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Prefabrication In Timber Construction

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2019 EOMF/CIF December Forest Seminar
Kemptville, ON
December 11, 2019



World Housing.....

- Worldwide, up to 3 billion people will need a new home in the next 20 yrs
- Push for urbanization: 50% today.. 75% in 2040!
- Cities are typically built from steel and concrete
- **However, steel & concrete contribute over 8% of World's GHG emissions**
- Provide green building solutions that meet such evolving demands and wood can be a key part of the solution



Trends/Opportunities in the Construction Industry

- Growing interest in sustainability/green buildings
- More prefabrication....panelized or modular construction
- Increased use of EWPs including mass timber
- Building codes evolving and permit more wood use
- Increased interest in larger and taller wood buildings using mass timber or hybrid wood and concrete or steel



Over 90% of Residential Homes in Canada are Built with Wood



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Traditionally Site Built

- Structural systems are constructed entirely or largely on site using lumber
- Linear construction; requires each step to be completed before the next can begin (i.e., platform)

But things are changing in Canada!! Interest in Industrialized Construction.. Panelized and Modular....Especially in mid/high-rise WFC



How to Build Faster, Safer and Better and do it for Less??!



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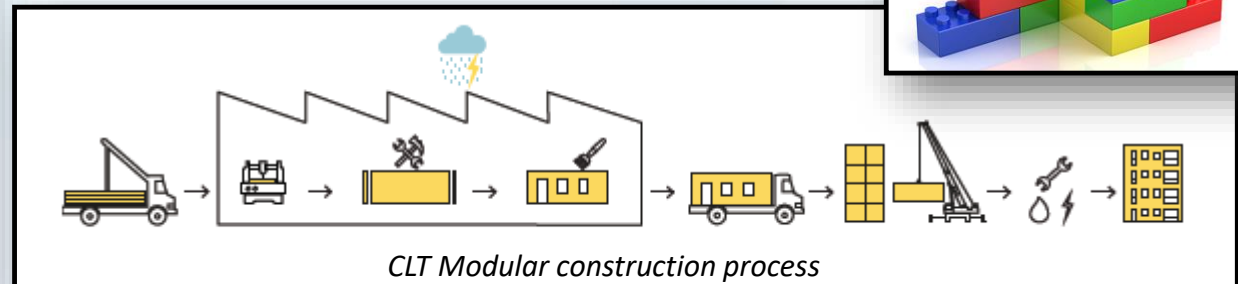
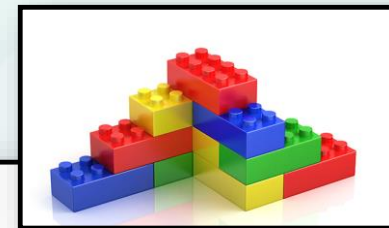
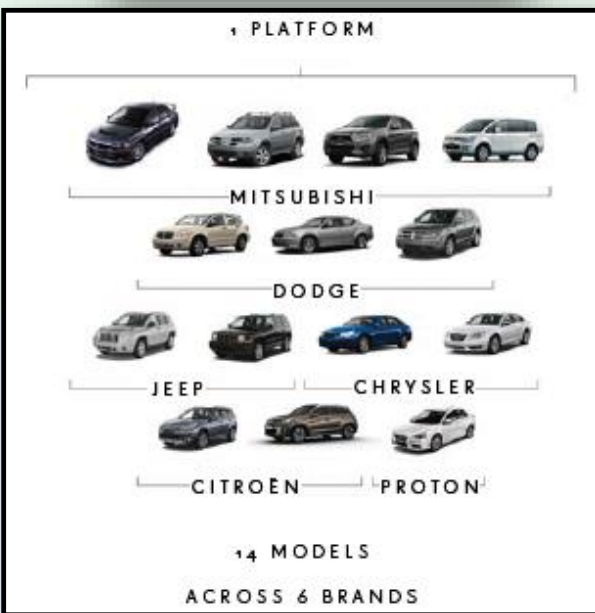
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Industrialized Construction

Future of the Timber Construction Industry!



