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Content:

NEWSLETTER

Remark from IRC holder

The work of the IRC program is gathering momentum as we enter the third year of the program. Over the last few months, we have developed analytical approaches to address the following design issues:

- Prediction of strength and stiffness of timber-concrete self-tapping screw connections based on component properties. The models account for presence of a gap between timber and concrete and layered structure of timber.
- Support end fixity effects on floor vibration performance of mass timber floor systems.

Given that self-tapping screws are the designers' choice for mass timber construction, ARTS group is coordinating international efforts to develop design provisions for self-tapping screw connection. Our goal is to harmonize the design and testing approaches for self-tapping connections in North America through CSA O86 Technical Committee and ASTM D07 Committee, and internationally through ISO TC 165 'Timber Structures'.

Through the NRCan GCWood program, we are also collaborating with Fast & Epp in the development of high performance hold-down and braced timber frame connections that are tuned to behave in an anticipated energy-dissipating manner under reversed cyclic loads. A series of high capacity connection and shear wall tests will be conducted in 2019 at the I.F. Morrison Structures Lab at University of Alberta to validate the performance of the developed connections and when used in a building system.

In addition to mass timber research, ARTS group is also active in research in the area of light wood frame construction. To that end, we have recently commenced three research projects on: 1. Evaluation of contribution of non-structural partition on lateral load performance of NBCC Part 9 buildings; 2. Panelized wood frame roof system; 3. Use of CLT in basement construction.

Finally, in conjunction with Integrated Wood Engineering Program at the University of Northern British Columbia, we co-hosted a one and half day Wood Track at the Modular Offsite Construction (MOC) Summit, which was held in beautiful Banff, Alberta on May 21- 24, 2019. The Wood Track attracted 34 papers from eight different countries.

New Website and YouTube Channel

Due to changes in the University of Alberta's online presents, the ARTS website has been relocated. The Arts website can be found under the URL www.uab.ca/timber. From now on you will find the information related to the IRC research group here.

Furthermore, the research team has installed a YouTube channel to present videos and impressions from previous and ongoing tests. You can find a link on the IRC webpage or enter the channel directly through here.

Catherine Lalonde Memorial Award 2018

IRC PhD student Thomas Joyce has been awarded one of two 2018 Catherine Lalonde Memorial Awards by the Canadian Wood Councle. Tom's work focuses on better understanding of large groups of inclined self-tapping screw connections and the investigation of the so-called group effect. Besides Tom, Hercend Mpidi Bita from the University of British Columbia received the annual award for his work on the mechanisms of disproportionate collapse in structures. The IRC would like to congratulate both awardees.

Marcus Wallenberg Prize 2019

The Marcus Wallenberg Prize is considered to be the Nobel Prize within the field of wood related research. “The purpose of the Prize is to recognize, encourage and stimulate pathbreaking scientific achievements which contribute significantly to broadening knowledge and to technical development within the fields of importance to forestry and forest industries.“ (www.mwp.org). This year’s prize has been awarded to Professor Gerhard Schickhofer from Graz University of Technology for his research on cross laminated timber. The IRC would like to congratulate Professor Schickhofer to this well deserved award.

Canadian Wood Council Education Forum

At the beginning of February, Dr. Chui attended the 2019 national Workshop on Wood Education in Ottawa. One postdoc and one Ph.D. student of the ARTS group joined the workshop. Among the 98 attendees were 51 educators and 16 students from the main Canadian Universities. During the two-day workshop, Dr. Chui gave a presentation about the state of wood education in Canada. Furthermore, the workshop held interesting round table discussions. Eight topics involving wood education curriculum were extensively discussed and tremendous input from attendees were received. An event report was created and incorporated into the project implementation plan.

2019 MOC Summit - Review

The 2019 MOC Summit (www.mocsummit.com) was held in the Fairmont Hotel in Banff. The IRC, in conjunction with the University of Northern British Columbia hosted one and a half days of timber related presentations and discussions on 22nd and 23rd of May. A total of 26 presentations were given dealing with the planning and execution of mass and modular timber projects, timber-concrete composite systems, connections, lateral load resisting systems, structural and serviceability design, and material research. Professor Stefan Winter from the Technical University of Munich delivered a keynote speech about CLT structures in Europe. The presented papers of the MOC Summit can be found in the detailed program on the MOC web page.

