UNIVERSITY OF ALBERTA

NSERC CRSNG

NSERC Industrial Research Chair in Engineered Wood and Building Systems

ISSUE 7

March 2020

Content:

NEWSLETTER

Remark from IRC holder

The IRC welcomes ACQBUILT Inc, Edmonton, as a new industrial partner beginning 2020. We are sorry to report that Pinkwood Ltd, Calgary, has decided to withdraw from the IRC due to company restructuring. We would like to acknowledge the support of Pinkwood Ltd over the last 3 years to the IRC program and other research projects. The IRC recently completed a survey of researchers, designers, producers, building officials and insurance companies to identify technical gaps and challenges for use of mass timber in construction. The findings will be of interest to funding agencies, research organizations and mass timber industry. Pending the approval of the funders, the final report could be shared with interested parties. As was reported in the last Newsletter, in conjunction with its key partners the IRC is playing a key role in the development of a new CSA standard on mechanically laminated timber, and structural design provisions on mass timber floor vibration, self-tapping screw connections and timber-concrete composite systems. Over the last two months, the various task groups and committees responsible for the development of these code change proposals have met to discuss the work plan and review draft proposals.

Annual CSA O86 Meeting

The annual CSA O86 meeting was held in Montreal on January 16 - 18, 2020. Dr. Chui and Dr. Jan Niederwestberg of the ARTS group attended the meeting as members of the Sub-committees and Working Groups. During the two and a half day meeting, the development of the next edition of CSA O86 was discussed. Several topics were identified for possible inclusion in the next edition of the standard, which is scheduled for 2024. Among the selected topics two topics proposed by Dr. Chui were identified as work topics for the next version, namely the development of design regulations for self-tapping screws and the associated requirements for the evaluation of the properties of these screws. Furthermore, a product standard for mechanically laminated timber was proposed. The product standard will address the production requirements of nail and dowel laminated timber, as well as other possible mechanical connectors. Apart from the topics discussed above, some of the potential major change proposals are lateral stability design of timber beams and CLT balloon wall design.

National Workshop on Wood Education

Dr. Chui and Dr. Hossein Daneshvar of the ARTS group attended the National Workshop on Advanced Wood Education in Ottawa on February 7 - 8, 2020. The Workshop was attended by over 100 participants from universities, colleges, wood industry, consulting companies and government agencies. A number of education initiations were presented, including Manuals for Architects and Builders, similar to the Wood Design Manual for structural designers, and an Advanced Wood Design Manual. Breakout sessions were held to seek inputs from the participants on the Education Roadmap of the CWC. Prior to the Workshop, Dr. Chui presented the concept of a new academic research network to the participants. There was general support of the concept, and a number of academic participants expressed an interest to participate in such a network.

Alberta Allows 12-Storey Timber Buildings

Alberta is the first province to announce that it will allow construction of 12-storey buildings using engineered wood products. A similar change is expected in the 2020 edition of the National Building Code of Canada.

Scholarships & Awards

Congratulations to Lei Zhang (PhD) and Mehsam Khan (MSc) for being awarded the Alberta Graduate Excellence Scholarship valued at $12,000. Lei's project is related to timber-concrete composite system with notched connection. Mehsam's project focuses on in-plane elastic properties of mass timber panels. Congratulations to both!

UofA during COVID-19

Like everyone, the UofA has been affected by the COVID-19 virus. The university has taken action to protect its community and to reduce the spread of the virus. Classes and exams have been moved online and students and staff have been asked to work from home. As a precaution, the I.F. Morrison Structures Lab has been temporarily closed.

Project updates

Minimizing Embodied Carbon with Timber-Concrete Composite Floors

A brief study was undertaken to investigate the trade-off between structural and environmental performance of timber-concrete composite floor systems. The embodied carbon content of a range of cross-laminated timber floors, with and without a composite concrete topping layer was investigated. The analysis was carried out using the γ-method in Eurocode 5, with volumetric embodied carbon data from Athena Impact Estimator.

In all cases, the floors were governed by serviceability requirements: generally vibration, and deflection when the vibration criteria were neglected. The results showed that using a concrete topping had a significant impact on the carbon content of the floor system and that a lower impact could typically be achieved by increasing the thickness of the timber panel instead (Figure 1). This outcome was observed for both vibration and deflection criteria, and for γ values from 0.25 to 1.0 (fully composite) (Figure 2). In addition, the concrete layer caused a significant increase in the dead load of the floor and would therefore increase the size of supporting framing members and foundations.

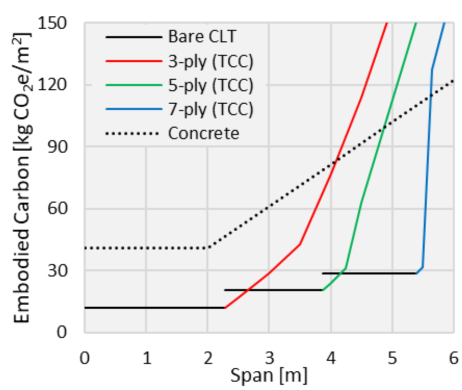

Figure 1: Minimum embodied carbon content of TCC floor systems with 3-, 5-, and 7-ply CLT (γ = 0.25). Reinforced

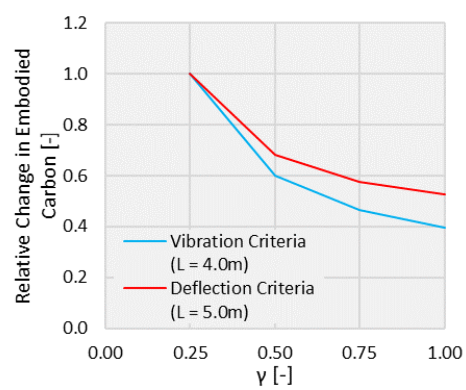

Figure 2: Effect of γ-value on embodied carbon content of TCC floors (3-ply CLT). Relative to γ = 0.25.

