CLT in Canada

Activities, Achievements and Projects

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FPInnovations is Canada’s Forest Research Institute

- Public Private Partnership (Federal, Provincial, Industry)
- Main Laboratories in Vancouver, Montreal, Quebec City
- 550 employees, annual budget $95 Million; the world’s largest private, not-for-profit forest products research institute
- Provides complete value chain solutions from forest management to structural systems
- Along with APA, AWC and USFPL, actively involved in introduction of CLT in North America
CLT in Canada

- CLT is now commercially available from 2 manufacturers
  - Structurlam Products LP, Penticton, BC
  - Nordic Engineered Wood, Chibougamau, QC
  - Others considering production
- Strong interest in CLT among designers, building officials, and developers
- Strong support from Federal and some Provincial Governments
- Over 30 buildings built across Canada that utilize CLT
- Considerable R&D activities conducted and are underway at a number of universities, FPInnovations, NRC and CWC

Objective-Based Codes Help CLT

- Adoption of objective-based building codes (since 2005) partially eliminated the bias against wood inherent in previous prescriptive codes
- The new format recognizes “Acceptable Solutions” and “Alternative Solutions”
- Use of innovative materials, products and systems (alternative solutions) is encouraged provided that the proposed solution has equivalent performance to an “Acceptable Solution” specified in the Code
Provincial Legislations

- BC Wood First Initiative and the Wood First Act help facilitate a culture of wood for construction in BC
- The Act requires that wood is considered as the primary building material in all new publicly-funded buildings (2009)
- Similarly, province of Quebec passed a Wood Charter in April 2013. Developers of all government-financed projects to consider wood in their building options
- Huge opportunity for CLT as BC funds $3 billion, and Quebec almost $5 billion worth of capital investments a year

Provincial Demonstration Project - Wood Innovation and Design Centre (WIDC)

- Location Prince George, BC; Capital cost $25 million
- Once complete, WIDC with height of more than 29m will be North America’s tallest contemporary wood structure
Federal Government Tall Wood Building Demonstration Project

- In May 2013, CWC issued a request for Expressions of Interest (EOI) for Canadian developers and designers willing to use innovative approaches in design and construction tall wood demonstration building
- $5 million NRC funding for the project to help link new scientific advances with technical expertise and showcase the benefits of innovative wood structural solutions
- Eight EOIs were received by the October 2013 deadline
- Three shortlisted
BC Advisory Group on Advanced Wood Design Solutions

- Objectives:
  - Develop guidance documents to assist design practitioners in development and evaluation of advanced wood and wood-hybrid design solutions in BC
  - Advise on the research that will benefit development and use of advanced wood and wood-hybrid solutions
- Fire performance of CLT and drying of CLT panels one of the topics

NEWBuildS Research Network

- The Natural Sciences and Engineering Research Council of Canada (NSERC), FPInnovations and NRCan have partnered to create the NEWBuildS research network in 2009
- The vision is to increase the use of wood products in mid-rise residential and non-residential buildings in Canada
- 23 professors and 17 principal researchers (FPI, NRC and CWC) supervise 60 graduate students and PDFs from 11 universities
- CLT is one of the 4 themes of research with 11 projects
NEWBuildS/FPIInnovations Tall Wood Design Project

- Objective: To execute the design process of a demonstration high-rise wood building by a team of professional experts and researchers in their respective areas of expertise
- The project is led by 3 experts:
  - Robert Drew, Architect. Perkins+ Wills
  - Eric Karsh, Structural Engineer, Equilibrium
  - Andrew Harmsworth, Fire Expert, GHL
- 20-storey tall building with a one-storey podium, location North Vancouver, BC

FPIInnovations’ CLT Handbook

- State-of-the-art peer-reviewed technical Source for designers that facilitates use of CLT as alternative solution
- Second edition expected by summer 2014
US CLT Handbook

- FPInnovations, AWC, USFPL, APA and WoodWorks US developed the US CLT handbook with funding from Binational Softwood Council, USFPL, FII and 3 CLT manufacturers

FPInnovations’ Technical Guide for Design of Tall Buildings

- The purpose is to facilitate acceptance by Authorities Having Jurisdiction (AHJ) of tall wood buildings using the alternative solutions path in building codes
- Developed in support of the tall wood demonstration projects
- It is a generic, consensus based multidisciplinary document applicable to any tall wood building system
- Developed in collaboration with more than 70 architects, engineers and researchers
- 90% draft is complete
- Completion expected for March 2014
CLT Product Standardization in Canada

- Canadian experts actively participate in the North American Advisory Committee on CLT
- Participated in developing the North American CLT product standard ANSI/APA PRG 320

