# NEWBUILDS NEWSLETTER: FALL 2013

## NEWBuildS Activities:

### NEWBuildS CLT Industry Focus Day - July 19th, 2013

- Dr. Y. H. Chui, Scientific Director & Ms. Lynn Embury-Williams, Chair of Board of Directors, hosted a CLT Industry Focus Day at Radisson Hotel Vancouver Airport, Richmond, BC.
- The CLT (Cross Laminated Timber) Industry Focus Day provided a forum to facilitate interaction between NEWBuildS researchers and invited audience with experience of designing CLT structures (fire engineers, code consultants and architects), CLT manufacturers, building regulators, industry associations and FPInnovations researchers. NEWBuildS researchers interacted in an informal environment with those who would benefit from their research.
- The goal was for researchers to receive feedback on their projects from designers, manufacturers and regulators and also for designers, manufacturers and regulators to discuss issues of concerns to them, thereby providing potential project ideas for the future. There were 66 participants consisting of 16 University researchers, 7 FPInnovations scientists, 10 from manufacturers, 10 designers / specifiers, 8 government officials and others.
- Guest speakers included architects, design engineers, and manufacturers of CLT products. NEWBuildS researchers also presented their research projects and findings on CLT.

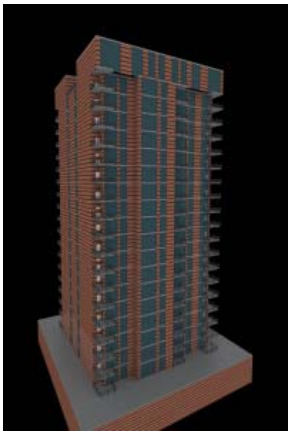

Mr. Bill Downing
Structurlam Products Ltd

- The Round Table and Group Discussions following the presentations were moderated by the Chair of NEWBuildS Board and Dr. Chris Gaston, FPInnovations. A list of 38 technical issues and future research needs in 6 categories was developed. Exit survey from participants gave the Event a score of 88%.
- The Program package and the 14 presentations are available for review and download @ http://newbuildscanada.ca/news/events/ under Past Events.

*NEWBuildS appreciated the presentations from the guest speakers and researchers and thank all for their contribution to make this event such a success.*

## NEWBuildS/FPInnovations HQP Tall Wood Building Design Project:

- The project objective is to execute the design of a high-rise wood building. The first meeting of the design team and advisors took place on September 20th, 2013 at FPInnovations, Vancouver, BC. The design team consists of six HQPs from NEWBuildS who are working under the guidance of design professionals, NEWBuildS researchers and FPInnovations researchers. The draft Tall Wood Building Guide published by FPInnovations will be a key reference document for the project.
- The expected impact is to establish a process and procedure on how to expedite the technology transfer from research results to actual building design, a process and procedure not well practiced in North America using existing state-of-the-art knowledge gathered from NEWBuildS projects and FPInnovations programs.
- This project is led by 3 professional experts; **Mr. Robert Drew**, Perkins + Wills, Architect; **Mr. Eric Karsh**, Equilibrium Consulting Engineers and **Mr. Andrew Harmsworth**, GHL Consultants. The design team will develop the specifications, including geometry, location and specific needs, of a high-rise building. Three sub-groups of the design team with focus on Structural engineering (seismic and vibration), Fire engineering and Building envelope have been established.



- The building will be 20-storey tall with a one-storey podium and will be designed based on environmental parameters of North Vancouver, BC.
- The HQPs had developed the work plan for each sub-group and carried out its design process with regular conference calls within and between sub-groups. The next design team meeting will take place on January 15, 2014 at FPInnovations, Vancouver. The formal report / project presentations are planned for April / May 2014.

*This project is jointly funded by NSERC (Natural Sciences and Engineering Research Council of Canada) and BC FII (Forestry Innovation Investment).*

## Canadian Manufactured Housing Institute (CMHI) Manufactured Building Design and Technology Forum:

BUILDING COMMUNITIES

- CMHI's 60th Anniversary Manufactured Building Design and Technology Forum took place on October 7 and 8, 2013 at the Canada Aviation and Space Museum in Ottawa, ON.
- Dr. Chui was a guest speaker and panel member on Research and Innovation in Manufactured Building Design and Technology.
- 13 NEWBuildS HQPs were invited to participate and present posters at this event. The posters were well received by CMHI members and CMHI has indicated that it will invite NEWBuildS HQPs to present posters at its 2014 annual conference.

