL:  
UL-V329)

Pre-Permit Review

Half-Lap

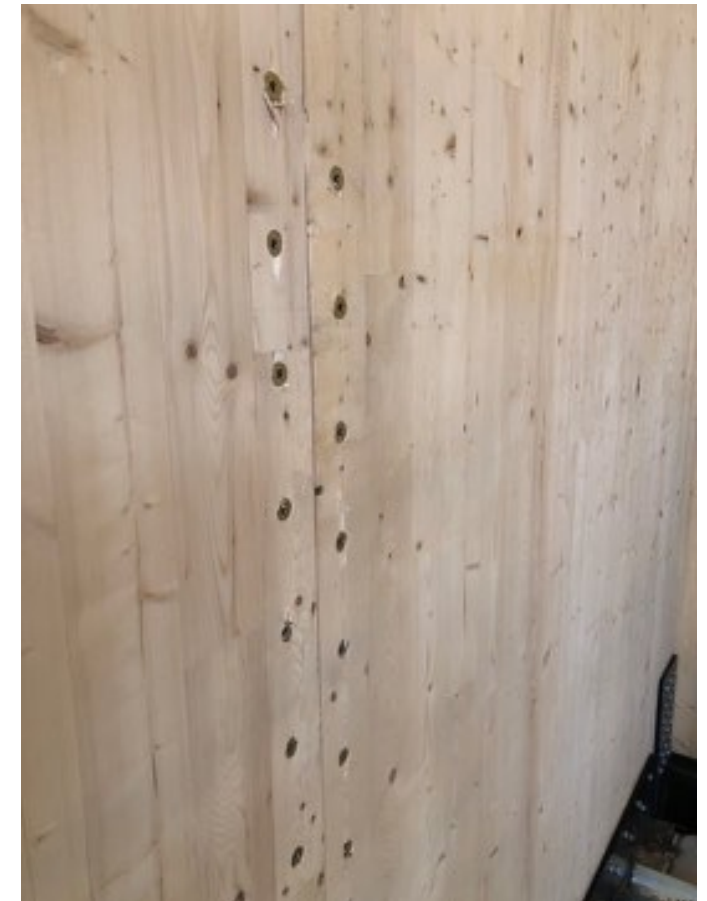
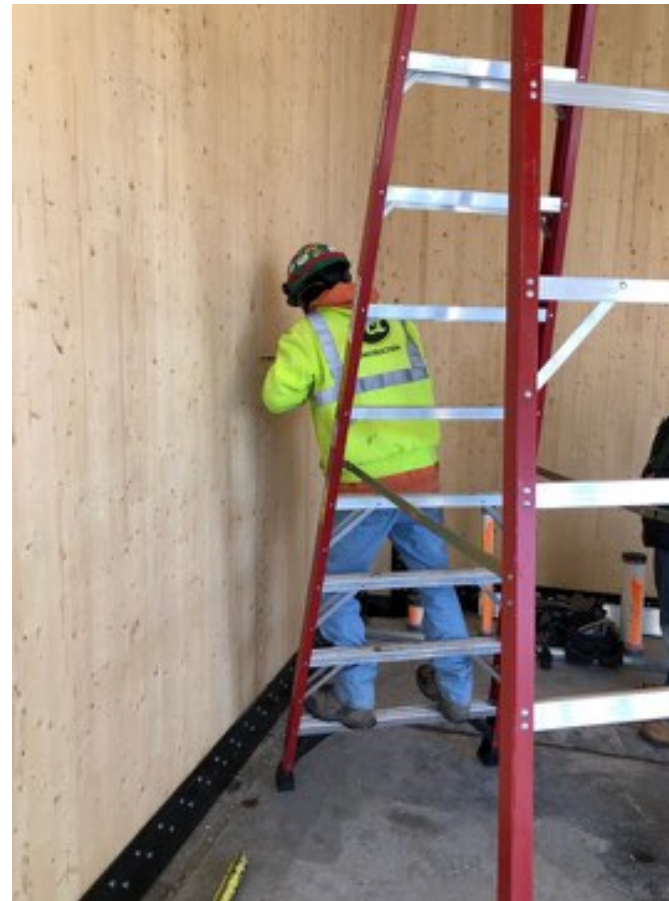
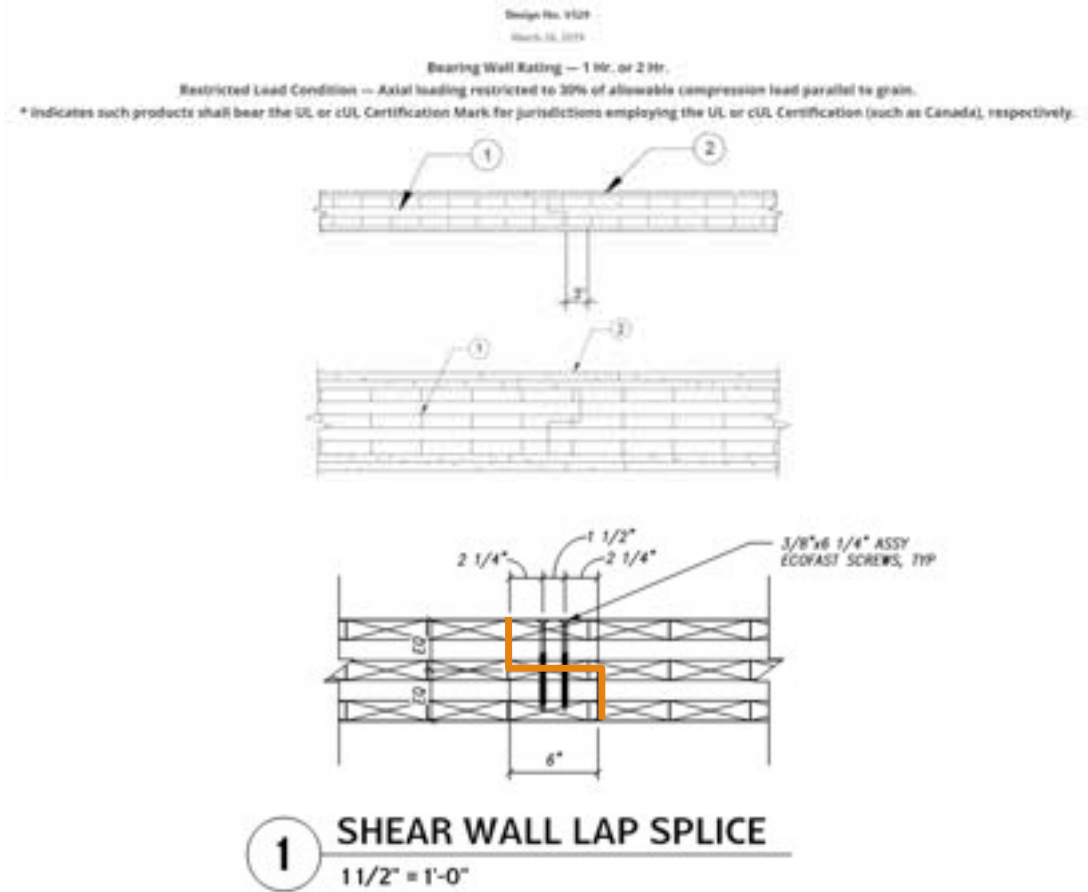
Construction



