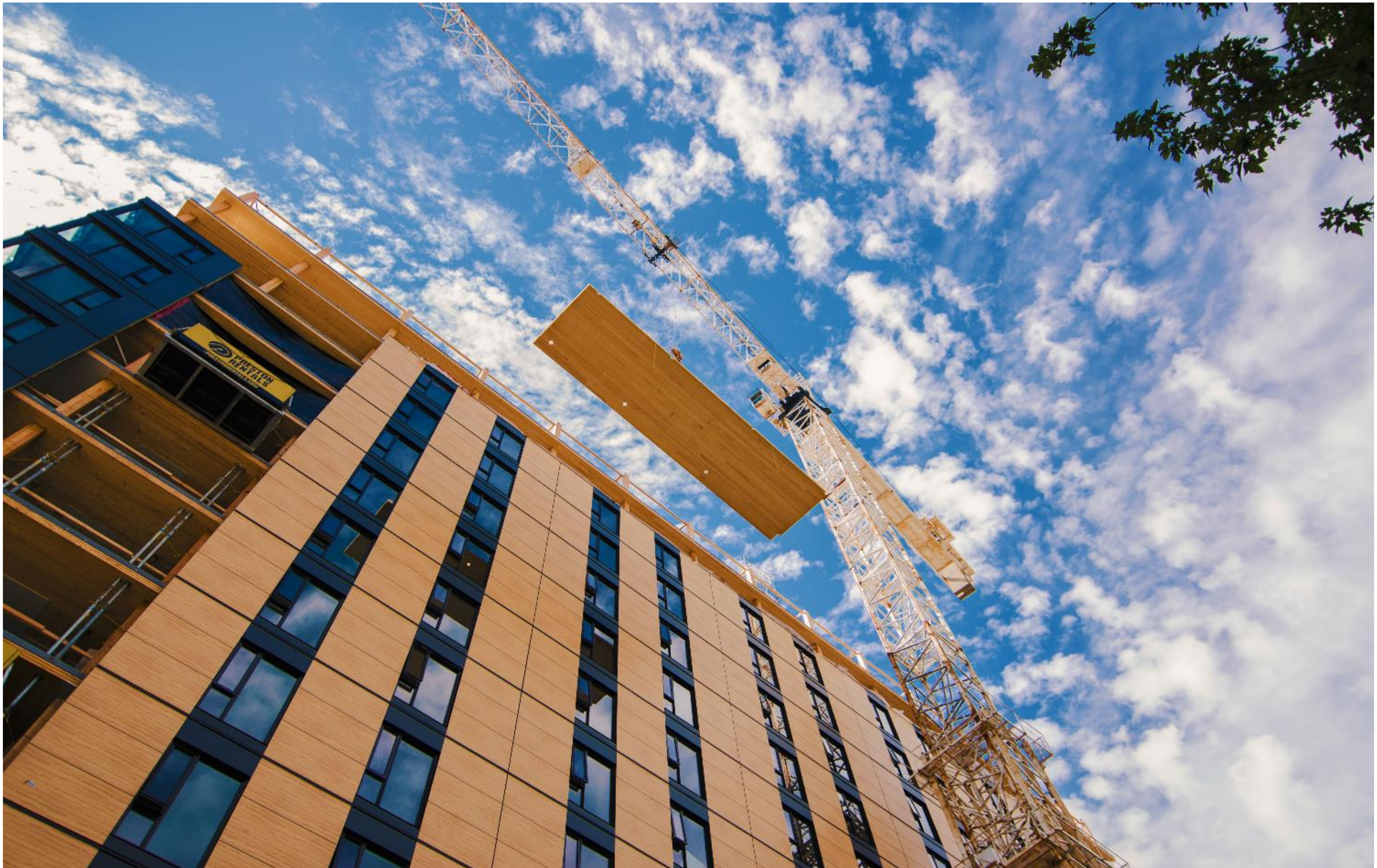


BROCK COMMONS
TALLWOOD HOUSE

AUA Conference

2018

CAMPUS AS A LIVING LAB

- Integrate research & teaching with operations
- Partnerships with private, public or NGOs
- Sound financial use of resources
- Transfer knowledge to industry application

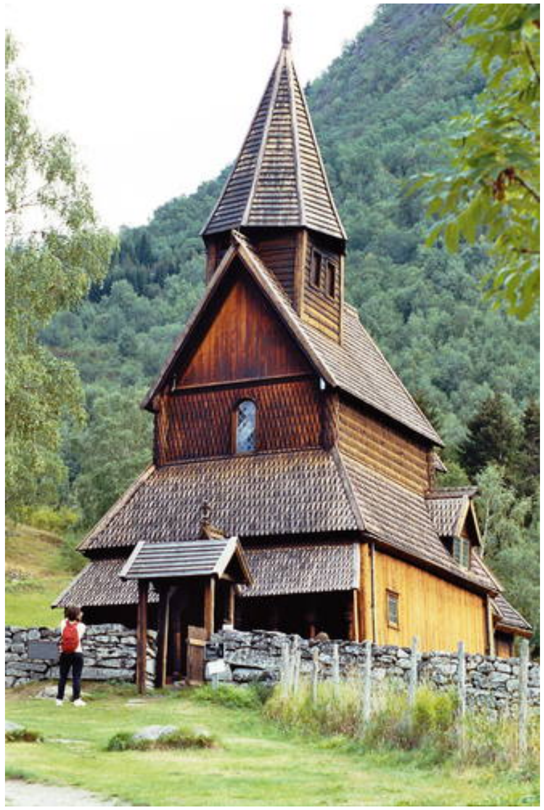
(Image: Don Erhardt)

HISTORICAL TALL WOOD BUILDINGS

Pagoda China | 219 feet

Year 1056

(Image: Gisling)