6th INTER Meeting in Tacoma

This year’s International Network on Timber Engineering Research (INTER) meeting will be held in Tacoma, Washington from the 26th until the 29th of August. Dr. Hossein Daneshvar’s submission with the title “Seismic Performance of End Brace Connections in Ductile Braced Timber Frames” was selected as one of the papers to be presented. The submission is based on the collaboration with Fast & Epp. The INTER meetings are commonly attended by the timber engineering experts from all over the world and therefore the IRC is glad to have its work presented at this stage.

Structural Ice Beam Competition

On March 5th three members of ARTS group took part in the "Ice Beam Competition" arranged by the Civil & Environmental Engineering Students' Society of the University of Alberta and came in first place. Each team had to form a 100 x 100mm beam with a span of about 650mm made from frozen water and using only light reinforcement (no metals). The ARTS group team used bamboo and jute fibre as reinforcement. With 1.2kN, the ARTS team’s beam reached the highest load in a flexure tests, 25% more than the 2nd highest load. Congratulations to winning team members.

Project updates

Mass Timber Panel-Concrete (MTPC) Composite with Self-Tapping Screws

The Mass Timber Panel-Concrete (MTPC) composite floor systems are often encountered in mass timber buildings. Such a floor system consists of a Mass Timber Panel (MTP) connected to a reinforced concrete slab with Self-Tapping Screw (STS) connector and a sound insulation layer in between. In this study three types of MTPs with normal weight concrete, three insulation thicknesses, two screw embedment lengths and two screw angles were tested to characterize connection stiffness and strength. The main goal of this connection test program was to provide preliminary test data to assist in the development of an analytical model to predict connection lateral stiffness and strength considering the insulation layer in the MTPC system. Test results showed that connections with screws at an insertion angle of 30° had a larger stiffness and strength than connections with screws inserted at a 45° angle. Stiffness appears to be more sensitive to the presence of an insulation layer compared to strength. Overall, 35–50% and 55–65% reduction of serviceability stiffness, and 5–15% and 22–34% reduction of strength were noticed for an insulation thickness of 5 mm and 15 mm, respectively. Screws in Cross Laminated Timber (CLT) showed higher strength while screws in Glue Laminated Timber (GLT) showed higher stiffness, but the difference is insignificant in all three MTP products with different failure modes. In Figure 1 and Figure 2, the strength and stiffness of screws into CLT and GLT are shown. The paper can be downloaded here.