# City Review Process

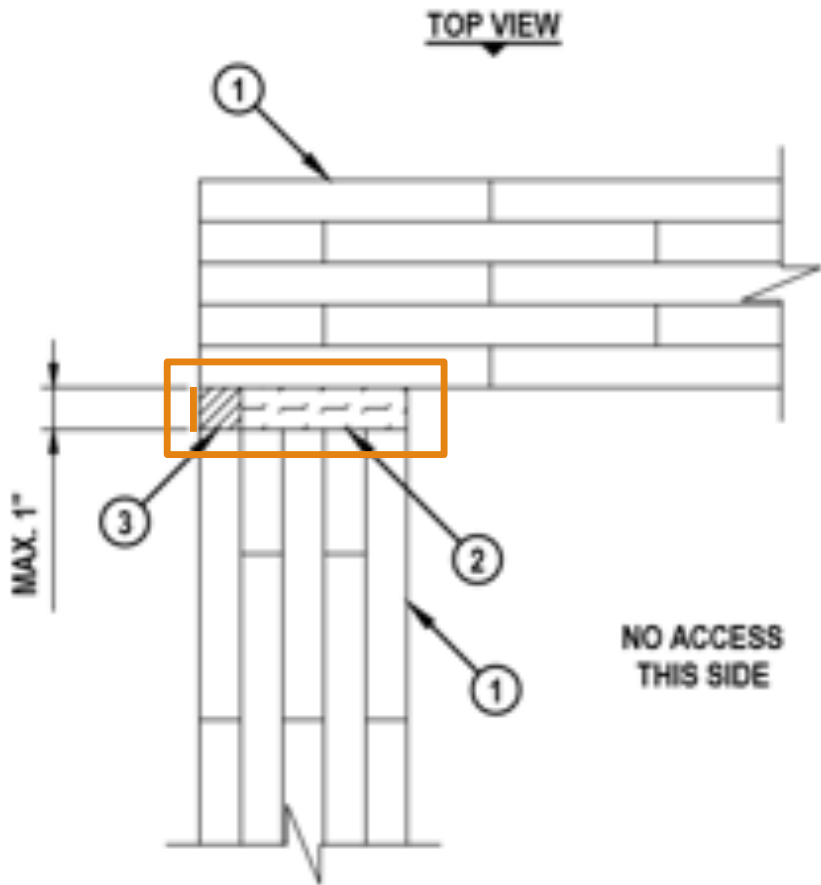
Weight of Steel Connectors:  
10,000 kg (22,000 lbs)