Sogn og Fjordane, Norway

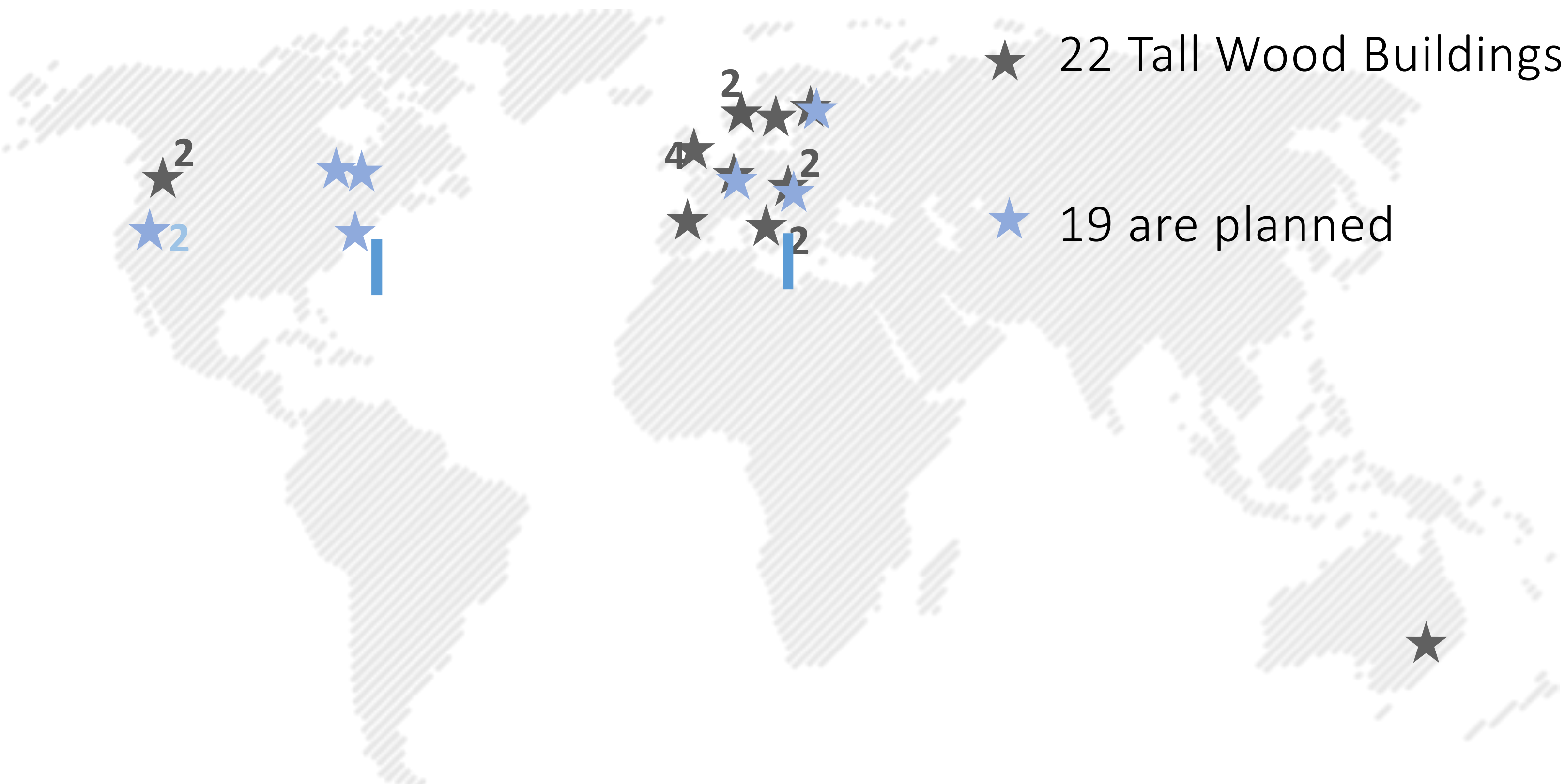
Year 1130

(Image: Unesco)

Barsana Monastery | 183 feet

(Image: Green)

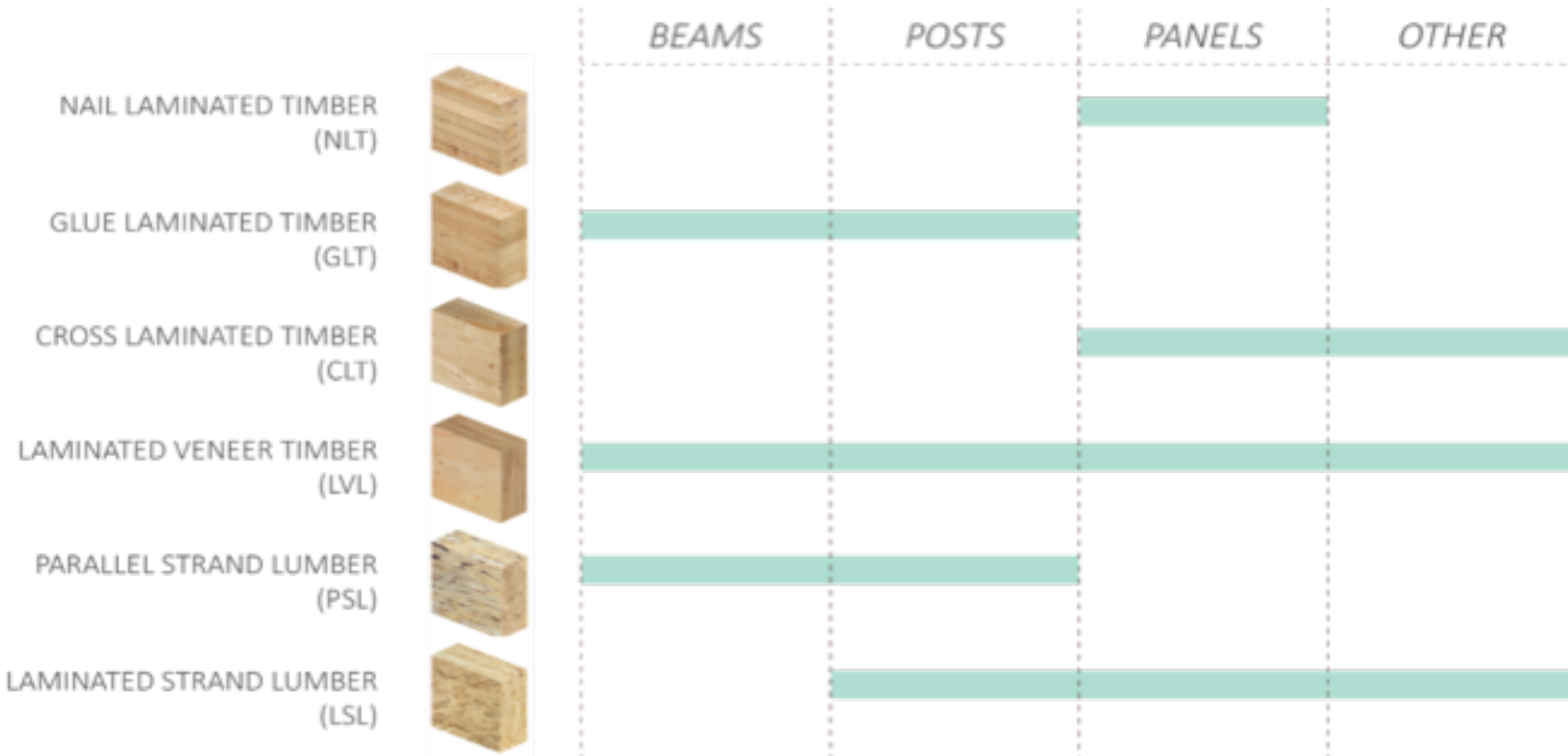
CONTEMPORARY TALL WOOD BUILDINGS



BROCK COMMONS TALLWOOD HOUSE

MASS TIMBER OVERVIEW

UBC sustainability



(Table:UBC)

TALLWOOD HOUSE OVERVIEW

18 storeys

9.2 ft. floor to floor

440 student beds

(Image:naturally:wood)

