

## Call for MSc or PhD Candidate in Civil Engineering: Digital Twins for Climate-Resilient Infrastructure

**Location:** Department of Civil Engineering, Lassonde School of Engineering, York University, Toronto, Canada

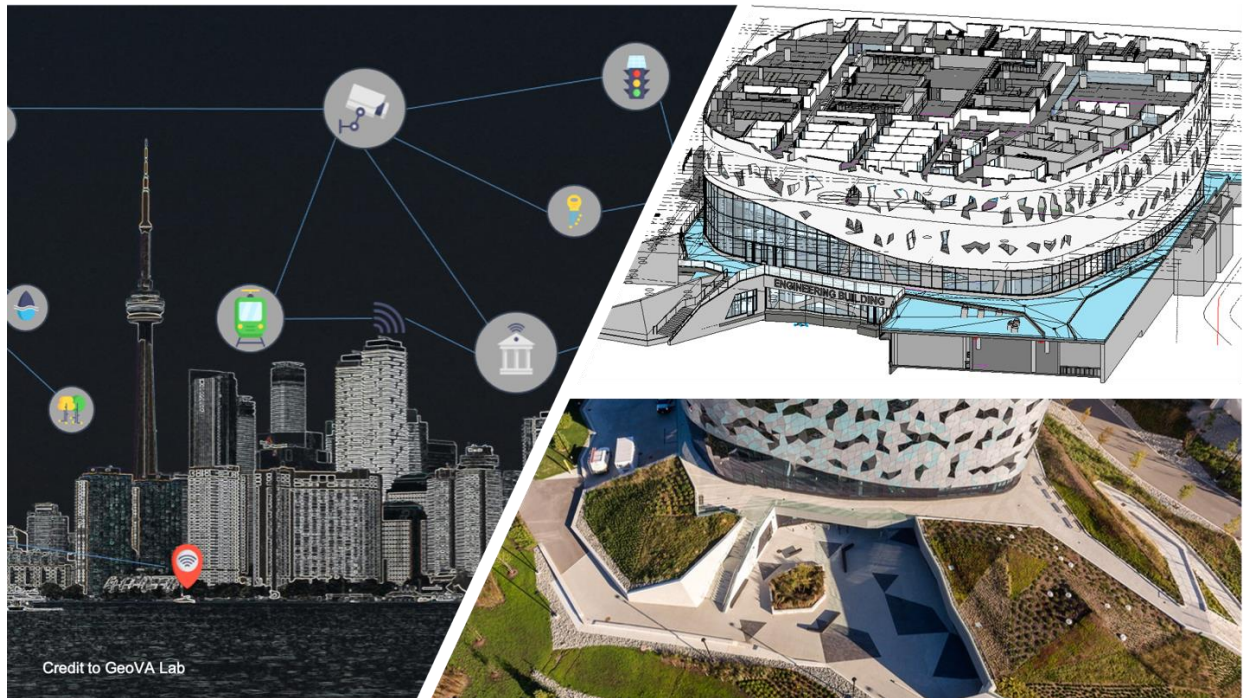
**Anticipated Start Date:** January or May 2023

**Application Deadline:** October 20<sup>th</sup>, 2022

**Funding:** Fully-funded graduate fellowship

**Investigators:** Dr. Liam Butler and Dr. Mojgan Jadidi

**Research Areas:** *Digital Twins, BIM, 3D GIS, IoT, Distributed Fiber Optic Sensing, Structural Engineering, Infrastructure Resilience*



### Project Scope

With the rapid development of technologies such as advanced sensing and the Internet of Things, more data is being gathered about our built environment than ever before. Typically, data-driven, or model-free approaches are used to glean performance information from an instrumented asset. However, this approach is limited by the data which is available and does not allow for parametric simulations of future 'what-if' scenarios. By synthesizing approaches which leverage both numerical and data-driven models, this project aims to develop a framework for creating a 'digital twin' prototype of an instrumented structure, subjected to variable climate conditions, which can be continually updated as new data becomes available.

### Role Summary

Applications for one graduate researcher position in civil engineering are currently being sought at the MSc level. However, outstanding candidates with the required qualifications will be considered for entry into the PhD program. Based in the Department of Civil Engineering and under the supervision of Prof. Liam Butler and Prof. Mojgan Jadidi, the graduate researcher will

develop and investigate the effectiveness of digital twin prototypes for application in infrastructure resilience monitoring. Lab-scale prototype structures will be fabricated and instrumented with advanced distributed fiber optic sensors (DFOS) capable of measuring dynamic strain and temperature changes. The structures will then be subjected to a variety of mechanical and environmental loading conditions. A variety of model-based and data-driven machine learning approaches will be tested to develop capabilities for simulating and detecting various damage mechanisms (e.g., fractured connections, locked bearings, fractured structural members, etc.). Building Information Modeling (BIM), 3D geospatial Information Systems (3D GIS), and Internet of Things (IoT) will be used as the other primary data sources to leverage intelligent structural monitoring and analysis. The proposed synthesis of the physical and digital representations of the built environment will support the dynamic visualization of key structural performance parameters and will allow for the seamless updating and long-term management of data while facilitating data exchange by generating models compliant with Industry Foundation Classes (IFC)<sup>1</sup>, CityGML<sup>2</sup>, SensorML<sup>3</sup>, etc.