- Learning from the evolution of the automobile industry!
- Same platform for different car models
- Adopt “Mass Customization!”
- Think of LEGO



Source: 2019, Swan Housing Association



Changing the Way We Build With Wood

- Typically the choice to use on-site wood framing vs. some level of prefabrication depends on many factors
- Prefabricated and modular construction can offer a number of benefits



Prefabricated Systems: Benefits



- Factory controlled environment: protected, unaffected by weather, year around protection
- Fast (i.e., house assembly within a day!)
- Reduced wastes
- Accuracy in cutting and assembly following a QA
- Trained and qualified staff
- Control of building process and project schedules
- Cost control for builders
- Repeatable process.. not repeatable products!

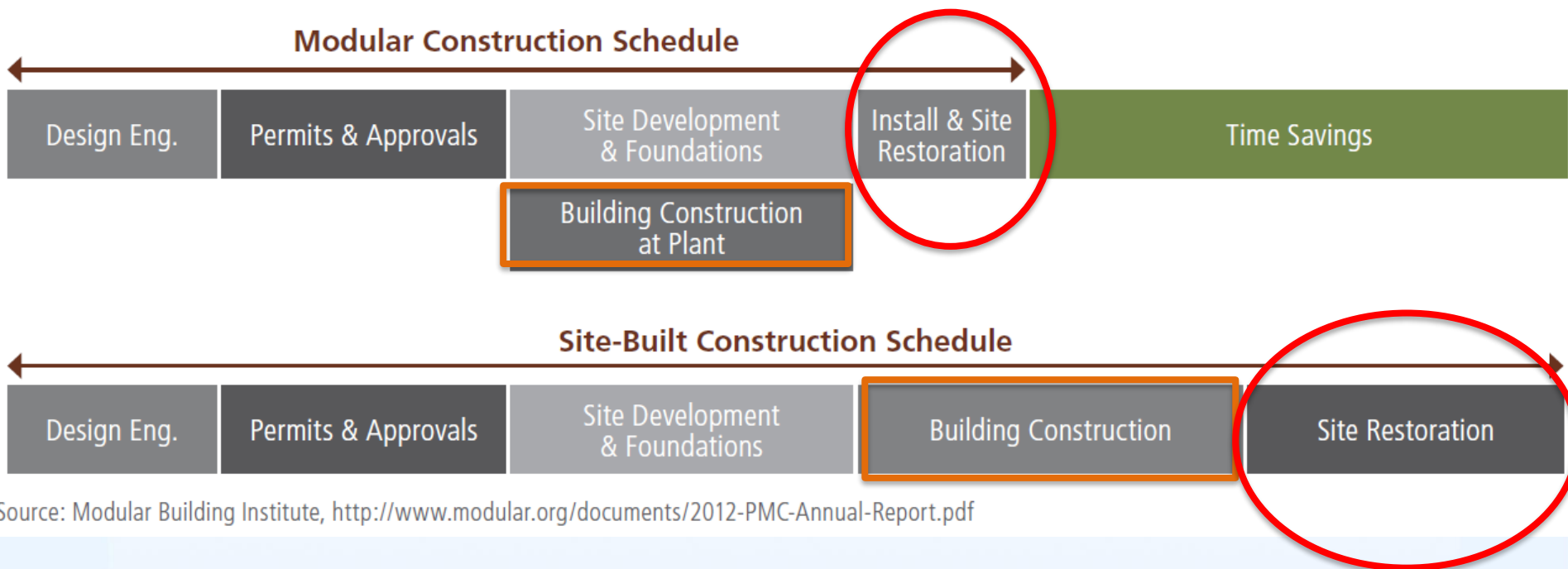
Photo:
Randek

Source: Ken Koo



Modular Construction Benefits

Time savings Add up to Cost Savings
Sequential vs. concurrent!