FLOOR LAYOUT

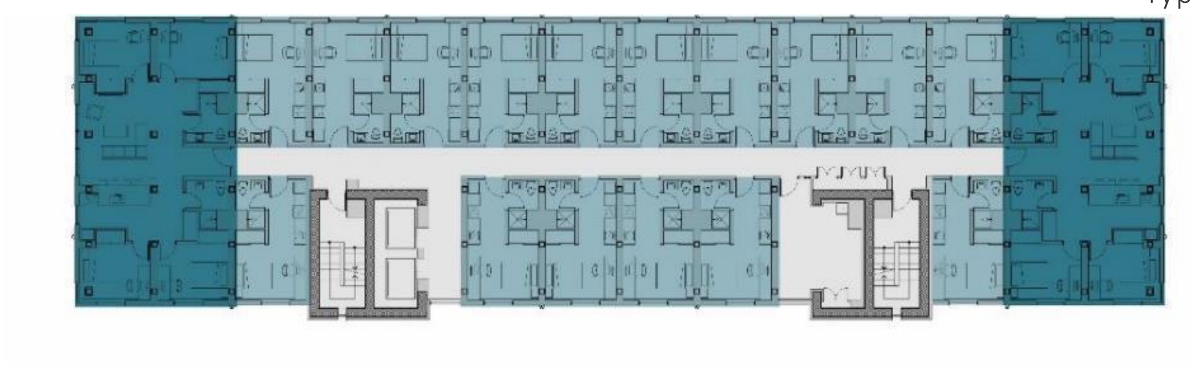
9040 ft^2 footprint

Ground Floor Plan

Service Space
Social Space
Access Areas

Typical Floor Plan

Four-bedroom
Studio
Access Areas

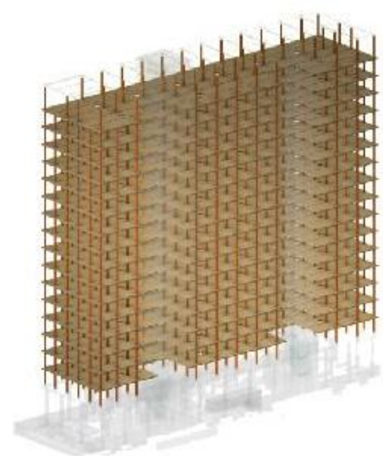


(Images: Acton Ostry Architects)

A HYBRID STRUCTURE

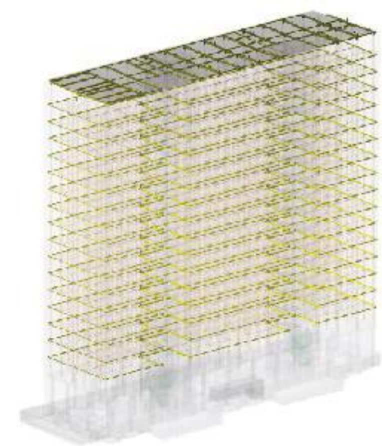
Cast-In-Place Reinforced Concrete Structure

- Foundation
- Ground Floor
- Second floor slab
- Building floors



Wood Structure Components

- CLT panels for floors
- GLT columns
- PSL heavy-loaded columns



Steel Components

- Connections
- Floor perimeters
- Roof decking + structure

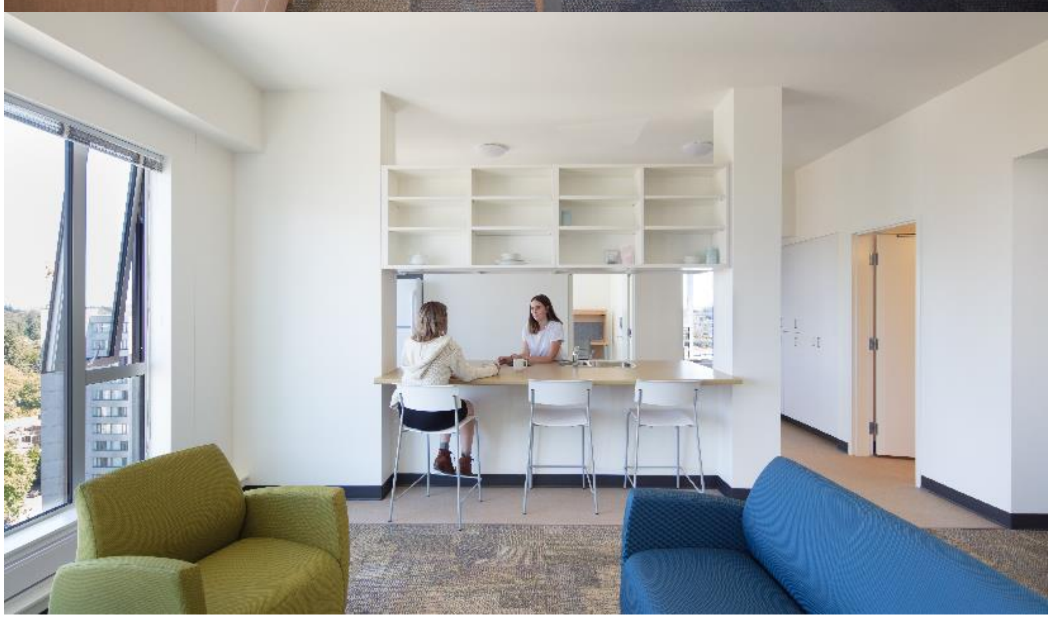
(Images: CadMakers Inc.)

ENCAPSULATION DETAIL

(Image: Acton Ostry)

- Concrete topping on the CLT panels
- Cover floors with carpet or resilient tiles
- 3 layers of type X gypsum board on walls and ceilings
- 4 layers of type X gypsum board on freestanding columns
- Concrete and 1 layer of gypsum board installed during construction for fire protection

WHY NOT EXPOSED WOOD?



Why not expose mass timber?

› reduce approval process time

› building maintenance

› replicability of the design

(Images: Acton Ostry Architects)

DESIGN RATIONALE & STRATEGY

Design Philosophy:

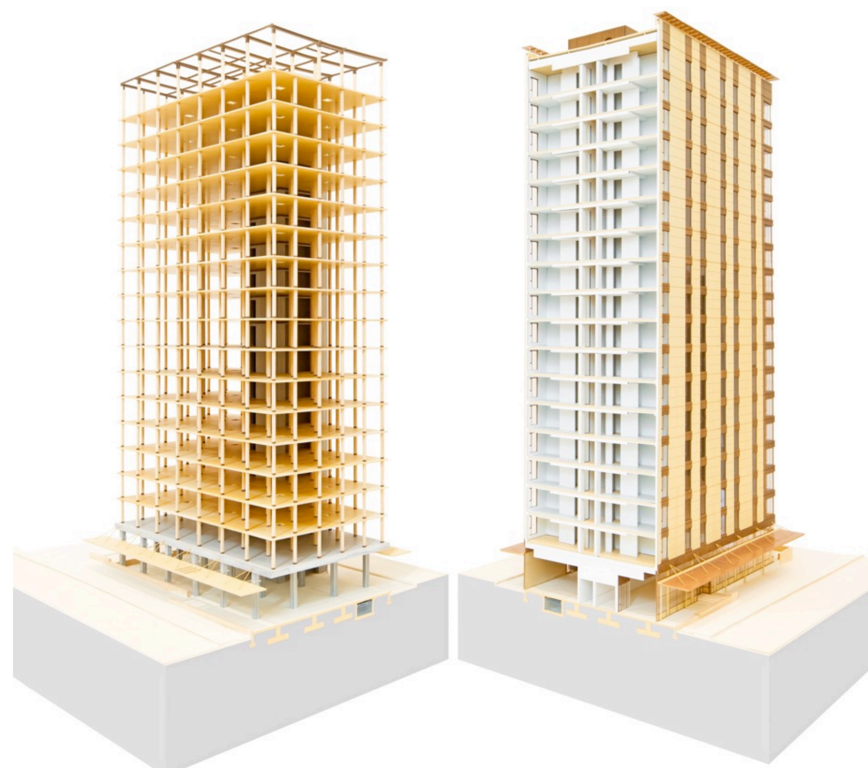
Tall wood in not about promoting a vision, but rather fueling an evolution

Design Objective:

To serve as a replicable model for future tall wood construction

Design Strategy:

Keep it simple



(Model: Acton Ostry Architects)

TALLWOOD HOUSE OVERVIEW

Key design tools:

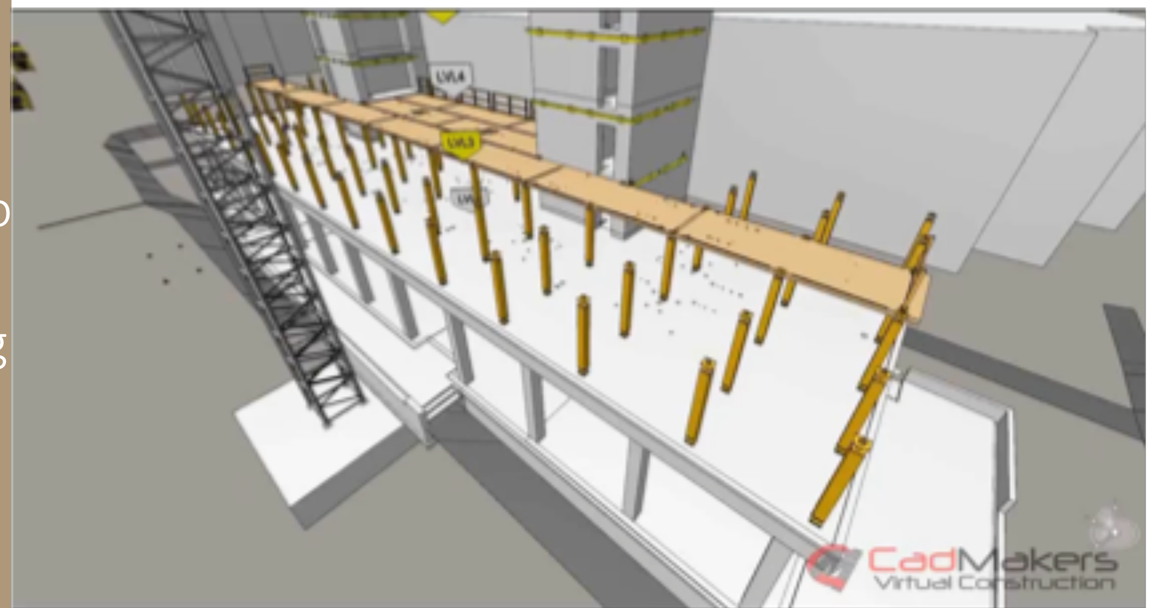
- VDC 3D modeling
- Full-scale mock-up
- Panel testing

(Image:naturally:wood)

VDC MODEL IN DESIGN PROCESS

3D model – design-assist tool:

- Design decision-making
- Building systems coordinatio
- Clash detection
- Quantity takeoffs for costing
- Constructability review

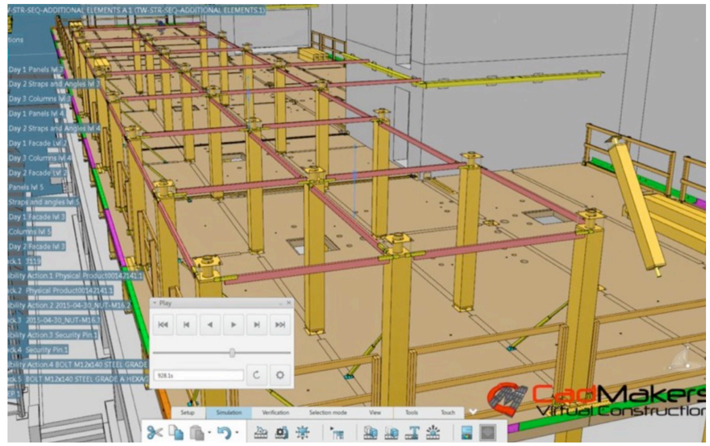


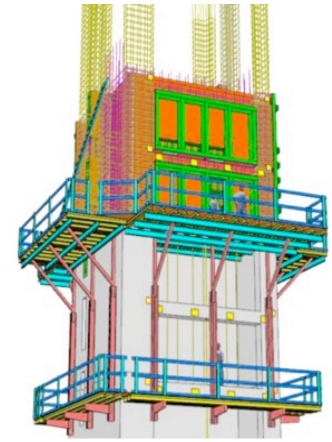
(Video: CadMakers Inc.)

VDC MODEL IN CONSTRUCTION PROCESS

Construction assist tool

- Trades communication
- Team cooperation
- Construction planning and sequencing





Fabrication model

- Direct output to the mass-timber fabricator
- Predesigned layouts of all MEP systems for CLT penetrations and cut-outs

(Images: CadMakers Inc. & naturally:wood)

FULL SCALE MOCK-UP

UBC sustainability

Optimize critical design /construction decisions:

- Connection details
- Procedures and sequencing
- Concrete topping
- Envelope materials
- Finishes

(Image: UBC)

MASS TIMBER TESTS

Structural Tests

- Point supported CLT panel load
- to understand how and at what point the panel would fail

Results

- withstood higher loads than anticipated
- redistributes forces as internal shear cracks propagated through the panel before critical failure

(Images: Fast + Epp)

PREFABRICATED ELEMENTS

Floor Panels

› CLT panels with cut-outs

Columns

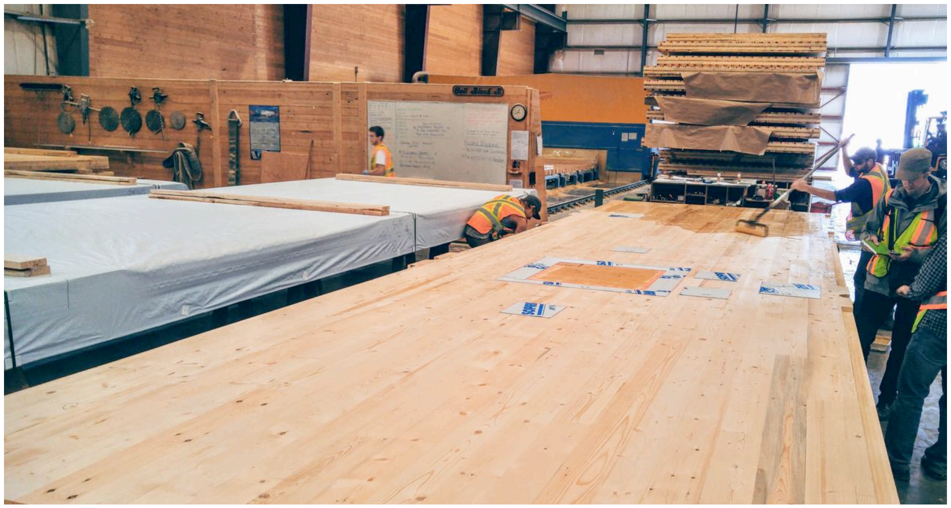
› GLT and PSL columns with steel connectors on both ends

Envelope Panels

› Steel frame rainscreen panels with punched windows

(Photo: naturally:wood)