# Permit Review – UL V329 (Half-Lap)





# Construction EJ 2: Perpendicular Joints in CLT



ATYPICAL DETAILS REQUIRED ENGINEERING JUDGEMENTS DURING CONSTRUCTION

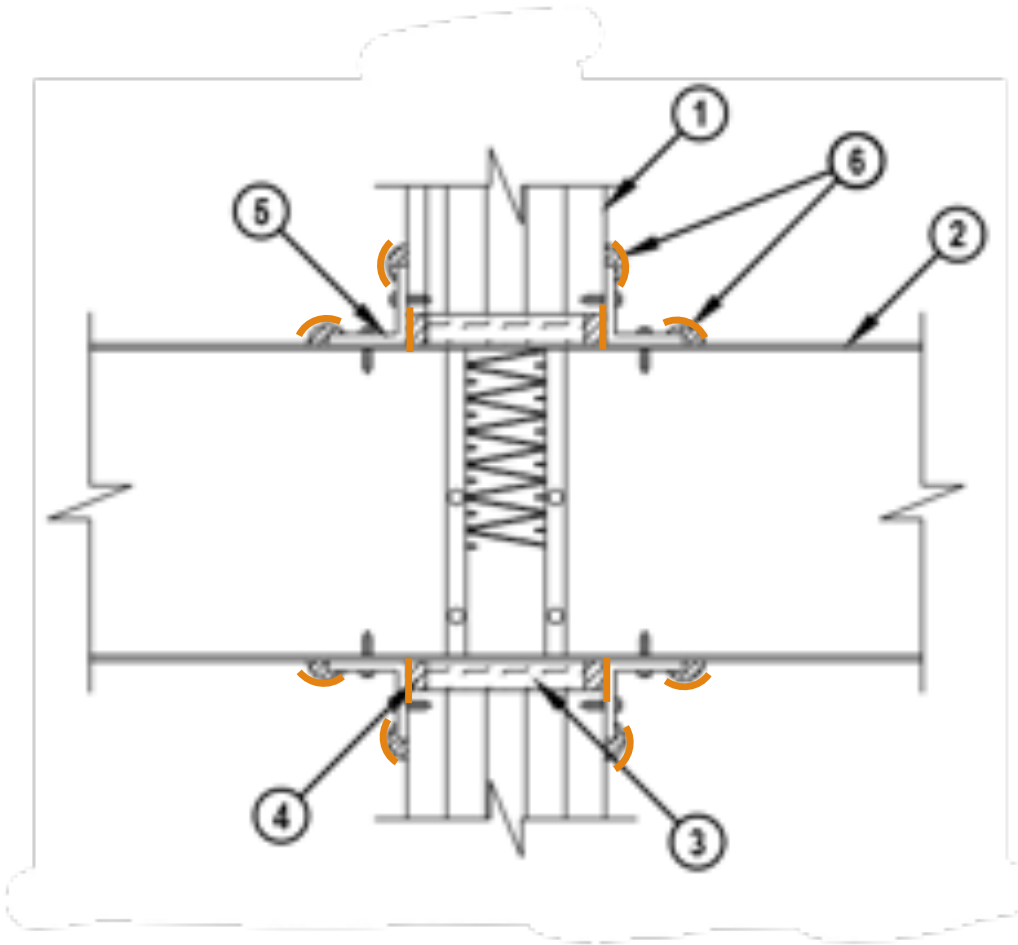
# Construction EJ 3: Hold-downs at Shear Walls



ATYPICAL DETAILS REQUIRED ENGINEERING JUDGEMENTS DURING CONSTRUCTION



# Admin Modification (F/S Damper)



UNIQUE **ASSEMBLIES** REQUIRED ADMINISTRATIVE MODIFICATIONS DURING CONSTRUCTION (MAY BE UL-TESTED...)

