2021 ANNUAL REPORT

Dr. Robert Driver
Director

UNIVERSITY OF ALBERTA

CISC Centre for Steel Structures Education and Research
University of Alberta
Faculty of Engineering
Department of Civil and Environmental Engineering

challenge
traditional
boundaries.

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OF ALBERTA

a story of growth

The Steel Centre began as an idea to more closely integrate industry and academic research. That initial vision has grown and developed in unprecedented ways, leading to a collection of programs and projects to invigorate engineering education and train top-quality engineers for tomorrow.

October 2016
Public Launch of CISC Centre for Steel Structures Education and Research with Dean Fraser Forbes.

2016

February 2017
Dr. Ali Imanpour is the first full-time professor hired for the Steel Centre.

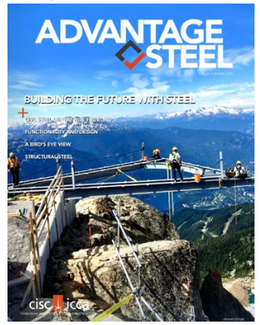
April 2017
Visioning and Strategic Planning Workshops: participants from industry and the UofA set a course for the future.

November 2017
WF Steel & Crane, S-Frame Software join as members.

December 2017
Steel Squad officially announced; first event at Collins Steel.

July 2018
SCORE, a student-run consultancy, launches. Graduate students complete real-world projects for member organizations.

May 2019
Steel Centre is featured in CISC's national industry magazine.



June 2018
Brown Paper exercise spurs new areas of development for the Steel Centre's continued growth.

2020
BuildingPoint Canada and Steadfast Engineering join the Steel Centre.

2021
Niik Group, CWB Welding Foundation, and IDEA StatiCa add to the Steel Centre's growing membership.

2021

April 2021
T3, the technology think tank at the Steel Centre, looks at the biggest problems facing industry.

contents

from the director

The Steel Centre grew in unconventional ways this year, thanks to both the shifting conditions of the pandemic and our ever-present mantra to challenge traditional boundaries. We've further developed cohesive relationships with and among our diverse network of members, who come together to make each Steel Centre project and program reach further than initially imagined.

Many fields struggle to create meaningful and efficient channels of communication among stakeholders, and construction is certainly no exception. While we do not pretend to aspire to changing the industry overnight, we are continually modelling methods for multi-faceted interaction and mentorship that connect designers to fabricators, fabricators and detailers to construction managers, students to practitioners, and structural engineers to the software engineers who build the tools they use each day. In the field, much of a construction project focuses on reaching the handover with as few delays as possible. At the Steel Centre we also take time to examine the process itself. Can interoperability between tools reduce headaches? The students at SCORE are piloting new workflows (p. 18). How will advanced tech tools reshape an engineer's day (p. 26)?

The growing diversity of our network enables the Steel Centre to ask multi-dimensional questions and seek answers that connect stakeholders. In 2021, we welcomed software firm IDEA StatiCa along with the Canadian Welding Bureau 's Welding Foundation. Few academic ventures bring together participants from such a wide variety of domains, but the Steel Centre has shown it to be a source of strength and new ideas. Celebrate with us a year of progress and new ventures in this look at the Steel Centre in 2021!

Dr. Robert Driver
Director
The Steel Centre

CANADIAN INSTITUTE OF STEEL CONSTRUCTION

C.W. CARRY CHAIR in Steel Structures

SUPREME STEEL PROFESSORSHIP in Structural Engineering Education and Innovation

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vision

The Steel Centre **imagines and transforms** the future of structural steel design, fabrication, and construction.

mission

We are an **industry-driven, student-centred** education and research network dedicated to **continually advancing the steel industry**, engaging in interdisciplinary collaborative research, providing **innovative education opportunities**, and developing leaders of the future.

values

We **challenge traditional boundaries.**

We are a **collaborative community** with uncompromised integrity.

Excellence is in our DNA.