## NEWBuildS Outreach Committee:

- At the completion of each HQP project, each PI/HQP is requested to prepare a Tech Note. The Tech Note captures the essential findings of the research project and summarizes the valuable information for industry, design professionals and researchers.
- Tech Notes are available for download @ http://newbuildscanada.ca/publications/tech-note/. There are now 12 Tech Notes posted at the site and will be updated when available.
- For detailed research findings, please review @ http://newbuildscanada.ca/publications/thesis/.

## New Researcher & Research Project:

NEWBuildS welcomes Dr. Dr. Jeffrey Erochko, Carleton University, as the new researcher. He was awarded funding for a new project T2-15-C5 – "Development of an Innovative Hybrid Timber-Steel Moment-Resisting Frame for Seismic-Resistant Heavy Timber Structures".

## FIBRE Network - Mark Wallenberg Prize Award Ceremony:

- Marcus Wallenberg Prize, widely considered to be the 'Nobel Prize' of the forestry related disciplines, was presented by the King of Sweden in a 'bow-tie' ceremony on September 22 to 24, 2013 in Stockholm, Sweden.

- FIBRE sponsored the student competition to participate in the award ceremony. The selection committee interviewed the nominated HQPs from all eight networks and select 5 HQPs to represent FIBRE.
- NEWBuildS researcher, Hadia Awad, a PhD candidate from University of Alberta, was one the 5 successful HQPs. The following is the trip report from Ms. Awad;

  *It was a magical day as Stockholm was looking forward to see the Royal Family and listen to the prize winner's speech. The afternoon started with Young Researchers' session, held at the Grand Hotel. Mr. Marcus Wallenberg himself greeted all with a short humbled speech.*

  *The evening Ceremony started at Vinterträdgården, the "Winder Garden", at the Grand Hotel where Ceremony is held annually. I was lucky to be seated a few feet away from His Majesty the King of Sweden, Carl XI Gustaf. I enjoyed the Royal Swedish dinner with amazing music and finely tuned room acoustics. It was amazing to witness a Canadian scientist receiving this prestigious award from the King of Sweden - a truly an unforgettable night. The Canadian Ambassador also hosted a reception at the Embassy of Canada. .*

  *The next day, All were invited to a tour of Innventia; world leader R & D in pulp, paper, biorefining and KTH, Royal Institute of Technology.*

  *This was a once-in-a- lifetime chance to meet with such Noble, smart people, who really care about the future of our planet. It was a great chance to get close to such great decision makers who will participate in drawing the sketches of our future.*

  *Engaging young researchers in this event were a success itself and I bet each one of us will dream to be the prize winner one day.*

## FIBRE International/Internetwork Stage Application:

- FIBRE promotes the International/InterNetwork collaborations of graduate students/post-doctoral fellows with organizations external to FIBRE networks. The aim of the Stage program is to strengthen and promote projects on the international scene, establish new research partners and provide valuable training experience. The research proposed for the Stage must be related to the scientific programs of FIBRE networks.
- The FIBRE International/Internetwork Stage Award - FIBRE will award three $5000.00 travel awards to students/post docs from Bioconversion, NEWBuildS and VCO.

## Completed Theses:

| | | | |
|---|---|---|---|
| Carla Dickof | Master of Applied Science, Civil Engineering | University of British Columbia | Project T2-3-C4: CLT Infill Panels In Steel Moment Resisting Frames As A Hybrid Seismic Force Resisting System |
| Chao Zhang | Master of Applied Science, Civil Engineering | University of Toronto | Project T2-4-C3: Analysis of the Timber-Concrete Composite Systems with Ductile Connection |
| Henry Meleki | Doctor of Philosophy, Forestry & Environmental Management | University of New Brunswick | Project T2-10-C6: Finite Element Models of Effects of Moisture on Bolt Embedment and Connection Properties of Glulam |
| Sepehr Mohaddes Foroushani | Master of Applied Science, Mechanical Engineering | Ryerson University | Project T4 – 2 – C10: A Numerical Study Of The Effects Of Overhangs On The Wind-Driven Rain Wetting Of Building Facades |
| Atmane Ait kheddache | Master in Engineering | Université du Québec en Abitibi-Témiscamingue | Project T4–3–C11: Traitement d'ignifugation du bois d'ingénierie par des revêtements intumescents (Intumescent Coatings to Protect Engineered Wood Products) |