# Denver Adopts Tall Mass Timber Codes



Photo: Brock Commons, Arch Daily

## AMENDMENTS TO THE BUILDING AND FIRE CODE FOR THE CITY AND COUNTY OF DENVER

**The 2019 Denver Building and Fire  
Code includes the following codes except  
as amended herein.**

2018 International Building Code  
2018 International Fire Code  
2018 International Existing Building Code  
2018 International Residential Code  
2018 International Mechanical Code  
2018 International Plumbing Code  
2018 International Fuel & Gas Code  
2018 International Energy Conservation Code  
2017 National Electrical Code (or NEC version currently adopted by the State of Colorado)  
2019 Denver Green Code (a voluntary design and construction code)

### USER NOTE

The references in this document to the above listed codes shall be understood as references to those codes as amended. References to code sections in this document will not distinguish if those sections are amended or not.



Photo: HoHo Tower, Rudiger Lainer + Partner

ALLOWS TALL WOOD STRUCTURE AND TYPE IV-A, B, AND C CONSTRUCTION





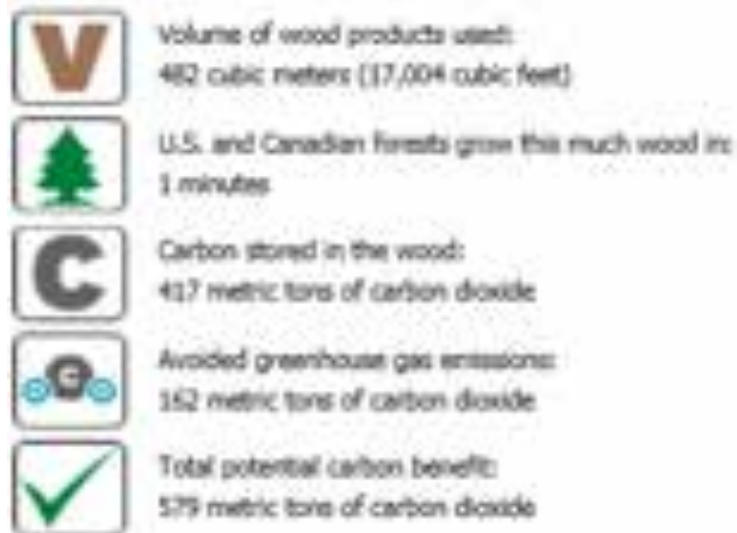
# Lessons Learned: Why Mass Timber?

Rendering courtesy of Lake Flato

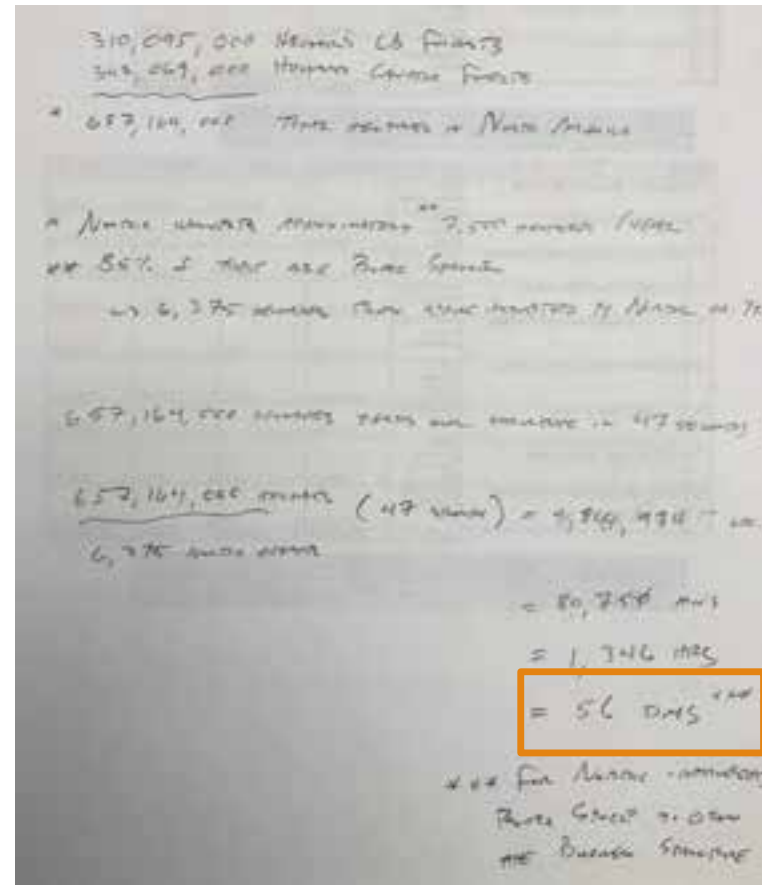
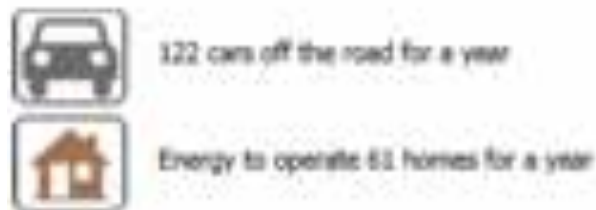
"It's not only realistic, it's imperative," argues Waugh. "It has to happen. In architecture you always go back to the sketch: the sketch is climate change."