Modular and Panelized Construction Considerations

- **Factory process:** location, factory type & equipments, process and time, storage, CNC machining, etc.
- **Design and assembly process:** concurrent process vs. traditional sequential site built process (i.e., design, permitting, engineering, site preparation, manufacturing, etc.)..integrated approach
- **Transportation:** transport size, route to site, oversized/over weight modules, time constraints, moisture protection during transportation, etc.
- **Site consideration:** Access to site, storage capacity, staging area, crane type & location, lifting considerations, module assembly strategy, etc.



Types of Prefabricated Systems



- **Components:**
Truss, I-joist, Mass timber (CLT) panels, Glulam, Structural Composite Lumber (SCL)
 - Using engineering, advanced processing and manufacturing
- **Panelized Systems/assembly:**
Wall, floor and ceiling panels
 - Reducing framing time 90% with on time delivery & installation by crane
- **Modular (Volumetric) Systems:** 3D modules
 - 85% completion including insulation, plumbing, electrical, cabinets, windows and doors as well as appliances



Photo: H+ME Technology



Photo: Maple Leaf Homes

Source: Ken Koo



Prefabrication: From Components to Assemblies



Curtsey of CWC



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CSA-A277-16 - Procedure for Certification of Prefab. Buildings, Modules, and Panels

Scope

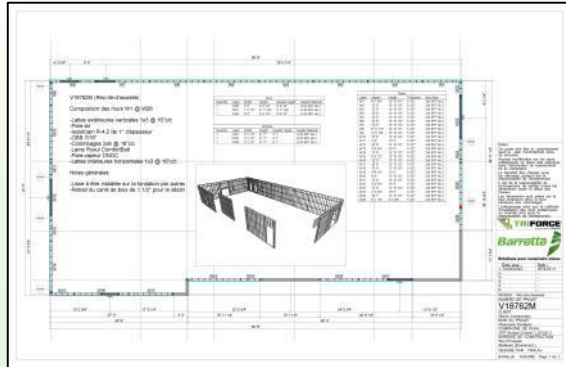


- *This Standard specifies the procedure for certification of prefab. buildings, and partially or fully enclosed modules and panels for buildings of any occupancy.*
- It provides requirements for
 - certification of the factory quality program;
 - certification of the prefabricated product;
 - auditing of the factory quality program; and
 - in-factory inspection of the prefabricated product..

Source: Ken Koo



Prefabricated Systems: Panelized



Panelization System:

- 3-D CAD/CAM/ BIM software
- Structural design software
- Automated or semi- manufacturing equipment
- In Plant QC process

Photo:
Randek



Source: Ken Koo



Panelized Systems: Construction Site



Panelized Systems: Installation



Photo:
Cecobois



Photo:
H+ME Technology

- Wall panels: e.g.
 - 2 lifting holes for the lifting straps, maybe with spreader bar
 - Quick connections systems
- Floor panels: e.g.
 - Certified crane and operator with capacity of 5,000 lbs
 - Panels are lifted by 4 certified lifting straps through lifting holes.



Panelized Systems: Roof system



Photo:
H+ME Technology

Photo:
ACQBUILT

Wood roof trusses

- Flexible for all shapes and spans
- Traditional installation: nailing of trusses to wall plates and sheathing to trusses
- Sometimes using metal clips
- Panelization by assembling of roof system on ground now possible



Prefabricated Systems: Modular Volumetric



Photo: Grandeur Housing



Photo: Maple Leaf Homes



Photo: Raines Court, London, UK
<https://en.wikipedia.org/>

- Modules produced in plant and shipped to sites in sections;
 - Max 16' wide, 14' high, 100' long
- Modules can be attached side by side and stacked on top of other modules
- Conforms to NBCC or provincial building code
- Conforms to CSA A277 Procedure for Factory Certification of Buildings with 3rd party Quality Assurance program
- Advantage: Speed of construction... major financial advantage for developer
- Quite popular construction methodology in Finland and Sweden

