Brock Commons Student Residence
The University of British Columbia
STUDENT RESIDENCE AT BROCK COMMONS

- Project Background
- Design Context
- Design Approach
- Building Overview
- Key Analysis / Design Issues
- Construction
- Conclusion
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Project Background
EXTERNAL FUNDING

- National Resources Canada (NRCan)
- Forestry Innovation Investment
- Ministry of Forests, Lands, And Natural Resource Operations
- Binational Softwood Lumber Council
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LOCATION/CLIMATE
LOCATION/CLIMATE
COST

CONCRETE
192 $/ft²

TIMBER
192 $/ft²
BUILDING CODES & MATERIAL STANDARDS

BRITISH COLUMBIA
BUILDING CODE 2012

ENGINEERING DESIGN IN WOOD
PROCUREMENT
SUPPLIERS
SUPPLIERS

CAPACITY

STARTING POINT

\[
\left( \frac{0.25 \text{ m}^3 \text{ WOOD}}{\text{m}^2 \text{ FLOOR}} \right) \times \sim 14570 \text{ m}^2 \\
= 3640 \text{ m}^3 \text{ OF MASS TIMBER}
\]
SUPPLIERS
CAPABILITY

DESIGN CONTEXT
SUPPLIERS

AVAILABILITY

DESIGN CONTEXT
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DESIGN APPROACH

SIMPLE KIT-OF-PARTS PREFABRICATION

CREDIT: SEAGATE
DESIGN APPROACH

STRUCTURAL FRAMING OPTIONS

POST + BEAM

TWO WAY FLAT PLATE

HONEYCOMB (CLT WALLS)

PRIMARY FRAMING

EQUAL SPANS
UNEQUAL SPANS
E/W PANEL ORIENTATION
N/S PANEL ORIENTATION
E/W PANEL ORIENTATION
N/S PANEL ORIENTATION

SECONDARY FRAMING

OPTION 1A
OPTION 1B
OPTION 2A
OPTION 2B
OPTION 3A
OPTION 3B
OPTION 4A
OPTION 4B

PANEL TYPE WOOD CONCRETE COMPOSITE
SINGLE SPAN CLT PANELS
BEAM TYPE WOOD CONCRETE COMPOSITE
MULTI SPAN CLT PANELS
MULTI SPAN CLT PANELS (E/W)
MULTI SPAN CLT PANELS (N/S)
SINGLE SPAN CLT PANELS (E/W)
SINGLE SPAN CLT PANELS (N/S)
DESIGN APPROACH

- **Post + Beam**
  - Equal Spans
  - Unequal Spans

- **Two Way Flat Plate**
  - E/W Panel Orientation
  - N/S Panel Orientation

- **Honeycomb (CLT Walls)**
  - E/W Panel Orientation
  - N/S Panel Orientation

- **Option 3A: Multi-Span CLT Panels (E-W)**

**Primary Framing**

**Secondary Framing**

- Option 1A: Panel Type Wood Concrete Composite
- Option 1B: Single Span CLT Panels
- Option 2A: Beam Type Wood Concrete Composite
- Option 2B: Multi-Span CLT Panels
- Option 3B: Multi-Span CLT Panels (N/S)
- Option 4A: Single Span CLT Panels (E/W)
- Option 4B: Single Span CLT Panels (N/S)
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SUPERSTRUCTURE
ARCHITECTURE
STUDENT RESIDENCE AT BROCK COMMONS

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- Design Approach
- Superstructure Overview
- Key Analysis / Design Issues
- Construction
- Conclusion
BUILDING CODES & MATERIAL STANDARDS

BCBC 2012 limited to 6-storeys → UBC an Independent Jurisdiction → British Columbia Safety Standards Branch → Site Specific Regulation → Building Permit
BUILDING CODES & MATERIAL STANDARDS

NBCC 2015

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<th>BCBC 2012</th>
<th>NBCC 2015</th>
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<tr>
<td></td>
<td>Vancouver</td>
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<tr>
<td>Sa(0.2)</td>
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<tr>
<td>Sa(0.5)</td>
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<tr>
<td>PGA</td>
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FIRE

KEY ANALYSIS/DESIGN ISSUES
FIRE

KEY ANALYSIS/DESIGN ISSUES
FIRE

Key Analysis/Design Issues:

- Cold wood
- Heated zone
- Char layer

Dimensions:
- d
- D
- b
- B
FIRE

F1 - Typical Floor

Assembly

- floor finish
- 40mm concrete topping
- CLT slab panel (refer to struct.)
- 16mm GWB type "X" - moisture resistant (non-paper faced)
- 38mm steel hat track
- 19mm steel res bar @ 400mm o.c.
- 16mm GWB type "X"
- 16mm GWB type "X"
- interior finish

Fire-Resistance Rating

2hr - refer to code report

Acoustic Performance

54 STC (estimated INSUL rating)
POINT SUPPORTED CLT

KEY ANALYSIS/DESIGN ISSUES
POINT SUPPORTED CLT
POINT SUPPORTED CLT

KEY ANALYSIS/DESIGN ISSUES
POINT SUPPORTED CLT

\[ G \approx 10 \cdot G_{\text{rolling shear}} \]