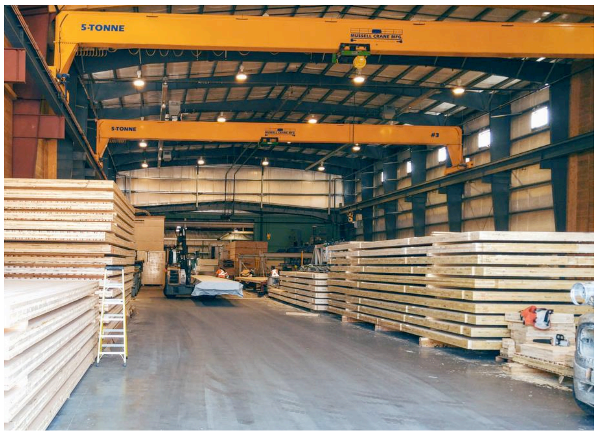
MASS TIMBER MANUFACTURING

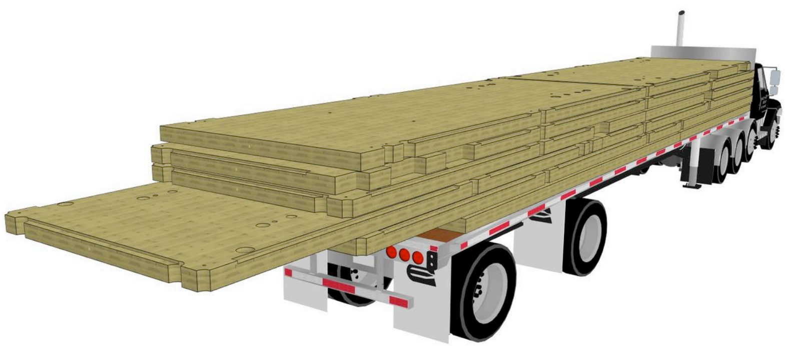


- mass-timber prefabricated in 3 months
- CNC[1] machines - tight tolerances
- Column steel connections were embedded

(Images: Structurlam, UBC)

SHIPMENT OF PREFABRICATED ELEMENTS





- Just-in-time delivery
- Fabrication arranged in a linear process coordinated with the delivery to the site
- Trucks loaded in reverse order of actual installation

(Images: Structurlam, UBC)

MASS TIMBER INSTALLATION

Installation process

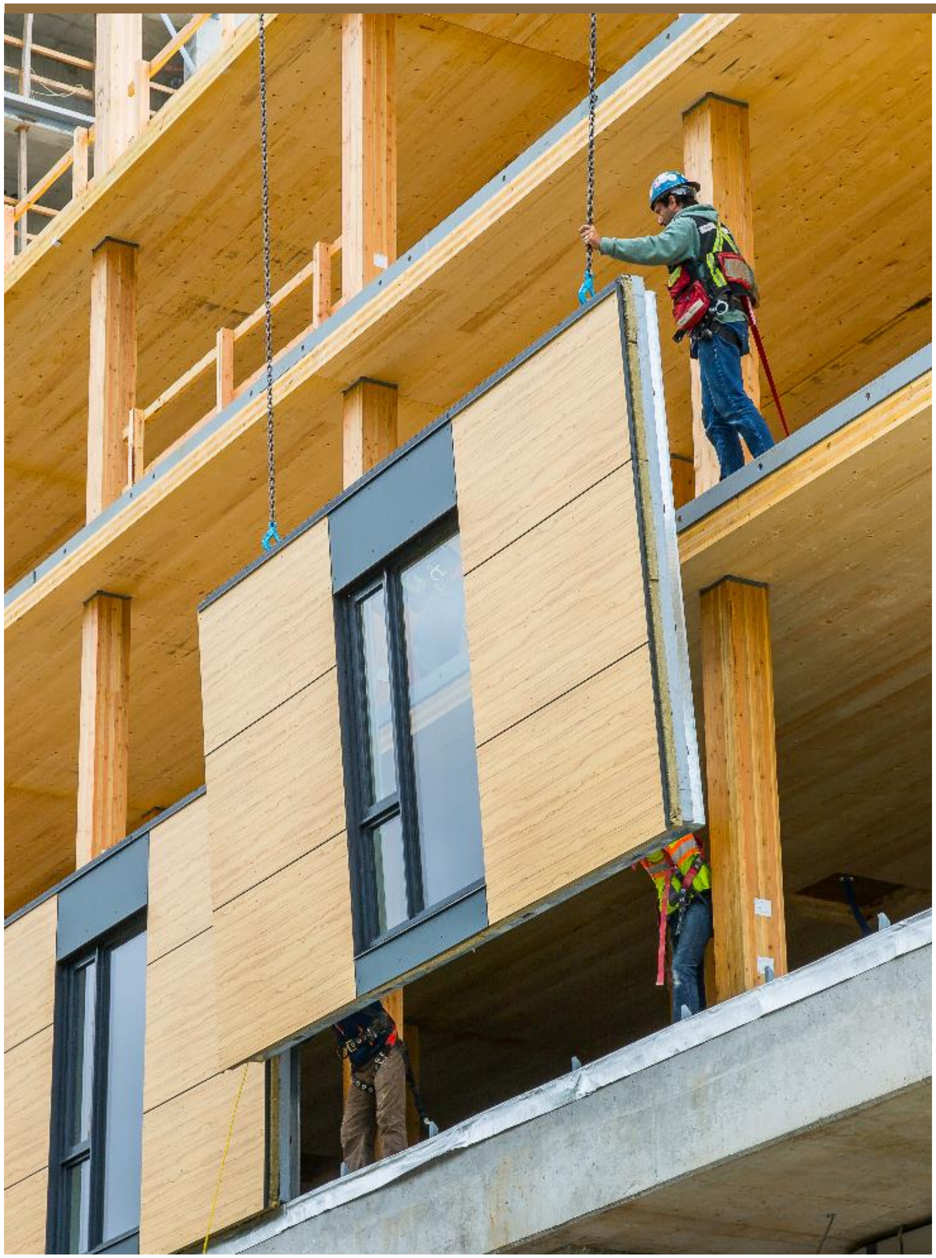
- Panels lifted by crane & manually secured in place
- Bundles of columns craned up & manually fixed into place

Prefabrication advantages

- Fast installation: 2 floors per week
- Simple installation required small crews

(Image: naturally:wood)

ENVELOPE PANEL INSTALLATION



Installation process

- Panels hung from perimeter steel L-angle attached to each floor

Prefabrication advantages

- Fast installation: 1 floor per day
- Required small crews
- Eliminated need for scaffolding

(Image: naturally:wood)

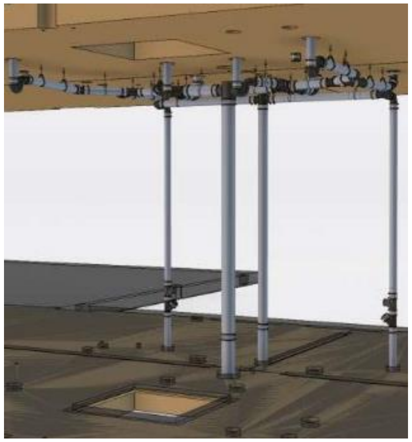
MECHANICAL/ELECTRICAL/PLUMBING SYSTEMS

MEP systems:

- Modelled in VDC
- Precut off-site

Mechanical room

- Cutting and welding of pieces were done off site
- Installation 1 month (vs. 3-4 month typical)