Source: Ken Koo



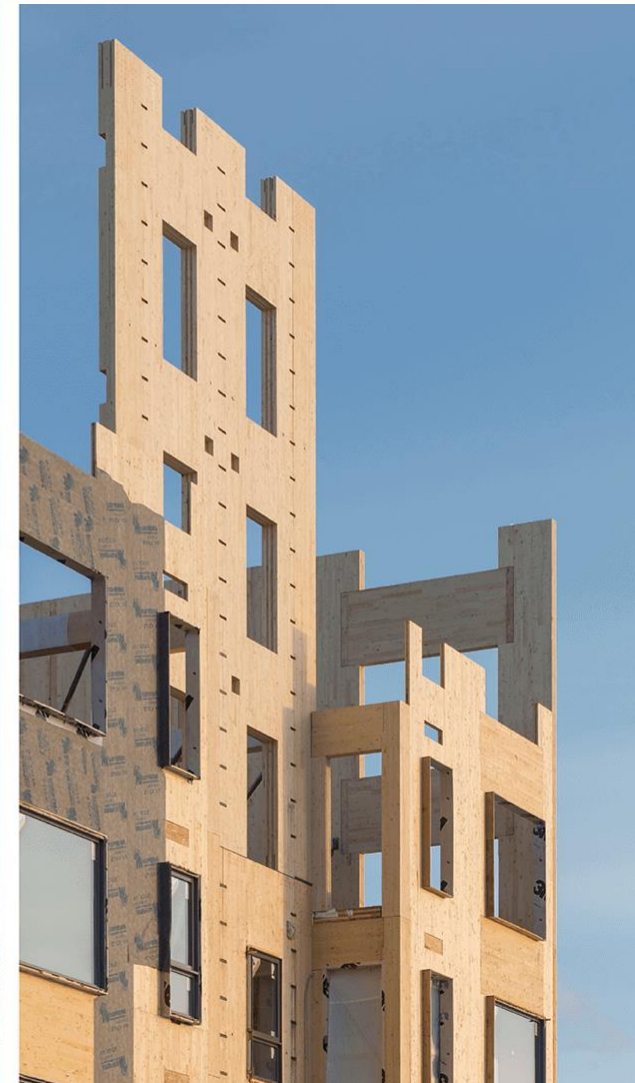
Prefabricated Systems: Modular Volumetric