## Future Network and related events:

- January 14, 2014 — Workshop on Seismic Design of Hybrid Buildings
  Kaiser Building, University of British Columbia
- January 15, 2014 — NEWBuildS Tall Wood Building Design Project 2nd meeting
  FPInnovations, Vancouver, BC.
- February 20, 2014 — FIBRE Cross-Country/Cross-Linking Workshop
  Western Canada Workshop, University of British Columbia
- May 8 Morning, 2014 — NEWBuildS HQP Tall Wood Building Design Project Workshop
  Radisson Hotel Vancouver Airport, Richmond, British Columbia,
- May 8 Afternoon, 2014 & May 9 — NEWBuildS Annual Workshop 2014
  Radisson Hotel Vancouver Airport, Richmond, British Columbia,
- May 12 – 15, 2014 — FIBRE Conference
  University of British Columbia

**Featured Project:**

## PROJECT T4-8-C10: Evaluation of Energy Efficient Wall Systems for Mid-Rise Wood-Frame Buildings

Lead Investigator: **Dr. Mohamed Al-Hussein, Dr. Mustafa Gul**
**University of Alberta**

HQP: **Hadia Awad**

FPInnovations Co-Investigator(s): **Dr. Dr. Jieying Wang, Ms. Constance Thivierge, Mr. Kenneth Koo**

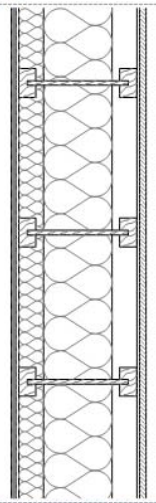
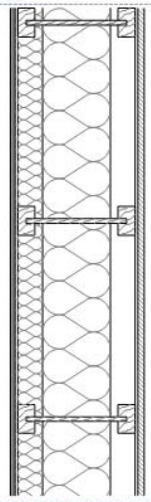
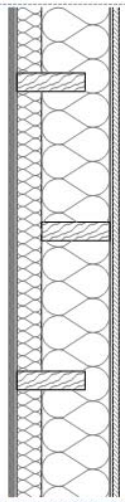
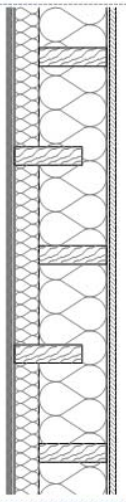
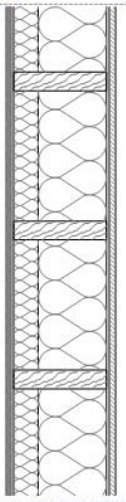
Buildings account for 30-40% of the total primary energy use and 24% of the generation of greenhouse gases globally. If current trends continue, by 2025, buildings worldwide will be the largest consumers of global energy, using as much power as the transportation and industrial sectors combined. Recent studies have found that improving energy efficiency in buildings is the least costly way to reduce a large quantity of carbon emissions. Meanwhile, the building sector offers significant potential to reduce primary energy use and $CO_2$ emissions through such measures as reduced heating demand, increased efficiency of the energy supply chain, and greater use of renewable resources for materials and fuels. For this reason, energy efficiency in buildings is now a primary objective for energy policy at the regional, national, and international levels. Several strategies can be used to realize this potential, including energy efficiency requirements in building standards, such as requirements that specify minimum energy efficiency for buildings.

This study aims at developing energy efficient wall systems for mid-rise construction that can, thermally, mitigate heat loss, and, structurally, increase load-bearing capacity, compared to conventional wall systems. Regarding thermal resistance performance, which is quantified in terms of R-values, four different wall systems have been developed, manufactured, installed in a full-scale testing house, exposed to the natural exterior climate, and examined for their thermal resistance performance on a long-term period, along with a baseline wall system. The selection of the wall systems was based on specific considerations: current practice; preliminary structural analysis; pre-fabricability; material availability; expected energy efficiency; and population growth, which necessitates more multi-unit buildings.