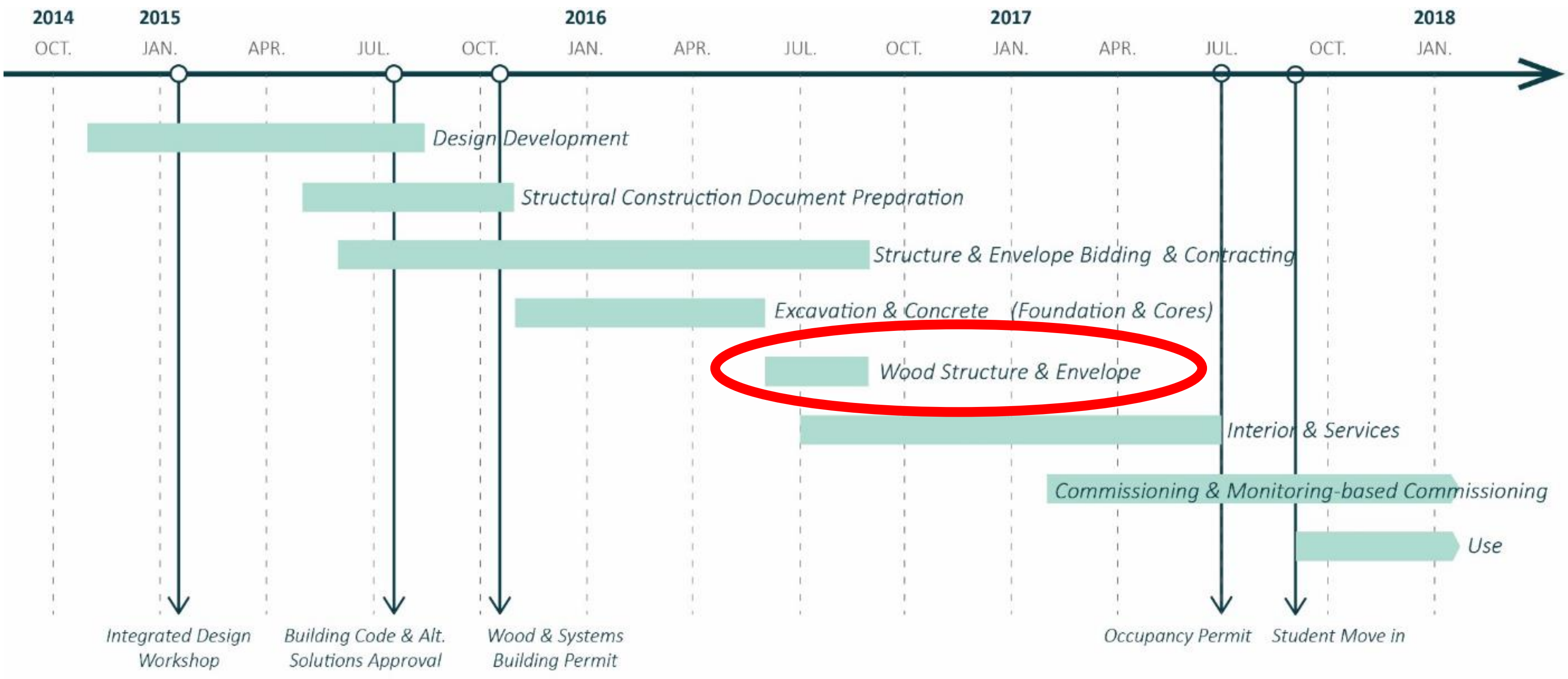
(Images: CadMakers Inc., Urban One, UBC)

CONSTRUCTION SEQUENCE

(Video: naturally:wood and Thomas Froese; Edit: Salah Koleilat)

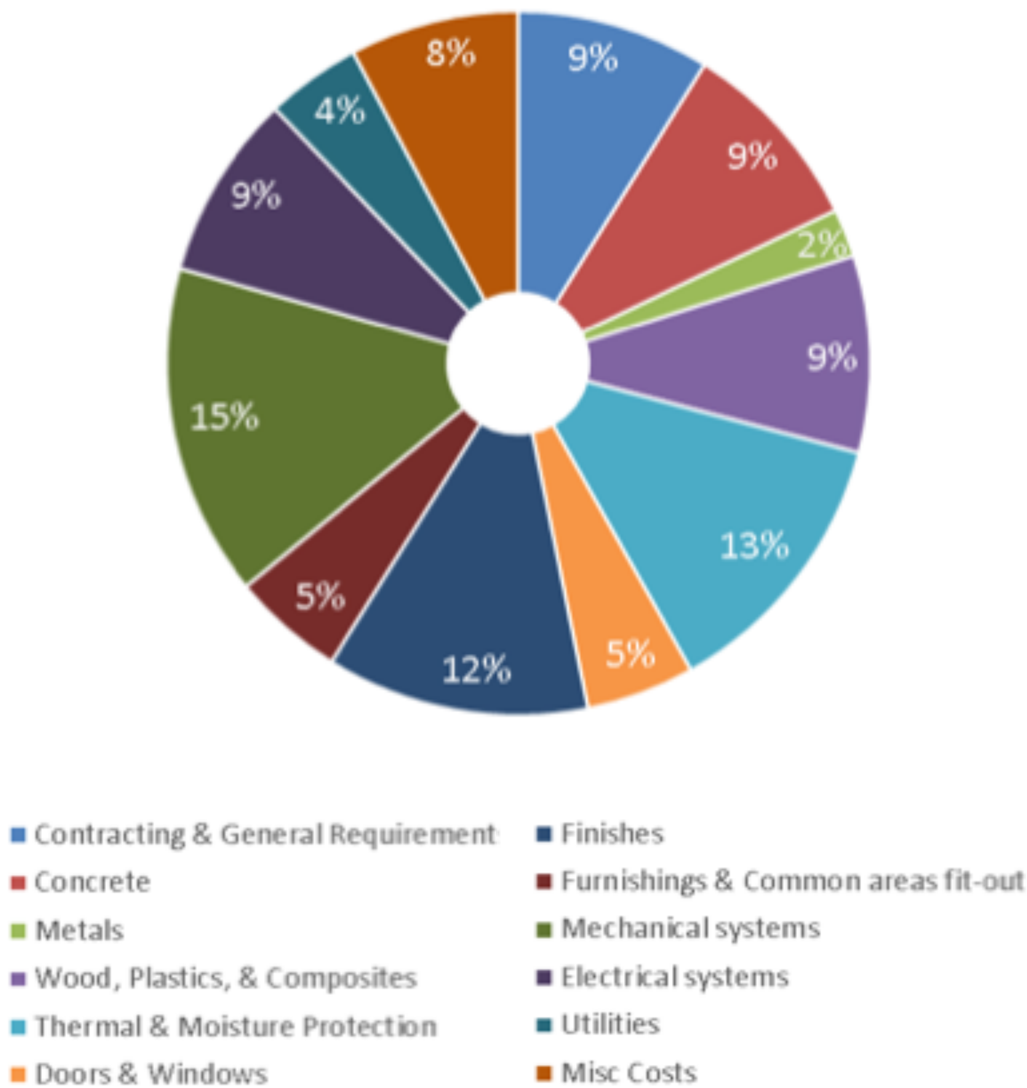
BROCK COMMONS TALLWOOD HOUSE

PROJECT TIMELINE



(Image: UBC)

