Prefabrication In Timber Construction

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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
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??!
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*!

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.

Source: 2019, SWAN Housing Association
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

Source: Ken Koo

**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..
Prefabrciated Systems: Panelized

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

Source: Ken Koo
Panelized Systems: Construction Site
Panelized Systems: Installation

➢ Wall panels: e.g.
  o 2 lifting holes for the lifting straps, maybe with spreader bar
  o Quick connections systems

➢ Floor panels: e.g.
  o Certified crane and operator with capacity of 5,000 lbs
  o Panels are lifted by 4 certified lifting straps through lifting holes.
Panelized Systems: Roof system

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

- 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 staked 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

Source: INTELLIGENT CITY + LWPAC
Compartmentalization Concept
Combining LWF and Mass Timber: 4 Storeys of Modular LWF Inserts
Design and Construct Taller and Larger Wood Buildings

Moving Beyond Mid-rise..
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 1\(^{st}\), 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.