Tall Wood Buildings: The Canadian Experience

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Natural Resources Canada (NRCan)

Toward Taller Wood Buildings Symposium
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Inspiring 100 Year Old Tall Wood Buildings in Canada

- Adaptive re-use of the industrial old brick & timber buildings from early 1900's
- Up to 8 storeys (≈100 ft or 31 m high)
- Up to 326,759 ft² (≈ 32,500 m²)
- Built from 1859 to 1940
- Factories, warehouses and manufacturing plants - during the industrial era
- All across Canada

Source: FPInnovations
Brick & Beam Buildings

- **Toronto - 129 buildings**
  - 43 buildings = 5 storeys +
  - 19 buildings = 7 to 8 storeys
  - Floor space = 190,000 ft^2 (single building)

- **Vancouver – 50 buildings**
  - Historical Buildings
    - The Landing
    - The Leckie

- **New apartments additions**
  - Meets current code requirements
Unfortunately…

- Construction of such buildings stopped mainly due to the introduction of modern building codes (NBCC 1941)
- Limits on wooden building height were introduced (i.e., combustible vs. non-combustible construction concepts)
Recently, strong interest to re-specify wood in non-res. & mid and high rise buildings

- Several factors have contributed to this:
  - Availability of new generation of innovative EWP, connection systems & design tools
  - Recent changes to building codes
  - Development of CLT (i.e., ease of prefabrication & assembly, use in infill projects)
  - Environmental concerns (i.e., climatic changes)
Natural Resources Canada (NRCan)

Over the last 10 years, NRCan has made significant investments to expand wood use in the NA non-residential and mid & high rise construction market

- Support research organizations in conducting R&D activities & facilitate code changes in Canada. Examples:
  - FPInnovations (TT Next Generation Building Systems and Products)
  - Universities (NEWBuildS – Investment in the Forest Sector)
  - Industry associations (NRC/CWC/FPI mid-rise project)

- 2010 NRCan’s Mid-rise Wood Demo Buildings Initiative

- 2013 NRCan’s Tall Wood Demo Buildings Initiative
NRCan’s Mid-rise Wood Demo Initiative: Examples

Complan bldg, Qc
(CLT-glulam top storey on existing 4 storey concrete)
NRCan’s Mid-rise Wood Demo Initiative: Examples

GSK bldg, Quebec city, Qc

Confederation College, Thunder bay, ON
NRCan’s Mid-rise Wood Demo Initiative: Examples

New ESB at UBC, Vancouver, BC
(Hybrid, wood-steel-concrete bldg)
Building Codes Revisions

- **British Columbia**
  - April 2009, residential construction up to six storeys
    - 250 buildings built, under construction or at the design stage (40 buildings completed)

- **Quebec**
  - Wood Charter in April 2013 – Amendment to allow up to 6 storeys

- **Ontario**
  - September 2014, announced approval of wood structures (up to 6 stories) – effective 2015

- **Canada - 2015 NBCC up to six storeys buildings**
  - Public consultations completed
  - Fall 2014: Review and approval by Canadian Commission on Building and Fire Codes
Modern Tall Wood Bldgs in Europe & Australia

9-Storey buildings, London, UK
1st storey concrete, 8 storeys CLT

2 @ 8 storeys CLT buildings, Oslo, Norway

4 CLT residential buildings/social housing @ 9 storeys, Milan, Italy

10 storeys CLT tower in Melbourne, Australia
“World Tallest Wood Building”
Modern Tall Wood Buildings (TWB)

Wood Innovation and Design Center, Prince George, BC
Height: 28 m

8 storeys office high-rise, Austria
Uses of innovative hybrid wood-concrete system (CREE). One storey/day!

14 storeys Wood Building, Norway (under construction)
Modern Tall Wood Bldgs: Design Concepts

30 storeys wood high-rise
(Source: Tall Wood Building: mgb ARCHITECTURE + DESIGN)

42 storeys wood high-rise
(Source: Skidome, Owings & merrill, LLP)
In May 2013 CWC issued a request for EOI for design teams to use innovative design and build high-rise wood demonstration projects.

Under funding from Natural Resources Canada (NRCan), this initiative links scientific advances with technical expertise to showcase the benefits of innovative wood-based structural solutions.

To support the initiative, a *Technical Guide for the Design and Construction of Tall Buildings in Canada* was developed by FPInnovations.