The testing methodology was conducted by installing several sensors on each wall system, including heat flux sensors, thermocouple sensors, and humidity sensors. The selected wall systems are two engineered-wood I-Joist (TJI 230) wall stud systems at spacing of 305 and 406 mm (12 and 16 inches), respectively; two 38x140 mm (2x6-inch) staggered wall stud systems at spacing of 305 and 203 mm (12 and 8 inches), respectively; and a baseline wall system which consists of 38x184 mm (2x8-inch) wall studs at a spacing of 305 mm (12 inches) as described in Table 1. The period of data collection is April 2012 to April 2014.

To determine the wall systems' thermal resistance, this study follows the summation technique described in ASTM Standard C1155-95, where Figure 1 summarizes the field data results in the form of the assembly R-values of the selected wall systems. The I-Joist wall system at 16-inch spacing achieved the highest R-value among the tested wall systems, followed by the staggered wall system at 12-inch spacing.

**Table 1- Description of the wall systems selected for thermal performance testing**

| Wall system | Wall system 1 | Wall system 2 | Wall system 3 | Wall system 4 | Wall system 5 |
|---|---|---|---|---|---|
| Stud type | TJI 230 | TJI 230 | Staggered 2x6 | Staggered 2x6 | Conventional 2x8 |
| Spacing | 12" | 16" | 12" | 8" | 12" |
| Plan |  |  |  |  |  |
| Insulation (inside-out) | ½" Gypsum Board | ½" Gypsum Board | ½" Gypsum Board | ½" Gypsum Board | ½" Gypsum Board |
| | 6 mm polyurethane | 6 mm polyurethane | 6 mm polyurethane | 6 mm polyurethane | 6 mm polyurethane |
| | 2" air gap | 2" air gap | - | - | - |
| | 5 ½" fiberboard | 5 ½" fiberboard | 5 ½" fiberboard | 5 ½" fiberboard | 5 ½" fiberboard |
| | 2" SPF | 2" SPF | 2" SPF | 2" SPF | 2" SPF |
| | 3/8" OSB | 3/8" OSB | 3/8" OSB | 3/8" OSB | 3/8" OSB |
| Top plates | 2"x10" | 2"x10" | 2"x8" | 2"x8" | 2"x8" |

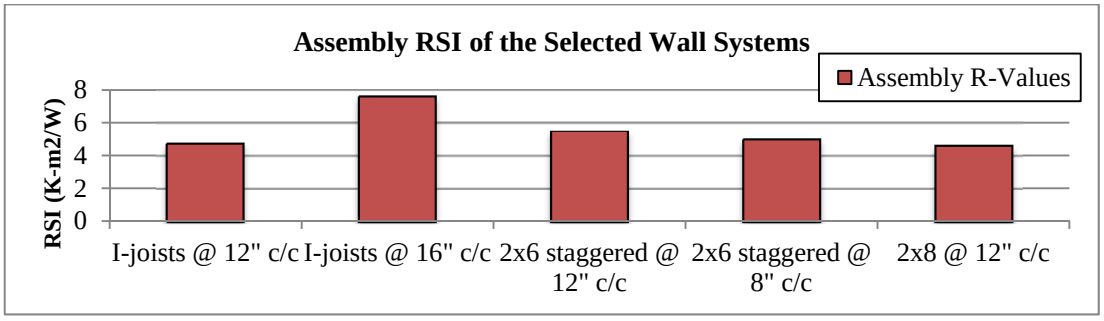



Figure 1- Assembly RSI values of the selected wall systems

Regarding the structural performance test, the compressive performance of different wall systems has been addressed. The deformation of the specimen is determined by installing six deflectometers attached to the wall specimen; east and west vertical, east and west in plane, and east and west out-of-plane. Figure 2 shows the position of the deflectometers attached to the wall specimen. Two types of loading were tested for each wall system: concentric and eccentric, as shown in Figure 2 (right). The compressive loading is expressed in terms of force, while the specimen deformations corresponding to the loading are expressed in displacement (mm). The compression and tension reactions are expressed in negative and positive signals, respectively. The specimen failure occurred due to either physical damage or the inability to bear load increments (plateau).