While the conclusions suggest to increase the thickness of the timber elements to reduce the environmental impact of the floor structure, they also showed that the use of timber-concrete composite is generally preferable to a typical reinforced concrete option from the perspective of embodied carbon. The study identified a need for further research on the impacts and opportunities for thin concrete topping layers, including the minimum thickness required for composite action and anchorage of different types of connectors.

Contact Us

Ying-Hei Chui
PhD, PEng
NSERC Industrial Research Chair in Engineered Wood and Building Systems
University of Alberta
+1 (780) 248-1176
yhc@ualberta.ca
www.uab.ca/timber
ARTS YouTube Channel

Influence of Insertion Angle, Diameter and Thread on Embedment Properties of Self-Tapping Screws

Inclined installation of self-tapping screws (STS) allows for axial load transfer and significantly higher connection capacity and stiffness. However, STS are not regulated in Canadian or European standards and guidance is not provided on how to account for combined lateral and axial loading. Embedment tests were conducted to determine the influence of STS diameter, insertion angle and fastener thread on embedment properties. Four different screw diameters (d) were tested, namely 8mm, 9mm, 11mm and 12mm. For these diameters, tests with threaded STS and smooth rods were conducted. In addition, five different insertion angles (α) were investigated (0°, 30°, 45°, 60°, and 90°). The tests were performed in accordance with the half-hole test procedure described in ASTM D5764-97A. In this method the holes for the fasteners are pre-drilled. For embedment tests involving the smooth rod, the diameter of the pre-drilled holes was equal to the diameter of the fastener. For embedment tests involving the fully threaded STS, the diameter of the pre-drilled hole was approximately 70% of the outer thread diameter of the fastener. After pre-drilling a wood block, the fastener was inserted and removed again. This process formed a threaded hole in the specimen. After that, the block was cut along the middle of the hole. Using specimens of Douglas Fir, a total of 164 embedment tests with 40 different configurations were conducted and analyzed.

Test results showed that embedment strength, stiffness, failure mode and yield load are strongly influenced by the insertion angle, whereas the influence of STS thread and diameter is less apparent. These results were combined with those from other studies and new equations for predicting embedment strength for all fasteners, threaded STS and smooth rods are proposed. All proposed equations are based on insertion angle (α), fastener diameter (d) and wood density (ρ). Equation 1 presented below presents the embedment strength equation for all conducted tests.

$$f_{h,\alpha} = \frac{0.56 \cdot \rho^{0.834} \cdot d^{0.016}}{8.2 \cdot cos^2\alpha + 2.9 \cdot sin^2\alpha} \quad (1)$$

Figure 3 shows the embedment strength determined from the laboratory tests (blue bars) as well as results based on an equation provide by Bejkta (2005) (red lines) and the results based on Equation 1 (black lines). The predictions were obtained for the average density of 525kg/m^3. It can be seen that the equation shows generally good agreement with the results from the laboratory tests.

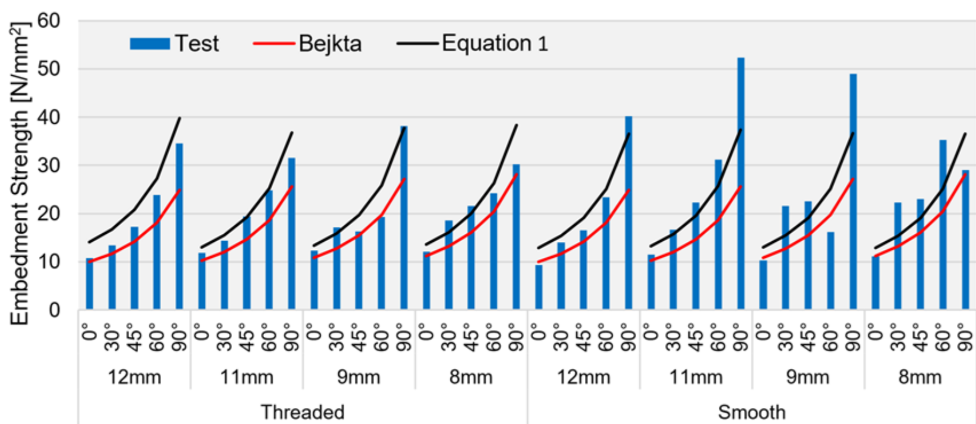

Figure 3: Comparison of embedment strength from tests, Bejtka (2005) and Equation 1

Reference:

Bejtka, I. (2005). *Verstärkung von Bauteilen aus Holz mit Vollgewindeschrauben*. Dissertation, Karlsruhe University