Code Activities

- Task group formed to guide CLT implementation in CSA O86
- CLT included as a product in 2014 CSAO86 with a reference to PRG 320
- Task group is working on 2016 CLT Supplement for CSAO86
  - Bending, and shear stiffness of CLT slabs
  - Bending, and shear resistance of CLT slabs
  - Compressive resistance
  - Resistance to combined loads
  - Connection resistances
- CLT will be proposed to be included as a system in 2020 NBCC with its own R-factors for seismic design
CLT Research Activities

- About 11 Universities, FPInnovations, NRC and CWC conducted and continue to do research on:
  - Structural performance of CLT panels used in walls and floors
  - Performance of connections used for CLT panels
  - Seismic performance of CLT components and structures
  - Fire Performance of CLT panels
  - Durability of CLT
  - Serviceability aspects of CLT
  - Environmental footprint
  - Health effects of CLT and wood in general
  - Acoustical performance

Seismic Resistance of CLT Walls
CLT Wall Configurations Tested

Connections Govern Seismic Performance
Cyclic Tests on CLT House

Seismic Performance

- Up to 3.2% drifts were observed on the bottom storey
Overall Backbone Curves

Analytical Work – Model Development

- Work conducted with Dr. Pei and Dr. van de Lindt
- The model is able to produce the hysteresis loops for various configurations of CLT walls with number of input parameters:
  - Wall dimensions
  - Gravity load level and location
  - No. of brackets, H-D and location
  - Number of wall panels (in case of multi-panel walls)
  - No. of nails or screws per bracket
  - Fastener hysteresis parameters
Modeling and Verifying the CLT Wall Performance

- Database of calibrated resistance values for various CLT wall configurations was developed

NEESWood Capstone building was re-designed as CLT building

Photo courtesy of Simpson Strong Tie
Non-Linear Dynamic Analyses

- 18 CLT buildings were designed, with 6 different $R_d$ factors ($R_d=1.5$ to 6.0), and 3 fasteners (nails and 2 types of screws)
- Buildings were modeled with SAPWood and subjected to 44 bi-axial nonlinear time history analyses
- Scaled FEMA P-695 biaxial ground motions were used scaled at the building period to match $S_a=0.743g$ (YVR design spectrum)
- Fragility curves for the maximum inter-storey drifts for different building configurations and different $R_d$-factors were developed

CDF for 6-storey CLT Building
CDF for 10-storey CLT Building

CDF for 15-storey CLT Building
Rd-factors for Different Building Heights

- Minimum Rd factor is 2.0
- Information developed was used for proposal of acceptance of CLT in NBCC

<table>
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<th>Performance Target in Terms of Storey Drift and PNE</th>
<th>6 Storey</th>
<th>10 Storey</th>
<th>15 Storey</th>
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<td>4.0% drift with 80% PNE</td>
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Durability of CLT

- CLT wall assemblies should be built “breathable”
- Prevent rain infiltrations
- Exterior exposed portion of panels could benefit from wood preservative treatment
- Wetting during transportation, construction & service should be prevented
Austria House, Whistler, BC

Dowling Residence, West Vancouver, BC

Architecture: Greg Dowling
Structural: Equilibrium Consultants
UBC Bio-Energy R&D Building

Earth Sciences Building (ESB), UBC, Vancouver, BC
ESB Connection details HSK, HBV

ESB Building, UBC
Elkford, BC Community Center

Roland McDonald House, Vancouver, BC

Home away from home for 73 seriously ill children and their families when need treatment at BC Children’s hospital
UBC Okanagan Fitness Centre, Kelowna, BC

Centre for Interactive Research on Sustainability (CIRS), UBC, Vancouver
Wind Turbine Training Tower, Dawson Creek

Fort McMurray Airport: Largest Building In North America that uses CLT

170,000 sqf building
About 560 large CLT panels
Wayne Gretzky Sport Centre in Brantford, Ontario

Office Building in St. Prime, Quebec
Durocher College, St. Lambert, Quebec

CLT Office Building, Montreal, Quebec
4-storey Condominium Building, Chibougamau, Québec

CLT Roof on Top of Concrete/Steel Building, Quebec, QC
Wood-Concrete Tower Concept, Canada

J. Wang and RJC
Original Concept by F. Lam, CC Yao and A. Boniface

FFT Concept, mgb Architecture and Equilibrium Consulting
Conclusion

- Because of its attributes, CLT is one of the most promising wood alternatives to concrete and masonry structures in non-res and mid-rise residential markets in Canada
- Strong support for use of CLT on all levels
- Research and technical info is constantly being developed to assist early adopters
- Over 30 CLT projects to date mostly in BC and QC
- Other parts of Canada are worming up to the idea
- We are whitening a wood renaissance in Canada
- Brightest days are yet to come