Mass Timber Lends Itself Really Well with Prefabrication

Mass Timber Lends Itself Nicely to Prefabrication



UBC 18-Storey TWB



Courtesy of UBC/FII

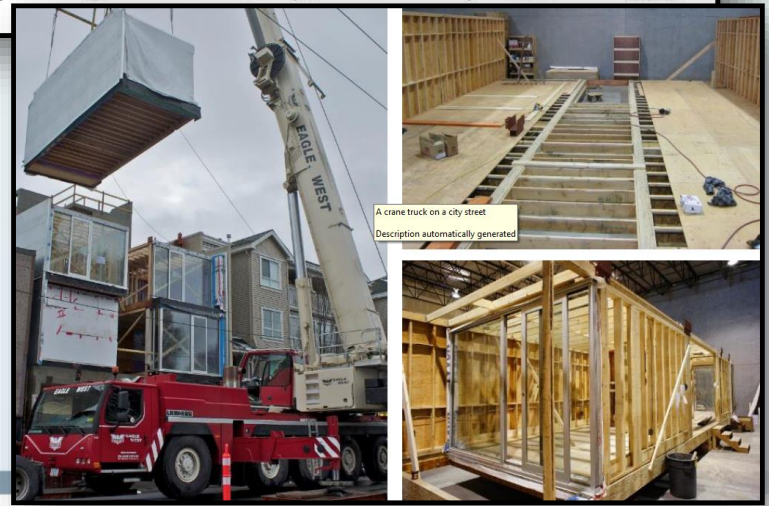
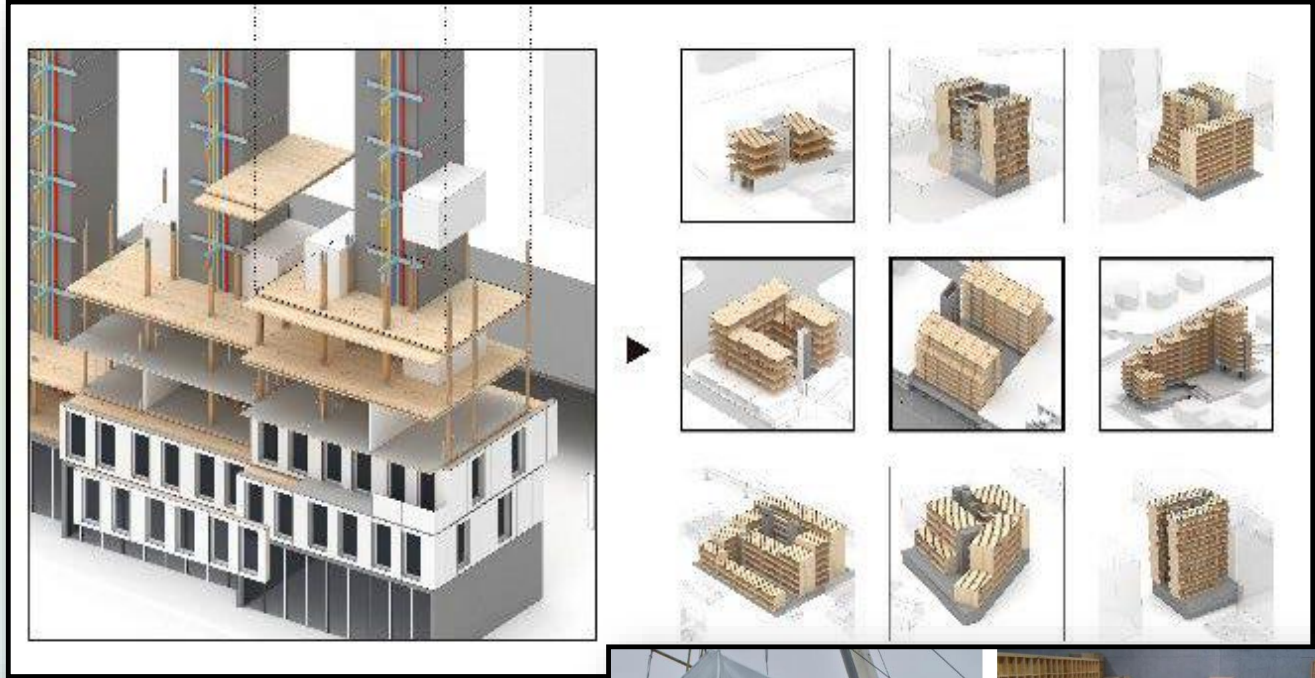
UBC BC TWB: Post-Post Connections



