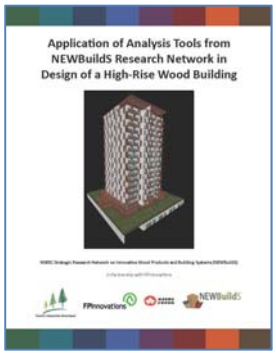
NEWBUILDS NEWSLETTER: FALL 2014

NEWBuildS Activities:

Tall Wood Building Project Road Show

- The 1st presentations of "The CHECKER BUILDING" – a 20-storey conceptual wood building took place in Vancouver last May. This project is funded by NSERC (Natural Sciences and Engineering Research Council of Canada) SNEI (Strategic Network Enhancement Initiative) program and BC FII (Forestry Innovation Investment).
- 2 additional Tall Wood Building Design Projects presentations - Road Show Workshops took place on Nov 12, 2014 in Montreal, QC and Nov 14, 2014 at University of Alberta, Edmonton, AB. University of Alberta researchers fabricated a model which was on display at both events.
- The Nov 12 event is jointly hosted by Cecobois & NEWBuildS with opening remarks by Mr. Louis Poliquin. The November 14 event is jointly hosted by Wood Works! Alberta and NEWBuildS with opening remark by Mr. Rory Koska.

- In addition to the HQP's presentations, 2 experts; Mr. Robert Drew, Perkins+ Wills, and Mr. Andrew Harmsworth, GHL Consultants made presentation related to the high-rise wood buildings. FPInnovations scientists introduced and presented the Technical Guide for the Design and Construction of Tall Wood Buildings in Canada.
- Both Roadshow Workshops are well attended with 141 and 143 participants. Attendance of such events can be recorded as professional development credits. The presentations fulfill the one of the key goals of network which is to disseminate research results and engage designers, specifiers, wood products producers, researchers, government regulatory bodies and associations. Feedback from the attendees was excellent.
- NEWBuildS appreciates event sponsorships from Alberta Innovates, Nordic Engineered Wood, SNC-Lavalin, Structurlam Products LP and LimTek Solutions Inc.
- All presentations are available @ http://newbuildscanada.ca/news/events/
- A project report will be published as part of the deliverable to NSERC and FII. A graphics designer will format the report to produce a professional report. The draft report is being reviewed and is at the final stage of review. The report should be formally published and available at the end of January 2015. The electronic copy will be posted on the NEWBuildS web site and printed copies submitted to the funders, partners and contributors such as PI's, HQP's and consultants.



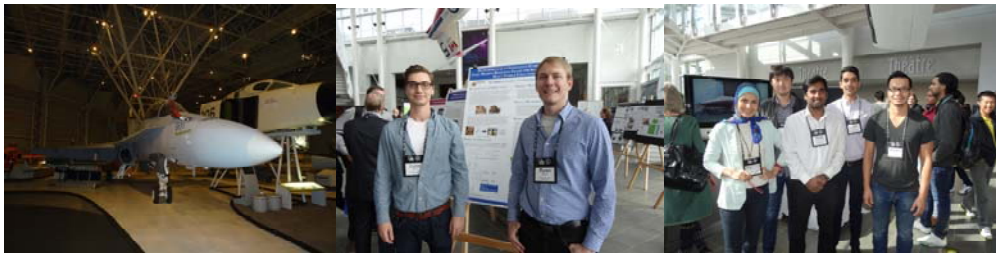
World Conference on Timber Engineering (WCTE)

August 10-14, Quebec City, Quebec

- WCTE is the prestigious international event in timber engineering, engineered wood products and design of timber structures. It is held every two years in different parts of the world and attracts delegates from all continents. The previous ones were held in Auckland, NZ and Riva del Garda, Italy.
- For 2014, the conference is held in Quebec City, QC, Canada and the theme is Renaissance of Timber Construction since Quebec is the birthplace of Canada's wood industry.
- This conference attracted 900 delegates and provided a good meeting place where all researchers can review each other's work, share ideas and collaborate on future projects. NEWBuildS researchers took an active part and attended this Conference. The researchers presented a total 18 papers as well as 8 posters.

Canadian Manufactured Housing Institute (CMHI)

- CMHI's Manufactured Building Design and Technology Forum took take place on October 7 to 9, 2014 at the Canada Aviation and Space Museum in Ottawa. CMHI Forum is held once a year where industry leaders meet and discover new designs, technologies, products and materials, explore new manufactured building solutions as well as exchange ideas with other manufactured building experts.
- In 2013, CMHI invited NEWBuildS researchers to present a poster sessions. It was a huge success and the invitation was extended in 2014.
- 9 NEWBuildS HQPs participated in the CMHI poster session. All were invited to attend CMHI functions such as presentation sessions on changes to the National Building Codes, CSA Standards for Prefabricated Buildings, Modules and Panels as well as factory tours to Guildcrest Homes and its factory design center and model homes.



NEWBuildS Administration:

NEWBuildS network extension approved

NSERC has approved the request by NEWBuildS Strategic Network for an extension until September 2015. The extension will permit some PIs to have HQP complete the research and fulfill the mandate of their research projects.

