Award Details

Durability of Low-Carbon Structures

Research Details

Competition Year:	2017	**Fiscal Year:**	2019-2020
Project Lead Name:	Macdougall, Colin	**Institution:**	Queen's University
Department:	Civil Engineering	**Province:**	Ontario
Award Amount:	21,000	**Installment:**	3 - 5
Program:	Discovery Grants Program - Individual	**Selection Committee:**	Civil, Industrial and Systems Engineering
Research Subject:	Structural materials	**Area of Application:**	Structural engineering
Co-Researchers:	No Co-Researcher	**Partners:**	No Partners

Award Summary

Given the danger of increasing carbon dioxide levels in the atmosphere, the Canadian government at the Paris COP21 conference committed to transition to a low-carbon economy. Highway bridges are critical pieces of Canada's infrastructure, and the sustainability of these structures, including their carbon footprint, needs to be addressed. As a bio-based material, timber is the only major structural material that is low-carbon.*******The connections currently used for timber can be expensive and limit the use of timber for bridges. One of the most important developments in timber design has been the availability of high-strength, long length (up to 1.5 metres), self-tapping screws (STS). STS can provide simple, cost-effective connections even for large timber elements. However, in order for STS to be safely and effectively used for highway bridges, their performance after experiencing the millions of cycles of loading due to vehicles (called “fatigue”) must be well understood.*******The proposed research will focus on the high-cycle fatigue performance of timber connections with self-tapping screws. The work will involve both experimental testing and theoretical modeling. The focus will be at both the “interface” and “connection” scales. The interface scale work will examine a single screw embedded in timber and understanding how this interface changes with repeated loading. The “connection” scale work will examine typical connections connecting full-scale timber components and understanding how these connections behave with repeated loads.*******Fatigue testing can take days or even weeks to complete. Thus, a critical part of this work is to develop and validate theoretical models that predict the fatigue performance for a given set of parameters (applied loads, type of screws, type of timber, etc.). These models can then be used by engineers to predict the fatigue performance in a given application, rather than needing expensive testing for every new configuration. The applicant has previously developed fatigue models for steel, concrete, and fibre-reinforced polymer (FRP) structures and components. However, timber (like other low-carbon materials the applicant has researched) is particularly susceptible to moisture and has large variability in properties. Thus, the research will be breaking new ground in adapting previously developed fatigue models to deal with these characteristics.*******The goal of transitioning to a low-carbon economy is possible, but conventional materials used for our built environment continue to be a challenge. Timber is an important low-carbon alternative, but fundamental research is needed now so that its full limits as a material for highway bridges can be explored. The research conducted by the applicant will provide critical guidance for engineers and the eight HQP trained will provide critical expertise in bringing this technology to industry. **