## Candidate Profile

MASc applicants must have an undergraduate (Bachelor) degree in **Civil/Structural Engineering** or a closely related engineering discipline by the project start date. PhD applicants must have both an undergraduate (Bachelor) degree and a Master's degree (thesis- or research-based) in **Civil/Structural Engineering** or a closely related engineering discipline. Applicants to the PhD program are also expected to have a significant publication record within top-tier engineering journals. In addition, successful candidates will demonstrate a broad knowledge and passion for Building Information Modeling (**BIM**), machine learning, 3D Geospatial technologies (**3D GIS**) and **infrastructure sensing**. Candidates with demonstrated research output (e.g., publications) and/or extensive experience in experimental work, numerical simulation and BIM would be particularly desirable. As this project is highly interdisciplinary and involves working in diverse research groups, candidates should possess excellent communication and writing skills, including the ability to communicate complex technical knowledge effectively with a wide range of stakeholders. Candidates should also demonstrate enthusiasm to undertake the research required to complete an MASc or PhD degree.

## Application Instructions

Any questions about this position should be directed to Prof. Liam Butler ([Liam.Butler@lassonde.yorku.ca](mailto:Liam.Butler@lassonde.yorku.ca)). Interested applicants should email, as a **single PDF document**, a **one-page research statement**, your **curriculum vitae**, and **transcript(s)** (unofficial) to Prof. Mojgan Jadidi ([mjadidi@yorku.ca](mailto:mjadidi@yorku.ca)) and Prof. Liam Butler ([Liam.Butler@lassonde.yorku.ca](mailto:Liam.Butler@lassonde.yorku.ca)) by October 20<sup>th</sup>, 2022. In your email subject line, please state: "Application for Digital Twins Project – [Your Name]".

Applications will be reviewed, and shortlisted candidates will be invited to an interview in November 2022. All prospective MASc or PhD students must meet the respective program requirements as outlined by the Department of Civil Engineering. The selected candidate will then

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<sup>1</sup> <https://www.buildingsmart.org/standards/bsi-standards/industry-foundation-classes/>

<sup>2</sup> <https://www.ogc.org/standards/citygml>

<sup>3</sup> <https://www.ogc.org/standards/sensorml>

be invited to submit their official application through the Faculty of Graduate Studies (<https://futurestudents.yorku.ca/graduate/apply-now/>).

## **Funding Package and Benefits**

This position includes a competitive funding and student benefits package to help meet the financial needs of a typical graduate student. The funding model is comprised of a fellowship amount and salary amounts from working as a Teaching Assistant and Research Assistant. Additional information regarding funding can be found here: <https://civil.lassonde.yorku.ca/graduate-funding/>.

## **Graduate Studies at Lassonde**

The Graduate Program in Civil Engineering offers advanced training leading to Master of Applied Science (MASc) and Doctor of Philosophy (PhD) degrees. Three main research themes distinguish the program: infrastructure, resilience, and sustainability through the established sub-disciplines of Environmental and Geo-Environmental, Geotechnical, Structures, Transportation, and Water Resources Engineering.

Cutting-edge research is being carried out in our state-of-the-art facilities, which are located in the Bergeron Centre for Engineering Excellence and across the Keele Campus. The facilities include 750m<sup>2</sup> of dedicated laboratory space, including the Structures High-Bay Laboratory, the newly established Climate-Data-Driven Design (CD3) Facility for Built Infrastructure, and additional research laboratories and computational facilities for Geo-Environmental, Geotechnical, Construction Materials, Transportation and Water Resources sub-disciplines.

Our state-of-the-art facilities will allow graduate students to conduct research on above-ground and buried infrastructure; on the performance of civil infrastructure during extreme loading events, including the influence of climate change; on the development of novel materials and construction technologies that improve the resilience of civil infrastructure; on innovative site remediation technologies; on development of technologies for construction using recycled and renewable materials; on construction over marginal-quality land and degrading permafrost; on smart wastewater and material recovery technologies; and on advanced transportation research including transportation safety, security, and intelligent transportation systems. Additional information about the graduate program in civil engineering is available here: <https://lassonde.yorku.ca/academics/graduate-program-in-civil-engineering>

## **York University and Toronto**

York University was founded in 1959 and has now planted its flag at three central campuses: Glendon, Keele and Markham Centre. York also has two locations in downtown Toronto: the Miles S. Nadal Centre and the Osgoode Professional Development Centre, as well as international locations in India and Costa Rica. The third largest university in Canada, York is a positive force for change as a leading teaching and research university. The student body is both large and diverse with over 53,000 students from 178 countries walking through its halls with over 1,400 full-time faculty members and librarians.

Research at York is strongly engaged internationally and has significant global impact. Indeed, over the past five years, 55% of York publications resulting from the collaboration of two or more authors have at least one author from outside of Canada. This leads all Ontario universities. York is currently ranked 33<sup>rd</sup> globally in the Times Higher Education Impact Rankings.

York scholars have achieved the highest recognition in their fields. They include over eighty Royal Society Fellows and twenty-five Distinguished Research Professors. They have been inducted as members of the College of New Scholars, Artists and Scientists and named Killam Professors, Humboldt Fellows, Fulbright Scholars, and Trudeau Foundation Fellows. They have been recognized as Steacie Medalists and Governor General's Award winners and receive a range of disciplinary honorifics and prizes for their books, lectures, and other scholarly achievements. York's allocation of thirty-five Canada Research Chairs is complemented by over thirty York Research Chairs and over thirty-five named Chairs and Professorships.

York University's Keele Campus is located in Toronto, Canada. Toronto is Canada's largest city and the capital of the Province of Ontario. While the city, which is on the north shore of Lake Ontario, has a population of approximately 2.9 million, the surrounding metropolitan area, the Greater Toronto Area (GTA), reaches upwards of 6 million. Toronto is distinctly multicultural, with an estimated 50% of the population being born outside of Canada. This has in turn made the city 'a city of neighbourhoods' because it is composed of many distinct, smaller areas with unique cultures.