We do **cool stuff for the real world!**

SCORE
by the STEEL centre

the STEEL squad
by the STEEL centre

the STEEL centre

STEEL centre INDUSTRY-READY

24 credits in total	at least 6 credits per core area	maximum 3 credits per event type

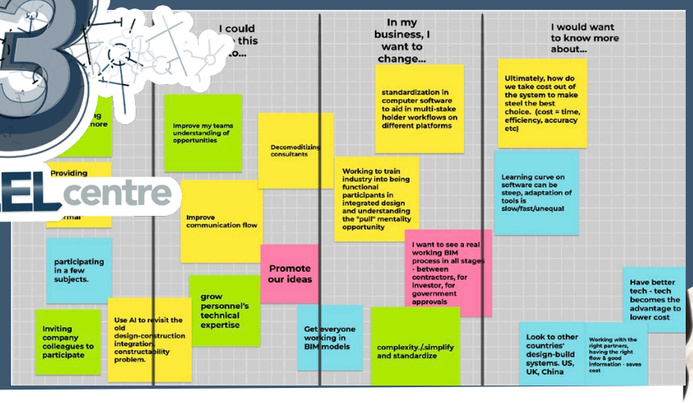
sample student portfolio

real-world engineering	industry collaboration	business sense
Steel for Lunch 1	CISC webinar	SCRG event coordinator
Jobsite visit 1	Office shadowing	Steel for Lunch 2
Engineers in Action*		Engineers in Action*
SCORE*	SCORE*	SCORE*
Summer internship*	Summer internship*	Steel for Lunch 3
Jobsite visit 2		

**Large or particularly complex projects may qualify for a maximum of 3 credits*

STEEL for lunch
by the STEEL centre

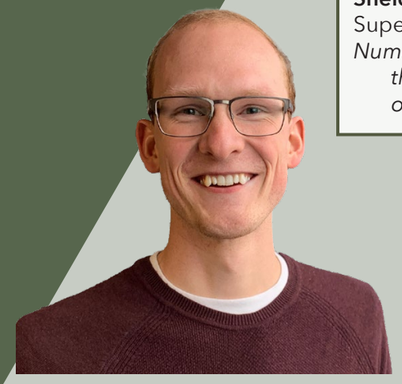
T3
by the STEEL centre



growing
in diversity and scale

The Steel Centre set out with a stated goal to build a diverse network of supporters, and that goal is being realized year after year as new members add their unique perspective to the Steel Centre. This year, **CWB Welding Foundation** has increased their level of support and is set to bring their well-established expertise in welding practice, training, and industry concerns to support training holistically-minded students with a sense of the construction process and how their decisions have cascading impacts. **IDEA StatiCa** adds to our growing representation from the tech industry, better positioning the Steel Centre and its members to imagine and prepare for coming shifts in tools and processes. **Niik Group** expands our representation with engineering consultants and their start-to-finish view of project needs. As we bring together this network of fabricators, designers, and industry leaders into each Steel Centre project, we infuse a richness of ideas and viewpoints into our research and training.

congrads
2021 graduates!



Sheldon Twizell (M.Sc.)
Supervisors: Dr. Imanpour, Dr. Driver
Numerical and Experimental Evaluation of the Lateral-Torsional Buckling Response of Welded Girders

Ian Chin (M.Sc.)
Supervisors: Dr. Tomlinson, Dr. Driver
Standardization of Embedded Plates for Steel/Reinforced Concrete Connections

Abrar Islam (M.Sc.)
Supervisor: Dr. Imanpour
Development of Enhanced Design Methods for Deep Wide-Flange Columns in Steel Moment Resisting Frames Under Earthquake Loading

undergraduates

Adriano Torres

Eric Duong

Maha Essa

people

support

Matt Jeppesen
Programs Administrator

AJ Darras
Research Associate

Greg Miller
Structural Engineering Technician

Cam West
Structural Engineering Technician

current students

researchers

Dr. Robert Driver, P. Eng.
Supreme Steel Professor
Steel Centre Director
Steel Structures

Dr. Ali Imanpour, P. Eng.
Assistant Professor
Steel Structures

Dr. Doug Tomlinson, P. Eng.
Assistant Professor
Steel/Concrete Composite Systems

Dr. Leijun Li, P. Eng.
Professor
Welding Metallurgy

Dr. Yong Li
Assistant Professor
Reliability & Advanced Analysis

Dr. Yasaman Balazadeh Minouei
Post-doctoral Fellow
Steel Structures

Dr. Mojgan Yaghoubshahi
Post-doctoral Fellow
Steel Structures

education

The Steel Centre prides itself on putting education and mentorship first, because a strong education program is also a strong research and training program. In this section, learn more about our multiple efforts to invigorate education for tomorrow's engineers.

The Steel Squad (p. 15)
Hands-on, active learning and mentorship opportunities for undergrad students with demonstrated interest in steel.