Emerging New Modular Concepts in Canada

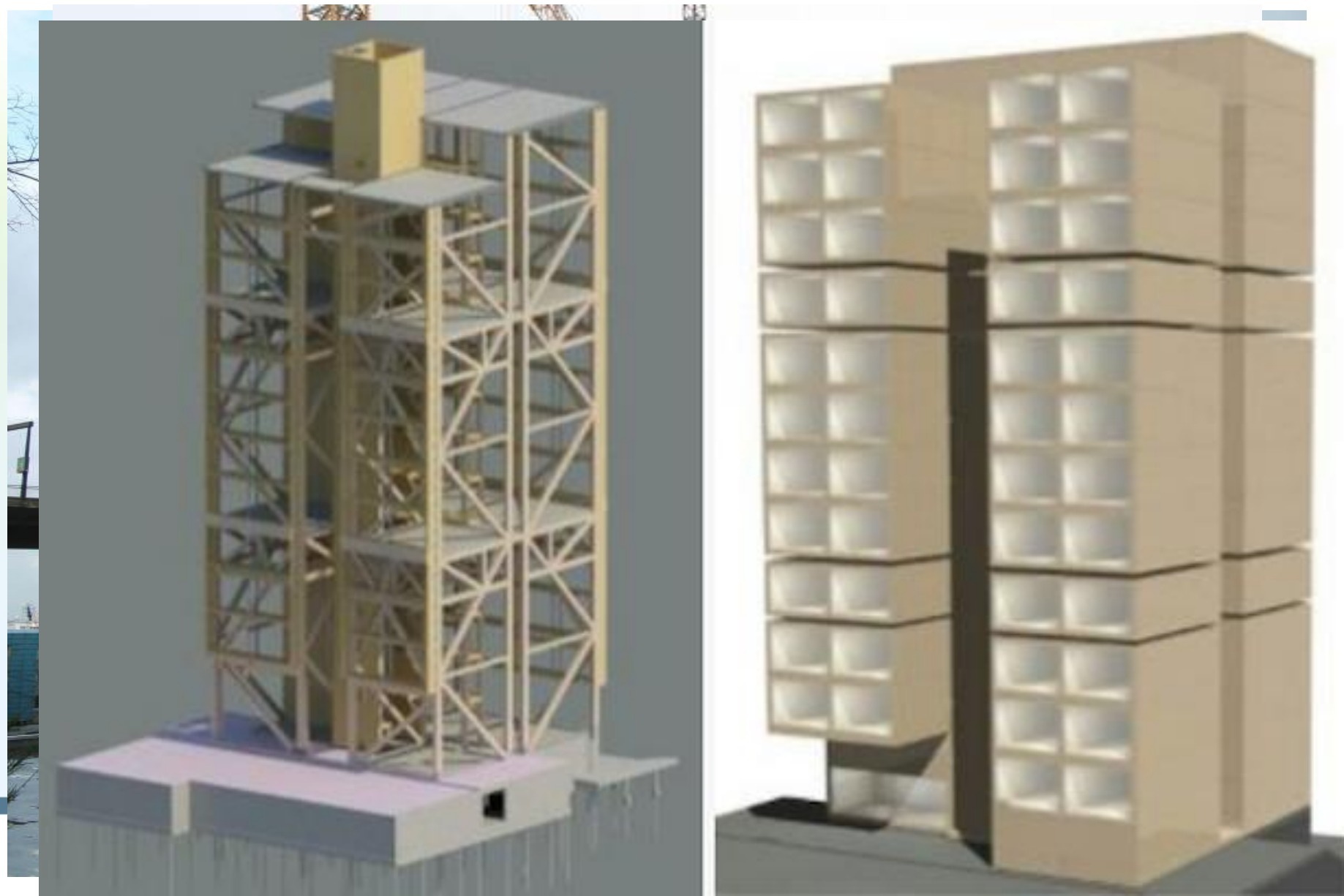
Platform for Life Concept

- Flexibility
- Replicability
- Scalability
- Affordability
- Resiliency



Compartmentalization Concept

Combining LWF and Mass Timber: 4 Storeys of Modular LWF Inserts





Moving Beyond
Mid-rise..

Design and Construct Taller
and Larger Wood Buildings

**Wood High-
rises!!**

Government of Canada's Programs/Initiative

Supporting Advanced Timber Construction in Canada



Government of Canada's Initiatives: Budget 2017

- Provide NRCan with \$39.8 million over 4 years under [*Pan-Canadian Framework on Clean Growth and Climate Change*](#)
- Starting in April 1st, 2018–19
- Objective:
 - Support demo projects and activities that increase the use of wood as a greener substitute material in infrastructure projects
- New program initiated:

Green Construction through Wood (GCWood)

Green Construction through Wood (GCWood)

3 Key Components (GCWood):

- Wood and hybrid wood demo projects (TWBs, low-rise, bridges)
- Building code revision (2020 & beyond) & supporting research
- Advanced education (e.g. education roadmap)

Over 15 demonstration projects have been selected for funding across Canada!



Final Remarks

- Opportunities for both panelized & modular construction are growing as architects & developers become more familiar with their benefits
- Modular construction is also opening doors to projects that weren't previously possible, especially in TWBs applications
- Mass timber lends itself well with prefabrication