<https://www.bbc.com/future/article/20190717-climate-change-wooden-architecture-concrete-global-warming>

# Sustainability Metrics



Equivalent to:



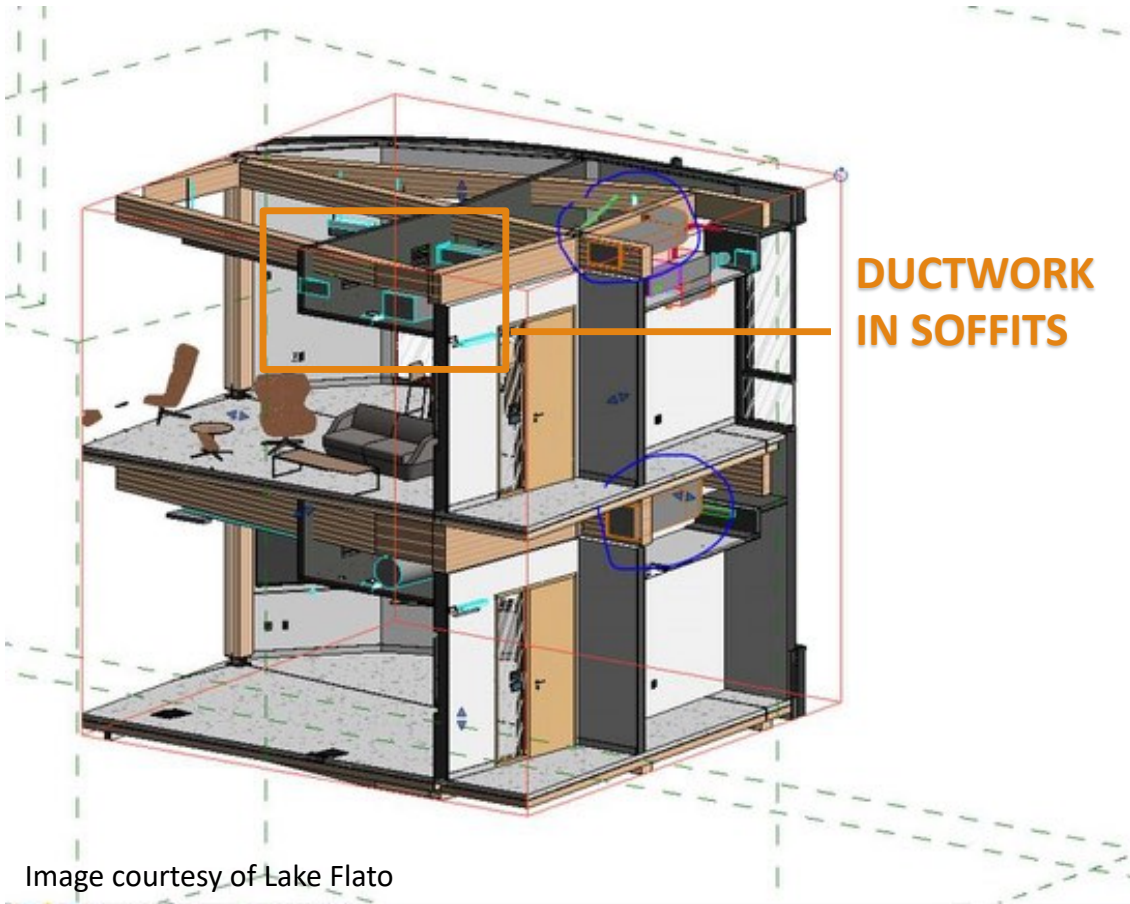
COULD WE REALISTICALLY RETURN TO WOOD AS OUR PRIMARY BUILDING MATERIAL?