Steel for Lunch and SCILS (p. 17)
A new program gives students even greater exposure to professional practice.

SCORE (p. 18)
A first-of-its-kind student-run engineering consultancy, where students take on real projects alongside member companies.

on-the-ground learning

The Steel Centre's undergraduate-focused group, the **Steel Squad**, got behind the scenes at several notable projects in Edmonton. Steel Centre members took their time to provide these unique opportunities to see the construction process from engineering through to final delivery, and learned of the unexpected challenges that often arise along the way. Real-world experiences in welding and cutting-edge tech ensure that student training is relevant and prepares students to see themselves as part of the full construction process chain. Thank you to members who make these experiences possible!

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student awards 2021

Steel Centre students are top performers, receiving a number of honours and awards each year for academic and research accomplishments. In 2021, students were awarded scholarships totalling an impressive $158,100. The Steel Centre's excellent students have attracted direct support from outside organizations, most recently the CWB Foundation's Welding Advancement Award, given each year to a Steel Centre student or students whose research advances the welding field. We are honoured by this support, and proud of our students and their accomplishments.

cwbwelding foundation
building the future of welding in Canada

$158,100 total awards & scholarships in 2021

- Alexander Graham Bell Canada Graduate Scholarship ($35,000)
- CISC Alberta Region G.L. Kulak Scholarship ($15,000)
- Alberta Graduate Excellence Scholarship (2 recipients; $12,000 each)
- MITACS Business Strategy Internship (2 recipients; $10,000 each)
- NSERC Undergraduate Student Research Award (4 recipients; $6,000 each)
- President's Doctoral Prize of Distinction ($5,800)
- Gordon F. Anderson DIALOG Graduate Scholarship ($5,000)
- University of Alberta Graduate Recruitment Scholarship (2 recipients; $5,000 each)
- Norman and Tess Reid Graduate Scholarship (2 recipients; $4,000 each)
- CWB Foundation Welding Advancement Award (2 recipients; $2,500 each)
- Brian Gerbrandt Memorial Graduate Scholarship (2 recipients; $2,500 each)
- SSRC Vinnakota Award ($500)
- Dean's Research Award ($500)

Legend
International award
National award
Alberta award
University of Alberta award
Steel Centre exclusive award

connections to industry

Steel Centre students learn from and alongside the pros

Adriano Torres (left) and Eric Duong (right), the first SCILS interns

Education comes first in the Steel Centre's full name, *CISC Centre for Steel Structures Education and Research,* and that's no accident. Research is a foundational aspect of the Steel Centre, but we keep our mindset focused on "education first". How can research help teach students? How might we develop better engineers for tomorrow? Along with top-notch education and research, a connection to industry and the ongoing practices, concerns, and opportunities in the professional field is essential for a future engineer.

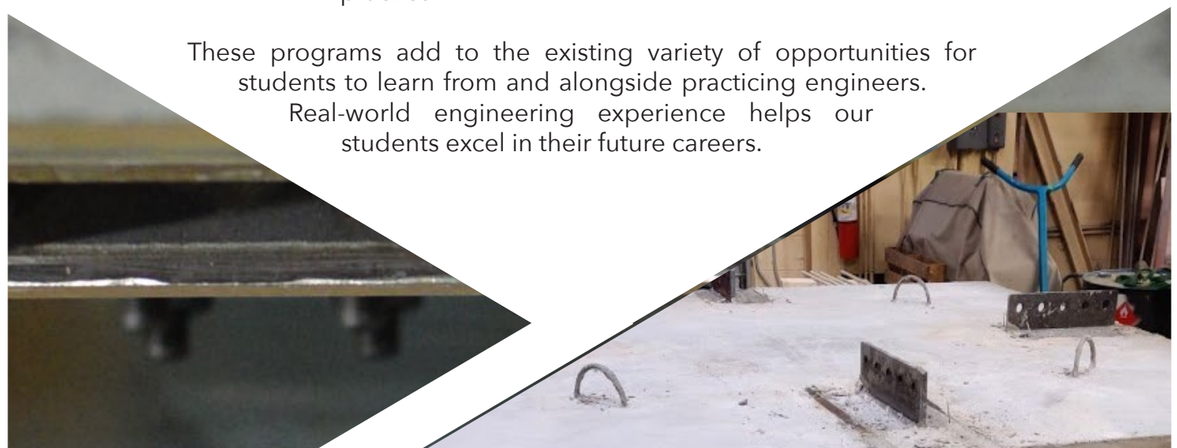
New in 2021, the **Steel Centre Industry Launchpad for Students (SCILS)** adds a formalized internship structure for students to connect with and learn from our members through 4-month summer internships in partnership with MITACS' Business Strategy Internship program. SCILS interns take on a defined project that develops their engineering and business sense, preparing them for real-world engineering (and contributing toward another new Steel Centre program, the Industry-Ready endorsement).