- Prepared by a group of more than 85 experts
- Guide designed to assist designers, code consultants, developers, building owners, and AHJ in understanding the key technical issues and challenges associated with the design and construction of tall wood buildings
- Written to be consistent with the design objectives in the 2010 NBCC
- Guide published in April 2014
- Funded by NRCan
Guide Content/Layout

Nine Chapters in Total

- Introduction
- The Building as a System
- Sustainability
- Structural & Serviceability
- Fire Safety & Protection
- Building Enclosure Design
- Prefabrication & Inspection of Assemblies
- Project & Construction Cost Considerations
- Monitoring & Maintenance
The Building as a System

- Provides the “Architect’s View” of the conceptual design process and how it is applied to TWB
- Thoughts on the integration of all building systems, its principles & potential solutions
- Discussion on code compliance following the "alternative solutions" path
- Chapter includes information to assist AHJ in establishing a process to evaluate a TWB project under alternative solution
Sustainability

- Factors that contribute to the overall sustainability of TWB (e.g., sequestering of carbon & reduction of embodied energy).
- Information on re-use and recycling of wood components
- How to evaluate the environmental impacts of the building over its lifespan
- A special emphasis on the life cycle assessment (LCA) and discussion of the various green building certification systems
Structural & Serviceability

- Recommendations for conceptual design
- Design considerations & input parameters for connections and assemblies
- Advanced analysis and testing of systems for design for wind and seismic
- Building sound insulation and floor vibration control (including hybrid floors)
Building tall with wood is fire safe

- Technical information as to how TWB can “meet” or even “exceed” the level of fire performance currently provided by the NBCC's acceptable solutions for tall buildings of noncombustible construction

- Guide also addresses issues of safety of firefighters and other emergency responders
Addresses design considerations for the building enclosure and durability of TWB

Control of heat, air & moisture transfer through the building enclosure and cumulative vertical wood movement

Five wood-based structural systems and associated wall assemblies are presented: platform, post-and-beam with wood-frame infill, mass timber, etc.)
Prefabrication and Inspection of Assemblies

- Best practices and standards (i.e., what is designed can in fact be built to a high quality level)

- Tall wood construction incorporates a large degree of prefabrication similar to steel and precast concrete buildings

- Chapter covers key issues associated with quality assurance, qualification of personal, fabrication, executing and inspection of records
Monitoring and Maintenance

- Recommendations for performance testing and monitoring and guidance on building maintenance
- Covers short and long term measurements to test and monitor the buildings
  (e.g., airtightness, vibration, sound insulation, floor and building vibrations, energy efficiency, etc.)
- Planning and costing for testing & monitoring
NRCan’s TWB Demo Projects Initiative

- EOI released by CWC in May 6th, 2013
- Submissions were received and reviewed by an Evaluation Team in November, 2013
- 3 projects were finally shortlisted
- Binational Softwood Lumber Council (BSLC), FII, FPIInnovations and NRC are also contributing financially and in in-kind
## Shortlisted TWB Projects

<table>
<thead>
<tr>
<th>Location</th>
<th># of Storeys</th>
<th>Total Floor Area, m²</th>
<th>Building Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quebec City</td>
<td>11</td>
<td>11,120</td>
<td>Condos</td>
</tr>
<tr>
<td>Vancouver</td>
<td>16-18</td>
<td>15,400</td>
<td>Student Residence</td>
</tr>
<tr>
<td>Ottawa</td>
<td>12</td>
<td>11,750</td>
<td>Condos/office</td>
</tr>
</tbody>
</table>

**Different systems being considered:**

- Post-tensioning system from New Zealand
- CLT/Glulam wood systems
- Hybrid wood systems
Incremental funds will be allocated to six (6) key elements/envelopes:

- Schematic design, design development and construction documents
- Research, testing and other support by 3rd party groups
- Building system code acceptance, cost analysis and approvals
- Construction
- Post construction
- Communications and training
Lessons Learnt

- Process is complex and requires extensive coordination with partners and stakeholders to ensure commitment from proponents and mitigate/share risks.

- Define common R&D to optimize resource and facilitate information sharing.

- Leverage additional funding from alternative sources.

- Key challenges experienced include:
  - Code acceptance (AHJ)
  - Land purchase & project financing
  - Builders capacity
  - IP issues

- More efforts needed on facilitating regulatory acceptance of TWB and future code changes.

- Engagement & education of stakeholders is key to broader future commercialization of TWB Education.
Next Steps

- Continue ‘due diligence’ and identify ineligible funding requests
- Align and match proponent request, eligible criteria and available funds
- Finalize the contractual agreements with proponents
- Develop common “R&D” plan/matrix applicable to each project
- Establish and monitor design development milestones for each proponent group
- Identify & secure possible new funding sources