**2.8 DAYS!** (ASSUMING TREES ARE HARVESTED AND REPLANTED EVERY 20 YEARS ON AVERAGE...)

OUR STRUCTURE GROWS IN 2.8 DAYS IN NORDIC-LEASED, BLACK SPRUCE, FOREST-STEWARDSHIP-CERTIFIED FORESTS!



# Rigorous Up-Front Coordination



BEAM PENETRATIONS, CLT-DECK AND WALL PENETRATIONS, FIBER-MESH-REINFORCED TOPPING SLAB...

# Shoring

Equivalent to 122 cars off the road for 1 year



SHORING OF SHEAR WALLS AND COORDINATION: SUBSEQUENT TEAMS & ORDER-OF-ERECTION, RIGHT-OF-WAY, ETC.



# Craftsmanship

Avoided GHG Emissions:  
162 metric tons of CO<sup>2</sup>



START-TO-FINISH ERECTION FOR CLT STRUCTURE (LVL1-ROOF) WAS 5.5 WEEKS (ALL BY THE 8 PEOPLE SEEN ABOVE)

# University Engagement

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Image courtesy of PCL Construction

THE CLIENT WANTED EXPOSED WOOD SURFACES AND THEY INSTALLED SOME OF THE DOWELS THEMSELVES!

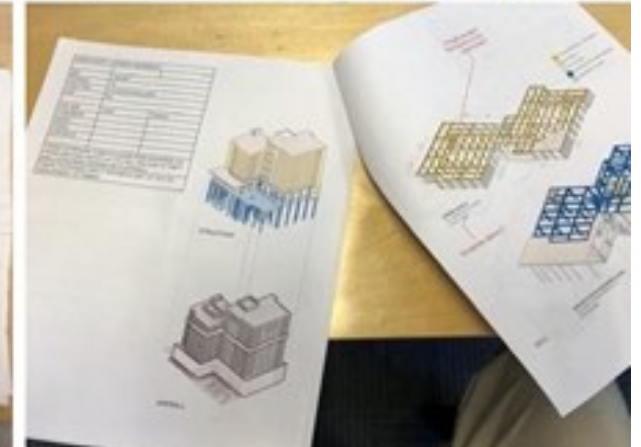
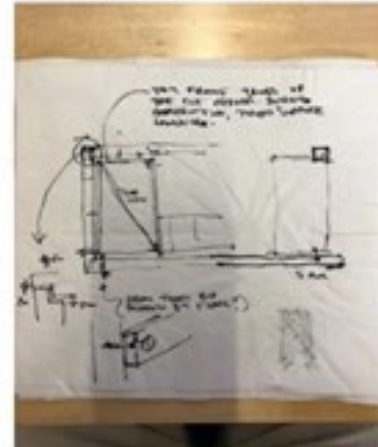
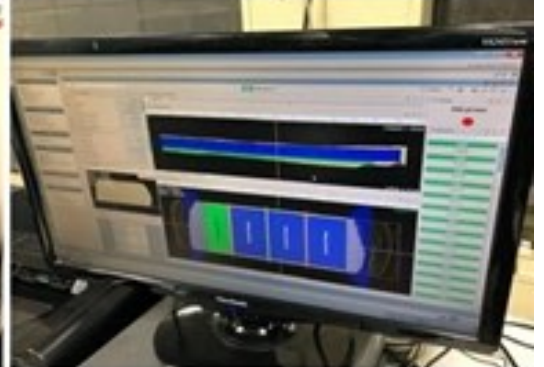


# Authenticity

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AND THE CLIENT DIDN'T WANT TO CHANGE THE WOOD'S APPEARANCE – THEY WANTED IT TO BE AUTHENTIC!



NOT JUST AN AUTHENTIC MATERIAL, BUT AN AUTHENTIC PROCESS – TRUE COLLABORATION ON ALL LEVELS!



# Happiness Quotient

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Ox Blue





# Thank you!

*This concludes The American Institute of Architects Continuing Education Systems Course*

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