SCILS by the STEELcentre

STEEL for lunch by the STEELcentre

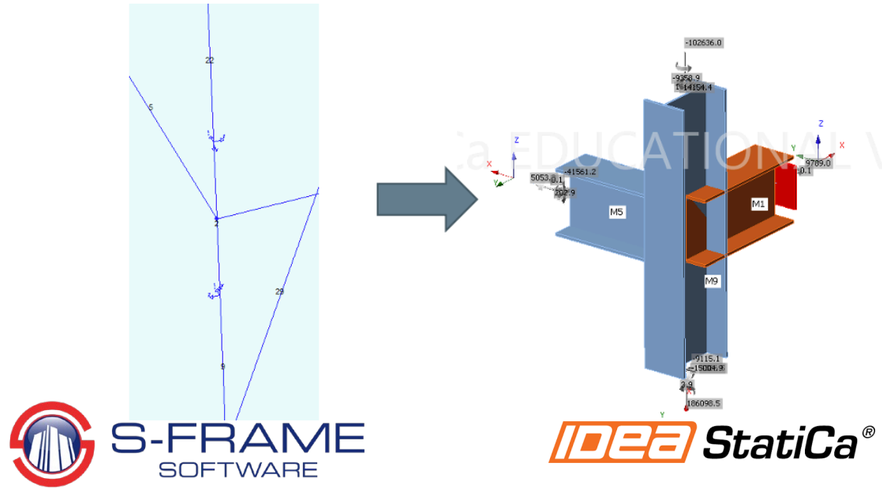
Our Friday lunchtime series **Steel for Lunch** continues with sessions that take students behind the decision-making process used for projects such as the Montréal Olympic Tower restoration and a tsunami evacuation tower on the BC coast. Direct access to the engineers who designed and oversaw construction enhances student awareness of the types of issues they are likely to encounter during their professional practice.

These programs add to the existing variety of opportunities for students to learn from and alongside practicing engineers. Real-world engineering experience helps our students excel in their future careers.



SCORE connects two top structural engineering design tools

A prototype import/export tool automates the workflow between S-FRAME for structural analysis and IDEA StatiCa for in-depth connection design

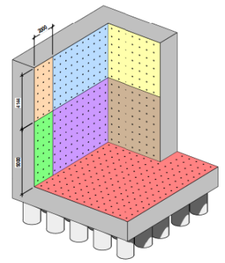


Future engineers at the Steel Centre's student-run mock engineering consultancy **Steel Centre OutReach Engineering (better known as "SCORE")** have developed an automated tool to speed up the engineering workflow. Two common structural engineering tools, S-FRAME and IDEA StatiCa, tackle related but distinct segments of the design process. S-FRAME is a structural analysis tool that calculates loads and forces on members and connections across the entire building. IDEA StatiCa is a detailing tool, used to design the specific connections to resist the loads indicated by S-FRAME's analysis. As both of these tools are developed by Steel Centre members, SCORE took on the task of creating an automated link between the two applications.

The SCORE team focused on a proof-of-concept goal: create a working intermediary app that can export a selected connection in S-FRAME and correctly import it into IDEA StatiCa. Although apparently simple, the two programs treat certain situations quite differently, requiring careful consideration as to how to accurately transfer model data between the two. For example, S-FRAME treats a beam spanning multiple columns as one continuous element, but IDEA StatiCa sees each side of the connection as separate elements. These differences in philosophy had to be identified and planned for in order to make a functioning tool.