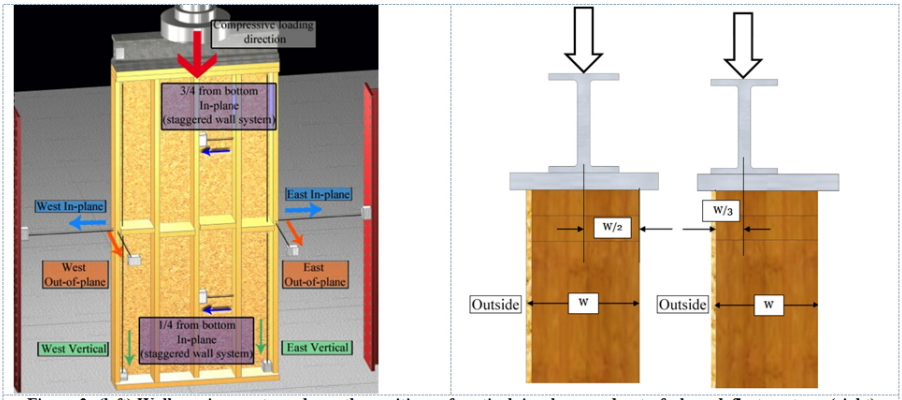



**Figure 2- (left) Wall specimen set-up shows the positions of vertical, in-plane, and out-of-plane deflectometers; (right) Loading set-up for both concentric (left) and eccentric (right) tests**

The observed specimen damages are summarized below:

- Excessive buckling, resulting in wood stud failure;
- Excessive bending of the loading head, resulting in the bending of the wall specimen (especially in the case of eccentric load tests);
- Damage to the top plate; and
- Plateau reaction of the wall specimen with load increments.

The structural test results in terms of load-bearing capacity (Figure 3) show that the conventional wall system achieved the highest maximum loading capacity (kN), followed by the I-Joist wall system. The main cause of failure observed about the I-Joist wall system is the crushing of the top plate due to uneven distribution of the applied load over the entire I-Joist members, but only at the I-joist flanges. Trus-Joist recommends solid rectangular plates that can match the stiffness of the I-joist flanges. Failure can also be related to the wide spacing between the I-Joist studs. The research team recommends that the I-Joist wall system, as well as staggered wall system can be used as non-wall-bearing capacity. It is also recommended to decrease the stud spacing of the I-Joist wall system to increase its load-bearing capacity.

*Note: 3 structural wall tests were done with I-joist wall spacing at 16" while the stud and staggered wall studs were tested at 12" spacing. Since test results are equivalent between I-joist and staggered wall studs, the I-joist wall should be stronger if spacing is at 12" spacing."*

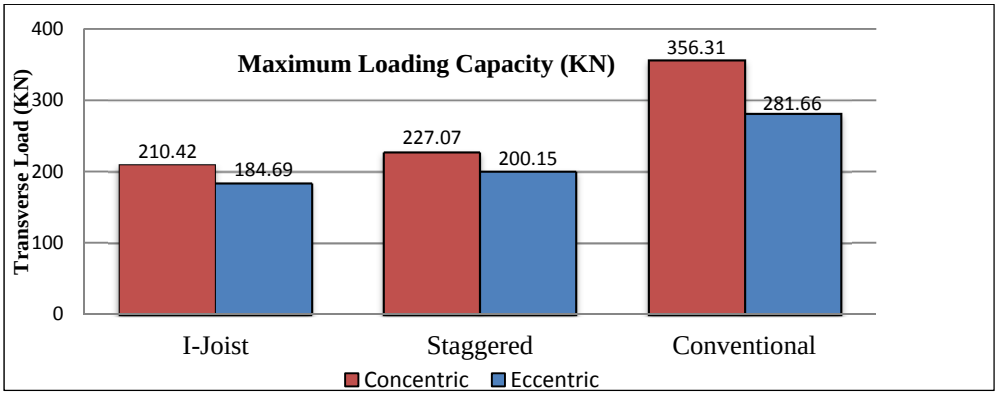



Figure 3-Average maximum loading capacities of both concentrically- and eccentrically-loaded wall systems

All in all, this study focused on the thermal performance of potential energy efficient wall systems for mid-rise wood-frame buildings. The developed wall systems achieved the minimum required R-value by ASHRAE Standard 90.1. Regarding the compressive load-bearing capacity of the developed wall systems, it is recommended to perform an intensive failure analysis, to find practical solutions for obtaining stronger load-bearing wall systems, and thus optimize both high thermal and structural performances.