NEWBuildS Outreach:

At the completion of each research project, each PI/HQP is requested to submit the research thesis and also prepare a Tech Note.

Up to now, 31 HQPs have completed their research and 24 theses have been published. All the graduated HQPs are employed in various sectors with majority of them working in industry.

The achievements of all the HQPs is recognized and acknowledged as follows;

1. Each Theme & Project will list graduated HQP with the thesis title and abstract @ http://newbuildscanada.ca/research/theme-1/
2. All theses are listed along with the university link, when available, @ http://newbuildscanada.ca/publications/thesis/
3. All Tech Notes are available for download. 18 Tech Notes are published @ http://newbuildscanada.ca/publications/tech-note/.

Completed Theses:

Qinyi Zhou	Master of Science, Forestry Engineering	University of New Brunswick	Project T1-1-C1: Development of Evaluation Methodology for Rolling Shear Properties in Cross Laminated Timber (CLT)
Tom Joyce	Master of Science, Forestry Engineering	University of New Brunswick	Project T1-11-C1: Connections in CLT Building Systems Thesis: Connections for CLT Diaphragms in Steel-Frame Buildings
Trevor Trainor	Master of Applied Science, Civil Engineering	University of Waterloo	T4-7-C9: Developing durable wood-frame building envelope systems for net-zero energy ready buildings Thesis: The Hygrothermal Performance of Exterior Insulated Wall Systems
Michael John Fox	Master of Applied Science, Building Science	Ryerson University	Project T4-7-C9: Developing durable wood-frame building envelope systems for net-zero energy ready buildings Thesis: Hydrothermal Performance of Highly Insulated Wood Frame Walls with Air Leakage: Field Measurements and Simulations
Matiyas Bezabeh	Master of Applied Science, Civil Engineering	University of British Columbia	T2-3-C4: Niche for and Feasibility of Steel-frame Multi-material Mid-rise Hybrid Systems Thesis: Lateral Behaviour and Direct Displacement Based Design of a Novel Hybrid Structure: Cross Laminated Timber In-filled Steel Moment Resisting Frames

Shawn Kennedy	Maîtrise en sciences du bois	L'Université Laval	Project T1-11-C1: Connections in CLT Building Systems Thesis: Fastener withdrawal and embedment strength in glulam and cross-laminated timber / Résistance à l'enfoncement et à l'arrachement de connecteurs filetés dans le bois lamellé-collé et lamellécroisé (CLT)

Update on NEWBuildS Web site:

NEWBuildS web site www.newbuildscanada.ca is updated constantly. All projects, events and presentations are available now to reflect the latest developments.

The traffic growth at NEWBuildS web site is as follows;

	Unique visitors	increase / year	Number of visits	increase / year	Pages	increase / year	Hits	increase / year	Bandwidth (GB)	increase / year
2010 since Oct	328		695		9,940		51,077		1.11	
2011	3,811		7,839		61,394		263,700		12.28	
2012	4,728	124%	18,373	234%	74,611	122%	233,441	89%	19.29	157%
2013	6,568	139%	27,350	149%	80,573	108%	262,065	112%	27.13	141%
2014	9,932	151%	32,806	120%	202,341	251%	571,561	218%	400.7	1477%

Future Network and related events:

- NEWBuildS Workshop 2015, Vancouver, B.C., May, 2015

FEATURED PROJECT:

Tall Wood Building Design project - Structural Design and Analysis of a 20-storey Demonstration Wood Building –"CHECKER Building"

Lead Investigator: **Dr. Zhiyong Chen**
Dr. Y.H. Chui
University of New Brunswick

FPInnovations Co-Investigator(s): Dr. Marjan Popovski

Introduction:

Wood products possess a high strength/weight ratio similar to steel, thus they could be suitable for constructing high-rise buildings. The practical height limit for a wood building is governed by several factors, including the performance of structural wood products, connections and joints, construction technologies, and design methods. A multi-disciplinary team of NEWBuildS researchers in collaboration with designers and architects conducted the design of a 20-storey demonstration wood building known as the CHECKER building. The goal of the project was to show

that tall wood buildings can be a viable alternative when latest wood products and innovative connection systems are used, and to identify potential technical challenges and corresponding solutions for tall wood buildings.

Structural Design:

The 20-storey demonstration wood building is assumed to be located in North Vancouver, BC, Canada, a location that has high earthquake, wind and rain loads. It is composed of upper 19-storey wood construction and a bottom-storey concrete podium. The total building height is 60m (3m per storey), and the standard plan dimensions are 27m × 27m with a 9m frame grid. The importance category of "Normal" and a site class of "D" are used for the structural design. The design and analysis of this building focuses on the upper 19-storey wood structure only.