PROJECT COSTS



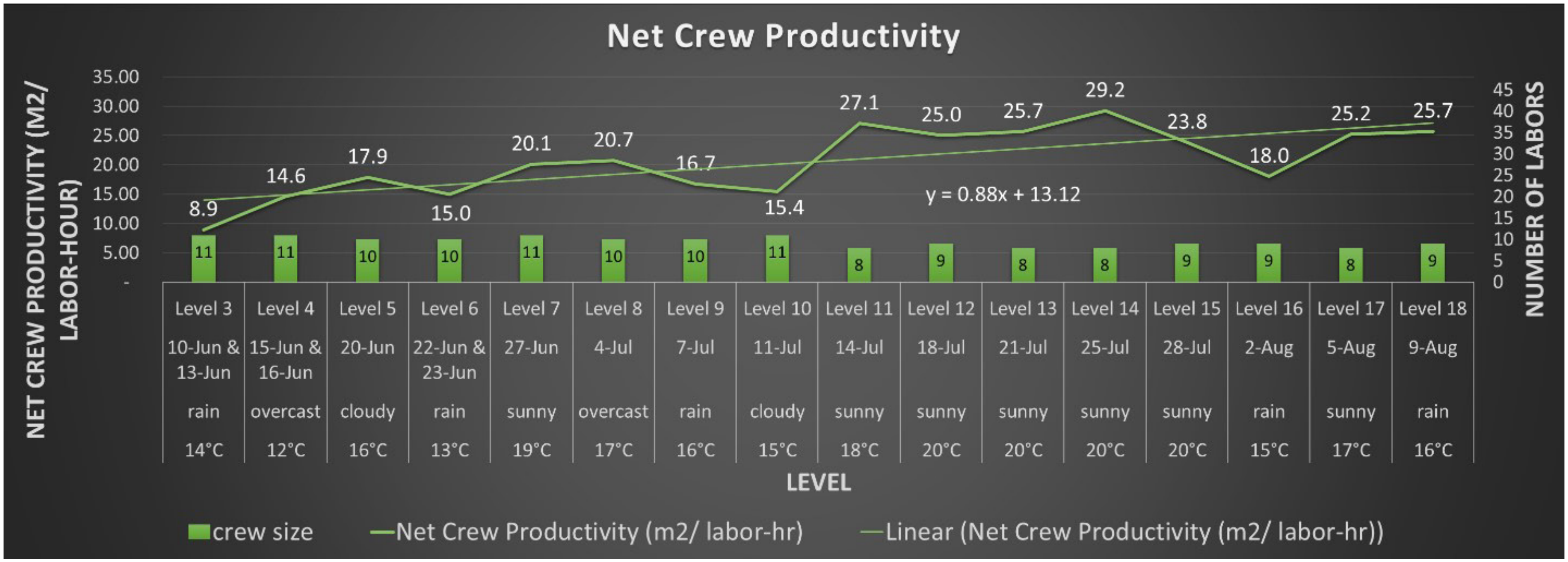
Total Project Costs: $50.5 Million

- Design costs: $3.8M
- Construction cost:
  - $40.5M
  - $249/gsf

Innovation premium:

- $2.8 M (7% of construction)
- 3rd party funded
- expected to reduce as market develops

PRODUCTIVITY ANALYSIS



- The productivity analysis showed an increasing trend net crew productivity for CLT and envelope panels
- The increased productivity shows the learning curve effect which is involved with the adoption of new building systems and technologies

(Graph: Mohammed Kasbar, UBC BIM TOPiCS Lab)

BROCK COMMONS TALLWOOD HOUSE

EMBODIED CARBON

Volume of wood:
2,233 cubic meters of CLT and Glulam

U.S. and Canadian forests grow this much wood in:
6 minutes

Carbon stored in the wood:
1,753 metric tons of CO_2

Avoided greenhouse gas emissions:
679 metric tons of CO_2

TOTAL POTENTIAL CARBON BENEFIT:
2,432 metric tons of CO_2

EQUIVALENT TO:

511 cars off the road for a year

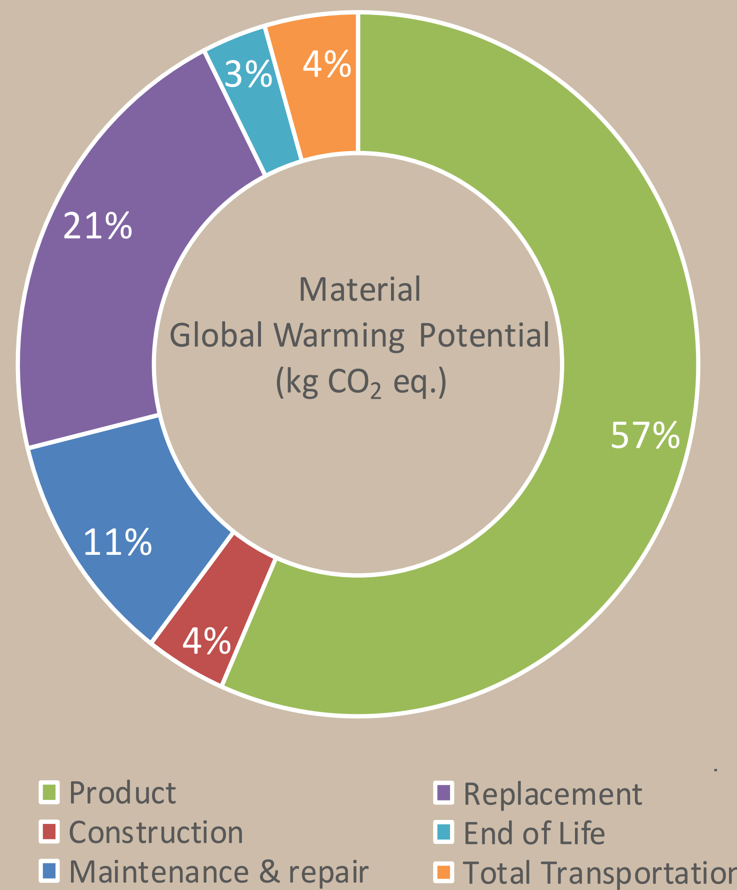
Energy to operate a home for 222 years

Source: US EPA

(Image Acton Ostry Architects)

BROCK COMMONS TALLWOOD HOUSE

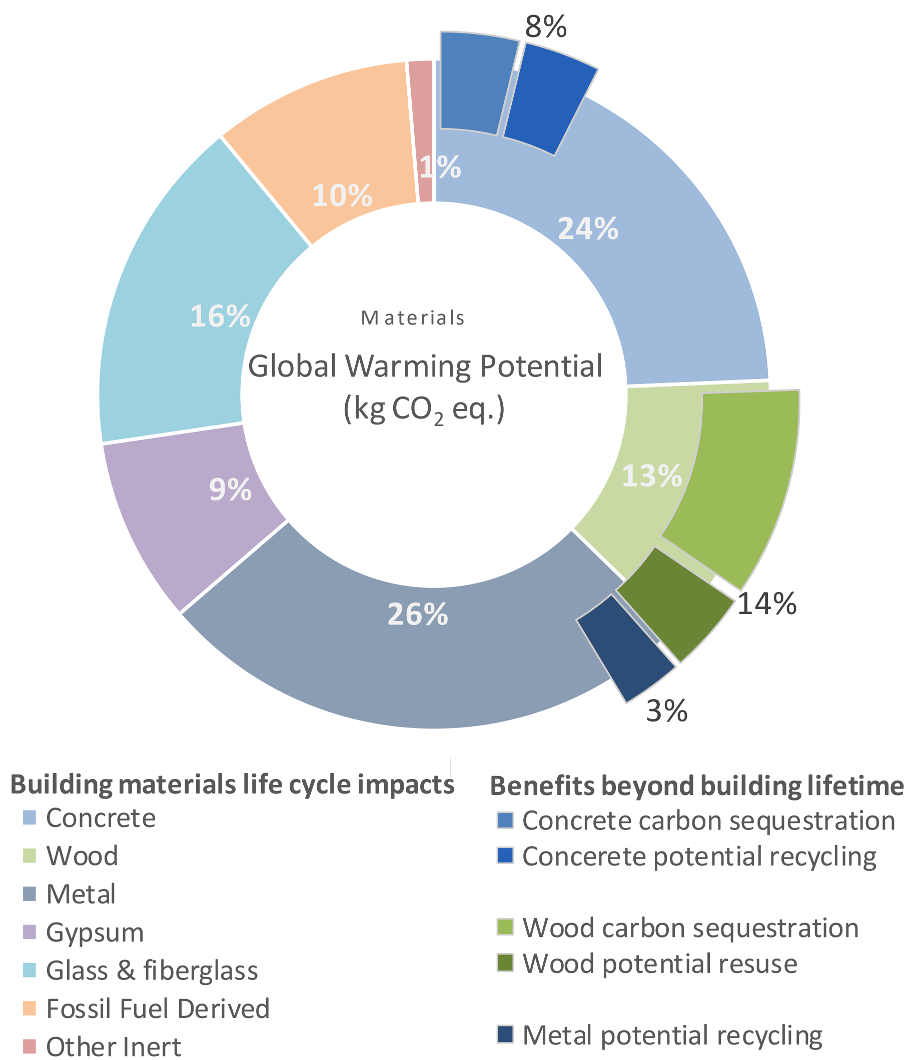
MATERIAL LIFE CYCLE CARBON IMPACTS



** Transportation in the product stage is included within the product category*

(Graphs: UBC, LCA Study: Athena Sustainable Building Material Institute)