KEY ANALYSIS/DESIGN ISSUES
POINT SUPPORTED CLT

KEY ANALYSIS/DESIGN ISSUES
POINT SUPPORTED CLT

\[ \tau_1 = \frac{(1.5)(V_1)}{(B_1)(D_1)} \]

\[ \tau_2 = \frac{(1.5)(V_2)}{(B_2)(D_2)} \]
POINT SUPPORTED CLT
POINT SUPPORTED CLT
POINT SUPPORTED CLT
COLUMN TO COLUMN CONNECTIONS

KEY ANALYSIS/DESIGN ISSUES
COLUMN TO COLUMN CONNECTIONS

2h glulam column protection

2h steel connector protection

2h CLT slab protection
AXIAL COLUMN SHORTENING

Δ2

Δ1

Δ1 (CONCRETE) = SHRINKAGE + ELASTIC SHORTENING + CREEP

Δ2 (TIMBER) = SHRINKAGE + ELASTIC SHORTENING + CREEP + JOINT SETTLEMENT

TIMBER COLUMNS

CONCRETE CORE

TIMBER COLUMNS

KEY ANALYSIS/DESIGN ISSUES
AXIAL COLUMN SHORTENING

KEY ANALYSIS/DESIGN ISSUES

- Dead Load Axial
- Live Load Axial
- Longitudinal Shrinkage
- Creep and Joint Settlement
AXIAL COLUMN SHORTENING

TIME OF INSTALL

SHIM PACKAGE

MECHANICAL
AXIAL COLUMN SHORTENING

SOME TIME LATER
AXIAL COLUMN SHORTENING

KEY ANALYSIS/DESIGN ISSUES
LATERAL DESIGN

KEY ANALYSIS/DESIGN ISSUES
LATERAL DESIGN

- $RdRo = 3.5 \times 1.6$ DUCTILE COUPLED CONCRETE SHEARWALLS $\sim R=5.6$

- MODE 1 = E/W ORTHOGONAL,
  - $T=2.0$ SEC.

- MODE 2 = N/S ORTHOGONAL,
  - $T = 1.65$ SEC.

- MODE 3 = TORSIONAL,
  - $T= 1.30$ SEC.

- EQ = 4.5% OF WEIGHT
CAPACITY DESIGN

- Capacity Design
  - Design Diaphragm to Flexural Capacity of Cores
  - Design Connections, Drags, Chords, Collectors with Overstrength Capacity

NO YIELDING

YIELDING
CAPACITY DESIGN
DIAPHRAGM DESIGN

25mm x 140mm PLYWOOD SPLINE
DIAPHRAGM DESIGN

KEY ANALYSIS/DESIGN ISSUES
DIAPHRAGM DESIGN

KEY ANALYSIS/DESIGN ISSUES
DIAPHRAGM DESIGN

KEY ANALYSIS/DESIGN ISSUES
DIAPHRAGM DESIGN

KEY ANALYSIS/DESIGN ISSUES
DIAPHRAGM DESIGN

KEY ANALYSIS/DESIGN ISSUES
DYNAMIC WIND ACCELERATIONS

KEY ANALYSIS/DESIGN ISSUES
DYNAMIC WIND ACCELERATIONS

DAMPING?

\[ \beta = 1\% \text{ to } 3\% \]
PRE-FABRICATION

3D Model → Customize Data → Material List → Shop Drawings → Material Production

CNC Code → QC/QA → JIT Shipping → Installation

KEY ANALYSIS/DESIGN ISSUES
PRE-FABRICATION

[Diagram showing the process of pre-fabrication with steps from 3D Model to Installation]

KEY ANALYSIS/DESIGN ISSUES
3D (.SAT and .IFC) models provided by CadMakers supplies general geometry – including all mechanical penetrations.

Use of a coordinated single model saved time and reduced confusion between the multiple parties.
PRE-FABRICATION

KEY ANALYSIS/DESIGN ISSUES
PRE-FABRICATION

KEY ANALYSIS/DESIGN ISSUES
PRE-FABRICATION

Issue 1.3

Still in the NO GO zone

Mechanical Penetration at gridline 9 just south of D penetrates the “no-go zone”. It needs to be at least 450mm away from Center Columns.
PRE-FABRICATION

KEY ANALYSIS/DESIGN ISSUES
PRE-FABRICATION

• ~0.95 mmfbm in 2 months time.
PRE-FABRICATION

- Glulam +/- 1 mm (standard +/- 6 mm)
- Crosslam +/- 1 mm, all directions (standard +/- 2 to 6 mm)
- Steel supplied +/- 0.5 mm
PRE-FABRICATION

- Fabrication arranged in a linear process for just in time delivery.

- Loads arranged on trucks to perfectly match installation sequence
  - Requires ample preplanning on the part of the project team
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MOCK-UP
MOCK-UP
SEQUENCING
CONSTRUCTION
CONSTRUCTION
CONSTRUCTION
CONSTRUCTION
CONSTRUCTION
CONSTRUCTION
CONSTRUCTION

CREDIT: ACTON OSTRY
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PROGRESS TO DATE

CONCLUSION

CREDIT: NATURALLY WOOD
CONCLUSION

- Efficient system suitable for student residences, micro-apartments or hotels
- Wider column grid possible with wider panels
- Structural simplicity = on site efficiency
- Involve your trades early. 3D coordination paid off.
- Kit-Of-Parts prefabrication has significant advantages
THANK YOU