A combination of shear walls with a core was chosen as the lateral load resisting system for the building. These two subsystems, the shear walls and the core, were linked by steel beams with hinge joints at each floor. The gravity load resisting system of this building consists of the beam-column frame and the lateral load resisting system. Concrete-glulam composite structure with HBV (Wood-Concrete-Composite) connectors and cross laminated timber (CLT) were selected as the long-span floor and roof system, respectively. To reduce the number of horizontal connections between panels and minimize the vertical deformation induced by the compressive stresses perpendicular to grain on the wood floor assemblies, a balloon framing technique using laminated strand lumber (LSL) panels was utilized for the shear walls and the core.

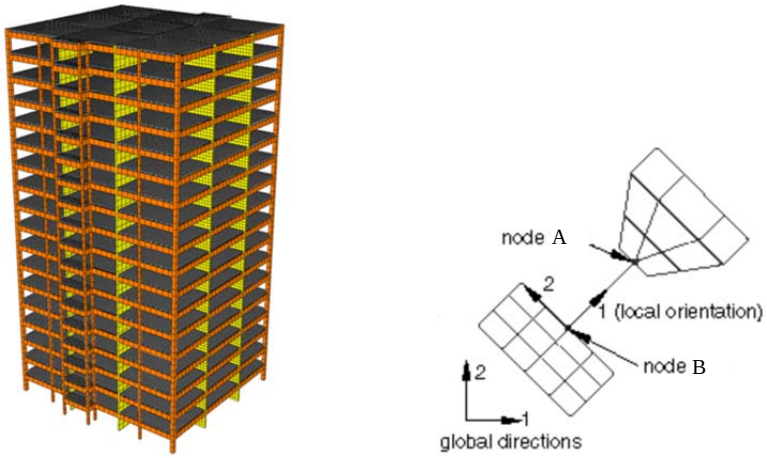
The mechanical connections in massive timber structures are often the weakest link and source of ductility of the structural system, so the selection of the connection type, its failure mode characteristics and the sequence of failure among the connections affect the structural performance of the buildings. To design this tall wood building with higher stiffness, strength and ductility, dowel-type connections and HSK (Wood–Steel–Composite) system were used in the vertical joints of the shear walls and the core, respectively. The HSK system was also used as the shear connectors and hold-down connections. The vertical joints of the shear walls and the core were designed to yield sequentially, and the ultimate limit state of the building was defined as the failure of the shear connectors and hold-downs.

Based on the gravity, wind and seismic loads and considering the fire performance of the structural members, the design details of the building are discussed below. Grade 2.1E "TimberStrand® LSL" with dimensions of 19m × 2.44m × 89mm was used to build the shear walls and the core. Three layers of LSL panels were combined together to achieve a total wall thickness of 267 mm. Steel beam S5×10 of Grade 50 was used to link the shear wall to the core subsystem. SLT9 CrossLam™ of nine layers (309mm) and SLT5 CrossLam™ of five layers (169mm) with single span were used as roof and short-span floor panel. TiComTec Glulam-concrete-composite deck, HBV – Vario system, made of 125mm concrete and 175 × 532mm glulam beam @ 800mm on centres was used as floor system. Beams and columns were grade 24f-E and 16c-E DFL glulam respectively. The cross sectional dimensions of beam were 315 × 532mm. Two sizes of glulam columns were used at different locations. Their cross sectional dimensions were 365 × 418mm and 730 × 418mm that was combined with two 365 × 418mm in the width direction. For the dowel-type connection in vertical joints of the shear walls, the diameter of dowel is 19mm, and the stiffness and strength of each dowel were 25.5kN/mm and 32.5kN, respectively. The HSK system for vertical joints of the core, shear connectors and hold-downs for the whole system, is a patented product of TiComTec

GmbH. The stiffness and strength of each "hole" of the HSK system parallel to the grain were 7.4kN/mm and 0.8kN, respectively; while those in the perpendicular direction were 2.5kN/mm and 0.8kN respectively.

Numerical Simulation of Structural Response:

According to capacity-based design, in timber buildings the connections are designed to be the weakest part of the system. Consequently, this demonstration building can be regarded as a structural system consisting of strong wood-based assemblies and weak connections. Thus, the structural assemblies and connections were modeled with linear and non-linear hysteresis behavior, respectively. A detailed finite element (FE) model of the CHECKER building (Fig. 1) was developed in ABAQUS using a macro-element model approach.



(a) Geometrical model with mesh (b) Macro-element model for connections

Fig. 1: FE model of CHECKER building

A series of comprehensive numerical simulations, including frequency, gravity-induced response, wind-induce response, response spectrum, pushover, and non-linear time history analysis, were performed to check the performance of the 20-storey demonstration wood building. The vertical compressive deformation and 'differential shortening' of the building under short-term gravity load are very small and would not cause functional problems. The lateral drift at the top, inter-storey drift ratio, along- and across-wind accelerations of the building under wind actions meet the design criteria. The seismic response, in terms of base shear and inter-storey drift ratio, fulfills the design requirements. Therefore, the design of the 20-storey wood building with advanced products and connections is appropriate.

Conclusions:

The design and analysis of the 20-storey CHECKER building has shown that tall wood buildings can be a viable alternative to steel and concrete when latest wood products and innovative connection systems are used, and highlighted potential technical challenges for high-rise wood buildings.