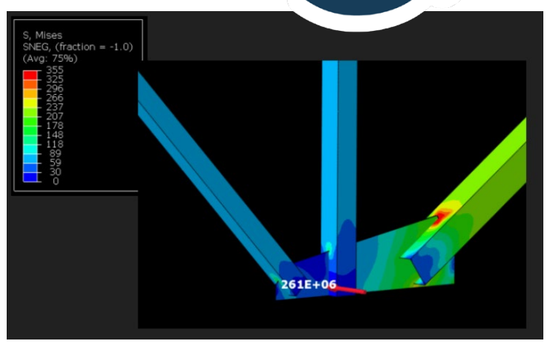
SCORE has shown once again that the team can produce professional-level results in a variety of domains. See the photos below for highlights of their other recent projects, and if you have a project idea of your own, contact them! SCORE is open to new ideas in any aspect of structural engineering: just write to score@ualberta.ca.

other SCORE projects



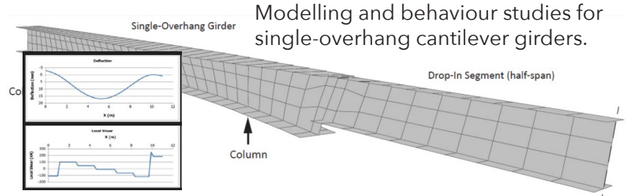
Client: DIALOG
SCORE worked in collaboration with DIALOG to design the new strong wall and strong floor for the renovation of the IF Morrison testing facility at the University of Alberta. SCORE was tasked to determine the loading, deflection and other criteria for the design of the new strong wall and floor and provide details for its construction.

SCORE by the STEEL centre



Client: Collins Steel
SCORE provided finite element modelling and analysis to verify the design of several complex connections.

Client: Canadian Institute of Steel Construction
Modelling and behaviour studies for single-overhang cantilever girders.



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research

At the Steel Centre, every student, including undergraduates, is involved in a research project. This hands-on experience coupled with outstanding education quality produces students that have a deeper, more natural understanding of steel construction. Steel Centre students work closely with partners from leading companies to identify and solve real problems faced by the steel construction industry.

Steel structures research at the University of Alberta typically involves both large-scale testing in the I.F. Morrison Structural Engineering Laboratory, as well as computer modelling including high-fidelity applications. Steel structures research carried out at the University of Alberta has been influential in the development of design codes and standards world-wide.

A new Emerging Technologies stream is taking shape, using generative design and AR applications to understand new ways to design, build, and teach.

See the list at right for a snapshot of significant areas of research at the Steel Centre.

research topics

structural stability

Structural Stability and Design of Steel Cantilever Systems
Influence of Open-Web Steel Joists on Gerber Girder Stability
Reduced Web Doubler Design for Connections Used in Pipe Racks
Assessing the Inelastic Lateral–Torsional Buckling Provisions of Canadian Design Standards for Welded Girders
Design Method for Steel Gerber Systems
Quantify Contribution of Large P-Delta Effect to Design Forces of Columns in Steel MRFs
Stability of Extended Shear Tabs
Progressive Collapse Resistance of Composite Steel Frame Structures

emerging technologies

Optimization of Single-Storey Steel Buildings Using Generative Design Methodology
Applications of Artificial Intelligence Techniques on Optimization of Structural Steel Conenctions
Machine Learning for Optimization of Steel Shear Connections
Application of the Hybrid Simulation Technique to Evaluate the Seismic Response of EBF Links

seismic design

Enhanced Seismic Design Method for Steel Multi-Tiered Buckling-Restrained Braced Frames in Canada
Seismic Response Evaluation and Design of Steel Multi-tiered Eccentrically Braced Frames
Test-based Design Methods for Steel Multi-tiered Concentrically Braced Frames
Advanced Hybrid Steel–Timber System for Seismic Applications
Development of Enhanced Design Methods for Deep Wide-Flange Columns in Steel Moment Resisting Frames under Earthquake Loading
Development of Simplified Seismic Design Guidelines for Steel Concentrically Braced Frames in Regions of Low and Moderate Seismicity
Predictive Fracture Model for Hollow Structural Sections subjected to Earthquake Loading

construction & rehabilitation

Rehabilitation of Deficient Concrete Columns with Steel Confinement Collars
Standardization of Embedded Plates for Steel/ Reinforced Concrete Connections
Improving the Design and Constructibility of Steel/Reinforced Concrete Connections

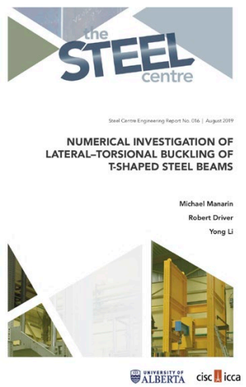
prefabricated structures

Performance and Design of Prefabricated Steel Braced Frames for Industrial Buildings
Development of a Modular Steel Structure for Multi-Storey Buildings
Development of a Resilient Steel Modular Moment-Resisting System for Seismic and Wind Applications