CARBON BENEFITS



(Graph: Urban One Builders, Sensible Buildings Science, UBC)12

- Carbon impacts are distributed across the different types of building materials
- Structural materials cause nearly half of material carbon emissions
- The volume of wood in is 2/3 the volume of concrete, but its carbon emission is only 1/2
- The carbon sequestration and reuse potential of wood result in net positive impacts from wood

BUILDING PERFORMANCE MONITORING

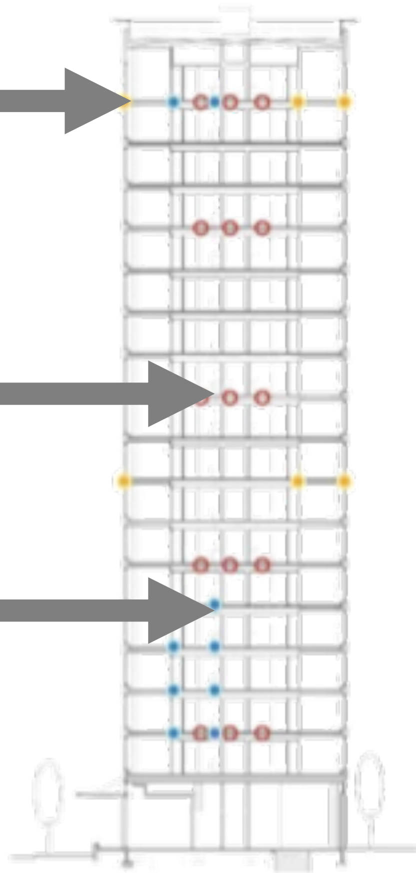
ubc sustainability

Goal

Validate design through performance and refine design strategies for future buildings

Monitoring Systems

- CLT Moisture Monitoring
  - Point Moisture Measurement (PMM) sensors for moisture content values
- Vibration Monitoring
  - Accelerometers for 3-Way vibration analysis
- Vertical Displacement Monitoring
  - String-and-Pot sensors for elastic and inelastic shortening measurement

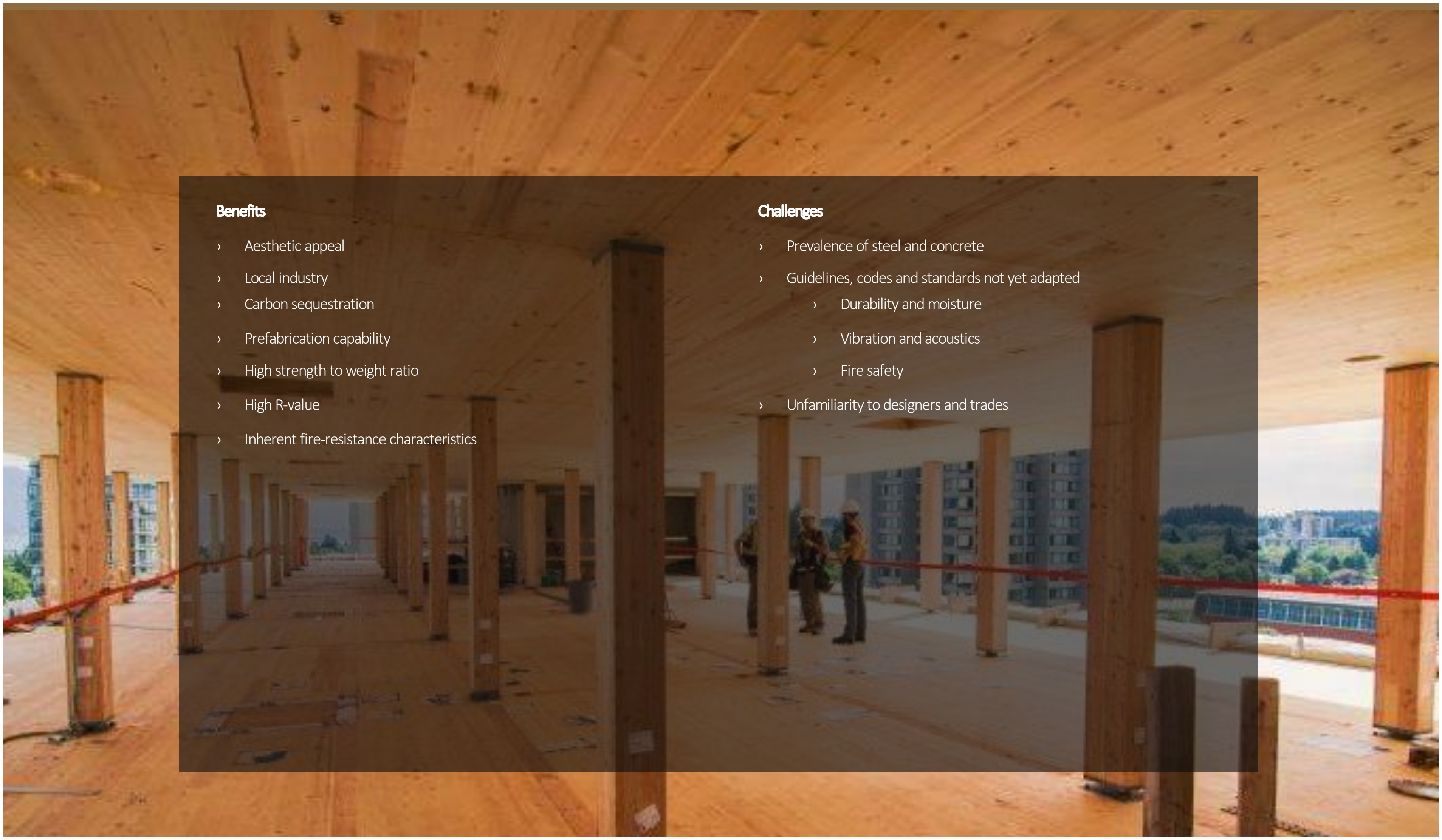


(Image: Acton Ostry)

BROCK COMMONS TALLWOOD HOUSE

MASS TIMBER BENEFITS & CHALLENGES

UBC sustainability



Benefits

- Aesthetic appeal
- Local industry
- Carbon sequestration
- Prefabrication capability
- High strength to weight ratio
- High R-value
- Inherent fire-resistance characteristics

Challenges

- Prevalence of steel and concrete
- Guidelines, codes and standards not yet adapted
  - Durability and moisture
  - Vibration and acoustics
  - Fire safety
- Unfamiliarity to designers and trades

(Image: Acton Ostry Architects)