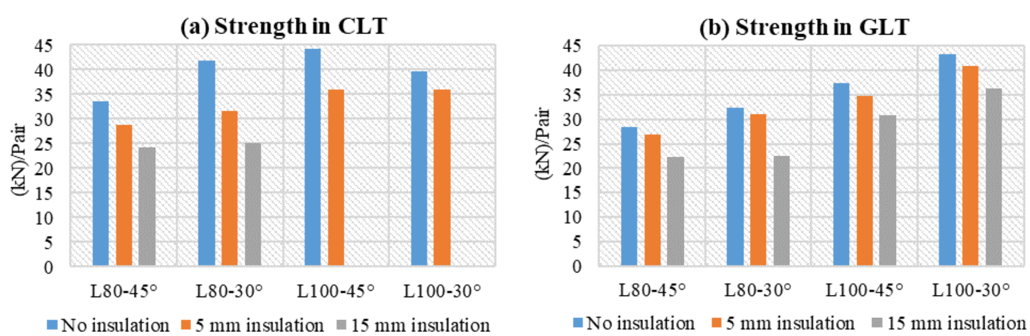

Figure 1: Strength per pair of screws; a) in CLT specimen and b) in GLT specimen

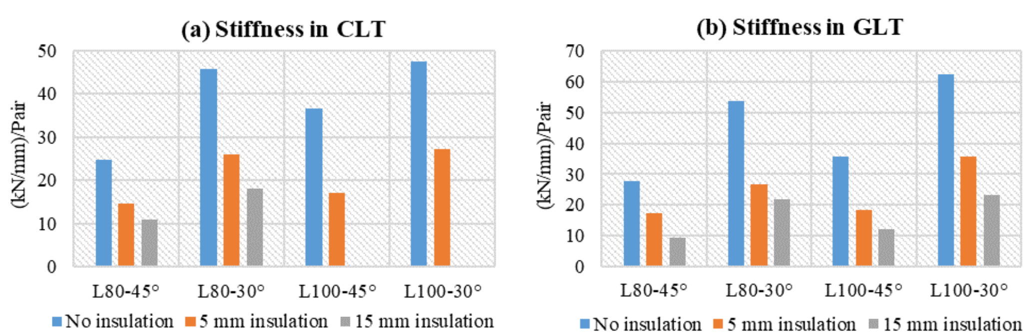

Figure 2: Serviceability stiffness per pair of screws; a) in CLT specimen and b) in GLT specimen

Contact Us

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Effect of End Support Restraints on Vibration Performance of Cross Laminated Timber Floors

Existing design methods for CLT floors often assume simple support conditions for calculating natural frequency and deflection. This assumption deviates from actual floor boundary conditions, while in-situ boundary conditions have been widely recognized as a significant factor affecting the CLT floor performance. In common CLT platform construction successive storeys often add gravity loads on the CLT floor panel at the supports, creating some degree of end restraint against rotation. Furthermore, significant restraints can be introduced by the CLT floor-to-wall joints fixed with different combinations of steel brackets, plates, screws, and anchors.

The end support restraints of cross laminated timber (CLT) floors are often ignored in design mainly because no effective tools are available to quantify the restraints. Traditionally, the rotational stiffness, R, is used to define the rotational restraint at the boundaries. Although the use of rotational stiffness is straight forward in analyses, it alone is insufficient to account for the performance of the structure. A “fixity factor”, r, previously developed for semi-rigid beam-column members is adopted as

$$r = \frac{1}{1 + 3\dfrac{EI}{RL}} = \frac{\alpha}{\theta}$$

in which r is the fixity factor, EI is the flexural rigidity of the beam, R is the stiffness of end rotational restraint, and L is the span. Furthermore, α is the end rotation of a simply supported beam under a unit end moment and θ is the rotation of the beam end plus the rotational restraint for the same unit end moment.

Figure 3 defines the end fixity factor.

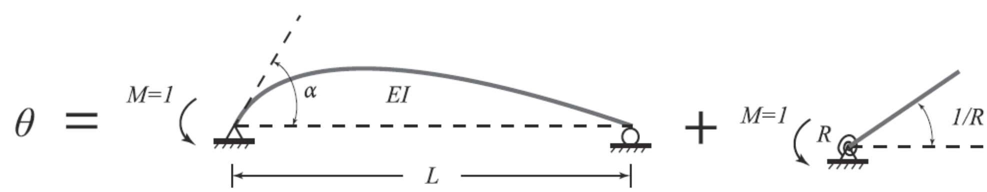

Figure 3: Defining the end fixity factor by rotation (α is the end rotation under a unit moment and 1/R is the rotation of a spring under a unit moment.)

This factor can vary from 0 to 1 and the simply-supported or fully clamped condition will be the limiting cases with the value of 0 and 1, respectively. This allows engineers to characterize the end fixity in an intuitive manner. By using the fixity factors, end restraint coefficients were defined and analytical expressions were derived for the fundamental natural frequency and mid-span deflection under a concentrated load, respectively. By comparing with reported experimental data, the proposed design formula showed excellent agreement with test results. Test methods for determining fixity factors were discussed. It was found that the traditional static tests on end-support joints solely cannot provide accurate characterization of end-support fixity. The mid-span deflection of beam bending test combining with the derived analytical expression can be used to inversely determine fixity factors and excellent accuracy was achieved. At last, it can be concluded that the proposed end fixity factor and derived formulas for restraint coefficients can be recommended as an effective mechanics-based approach to account for the effect of end support conditions of CLT floors and optimize the design of the floors with acceptable vibration performance. Additional work has been planned to develop relationship between top load applied at end of mass timber floor and rotational stiffness. A full paper of the related work can be downloaded here.