Steel Centre Engineering Reports (SCERs)

The Steel Centre keeps industry in the loop with new research

Research is an important part of what we do, but its value is only truly realized when that knowledge can make its way out into the world of practicing engineers. To aid this effort, we launched the Steel Centre Engineering Report (SCER) series. As students complete their investigations, their work is compiled and published as an SCER available to the public at steelcentre.ca/reports.



access the reports

Click here to download any published SCER. The full archive also includes Structural Engineering Reports published by the Steel Centre researchers prior to the Steel Centre's official formation.

Steel Centre publications 2021

Steel Centre students underlined.

Chapman, J.R., Darras, A.J., and Driver, R.G. (2022) "Behavior of Collared Concrete Columns Under Eccentric Loads." *Structural Journal*, American Concrete Institute, in press.

Chin, I., Driver, R.G., and Tomlinson, D. (2021) "Standardization and Testing of Embedded Plates for Design, Fabrication, and Construction Economy." *Steel Centre Engineering Report No. 020*, May, Department of Civil and Environmental Engineering, University of Alberta, Edmonton, Canada, 142 pp.

Derakhshan-Houreh E, Imanpour A. (2021). A Simplified Seismic Design Method for Limited-Ductility Steel Multi-Tiered Concentrically Braced Frames in Moderate Seismic Regions. *Canadian Journal of Civil Engineering*, 49(1): 1–13.

Derakhshan-Houreh E, Imanpour A. (2021). Seismic Response and Design of Steel Multi-Tiered Concentrically Braced Frames of the Conventional Construction Category. *Canadian Journal of Civil Engineering* (In Press).

Duong E, Darras AJ, Driver R.G, Essa M, Imanpour A. (2021). Applications of artificial intelligence techniques for optimization of structural steel connections. CSCE Annual Conference, Structures Specialty Conference, Canada, May 26-29 (*Virtual*).

Duong, E., Darras, A.J., Driver, R.G., Essa, M., and Imanpour, A. (2021) "Applications of Artificial Intelligence Techniques for Optimization of Structural Steel Connections." Paper STR548. Proc., *Annual General Conference (Virtual)*, Canadian Society for Civil Engineering, May 2629.

2021 publications, cont'd

Ehteshami-Moeini M, Razavi S-A, Imanpour A. (2021). Comparative Assessment of the Seismic Behavior of Reduced-Core Length and Conventional Buckling Restrained Bracing Systems. Proceeding of EUROSTEEL 2021, 9th *European Conference on Steel and Composite Structures, Sheffield, England, September 1–3 (Virtual*).

Emrani S-M-R, Epackachi S, Tehrani P, Imanpour A. (2021) A New Fiber-Based Macro Model for the Seismic Analysis of Steel-Concrete Composite Shear Walls. *Canadian Journal of Civil Engineering*, 10.1139/cjce-2021-0125 (In Press).

Esmaeili V, Imanpour A., Driver R-G, (2021). Stability of Gerber Systems with Top-flange Bracing. SSRC annual stability conference, Louisville, KY, U.S., April 13-16 (*Virtual*).

Esmaeili, V., Imanpour, A., and Driver, R.G. (2021) "Stability of Gerber Systems with Top-flange Bracing." Proc., *Annual Stability Conference (Virtual)*, Structural Stability Research Council, April 1316.

Imanpour A, Tremblay R, Leclerc M, Siguier R, Guillaume T, Balazadeh-Minouei Y, You S. (2021). Development and Application of Multi-Axis Hybrid Simulation for Seismic Stability of Steel Braced Frames. *Engineering Structures*, 252: 113646.

Imanpour A. (2021). Seismic Design of Two-Story Steel Concentrically Braced Frames with Bracing Members Intersecting Columns between Floors, *Structures Journal*, 33 (2021) 3885–3896.

Islam A, Imanpour A, (2022). Stability of Wide-Flange Columns in Steel Moment-Resisting Frames: Evaluation of the Canadian Seismic Design Requirements. Bulletin of Earthquake Engineering,https://doi.org/10.1007/s10518-021-01313-8.

Mokhtari M, Islam A, Imanpour A, (2021). Comparison of the seismic performance of steel moment- resisting frames and moment-resisting knee braced frames. CSCE Annual Conference, Structures Specialty Conference, Canada, May 26-29 (*Virtual*).

Mowafy A, Imanpour A, Chui Y-H. (2021). Evaluation of the Seismic Response of an Innovative Hybrid Steel-Timber Structure. Proceeding of EUROSTEEL 2021, 9th *European Conference on Steel and Composite Structures, Sheffield, England, September 1–3 (*Virtual*).

Torres A, Mahmoudi B, Darras AJ, Imanpour A, Driver, R.G. (2021). Achieving an optimized solution for structural design of single-storey steel buildings using generative design methodology. CSCE Annual Conference, Structures Specialty Conference, Canada, May 26-29 (*Virtual*).

Torres, A., Mahmoudi, B., Darras, A.J., Imanpour, A., and Driver, R.G. (2021) "Achieving an Optimized Solution for Structural Design of Single-storey Steel Buildings using Generative Design Methodology." Paper STR565. Proc., *Annual General Conference (Virtual)*, Canadian Society for Civil Engineering, May 2629.

Unsworth D, Driver R-G, Leijun L, Twizell S, Imanpour A. (2021). Characterization of Residual Stresses for LTB Simulations of Modern Welded Girders. *Journal of Constructional Steel Research*, 183: 106769.

Unsworth, D., Driver, R.G., Li, L., Twizell, S., and Imanpour, I. (2021) "Characterization of Residual Stresses for LTB Simulations of Modern Welded Girders." Journal of Constructional Steel Research, Elsevier, vol. 183(August) 11 pp. DOI: 10.1016/j.jcsr.2021.106769; online publication date: May 31, 2021.

Yaghoubshahi M, Imanpour A. (2021). An overview of HSS brace fracture in steel concentrically braced frames. *Journal of Constructional Steel Research*, 185 (2021) 106845.

gerber system stability

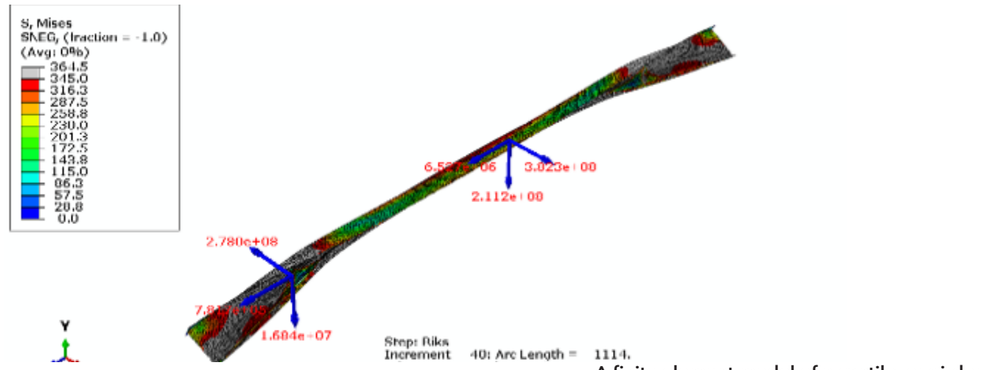
Vahab Esmaeili (Ph.D.) Maha Essa (M.Sc.) Zamir Datoo (B.Sc.)
Supervisors: Dr. Robert Driver, Dr. Ali Imanpour

Cantilever suspended-span construction using Gerber systems is a popular structural roof system in North America for single-story buildings such as shopping centers, warehouses, and industrial buildings. In this system, the wide-flange girder of a typical bay extends beyond the column to support the girder of the adjacent bay. Properly proportioning the cantilever span to the back span enables the designer to reduce the peak positive moments by allowing the structure to experience negative moments at the supports. Consequently, lighter and shallower girders are sufficient to carry the same loads with considerably smaller deflections. Furthermore, this system is statically determinate, and the simplicity of the beam-to-column connections results in faster fabrication and erection. All the above-mentioned benefits come at the cost of the challenges associated with the design of the Gerber system.

Several collapses of Gerber roofs have made it clear that there are stability issues implicit in these systems that are not reflected as part of a unified design method. Contemporary steel design standards such as the Canadian Standard for the Design of Steel Structures (CSA S16-19) provide little guidance on the design of Gerber systems, which necessitates understanding the complex stability response of such systems. Therefore, a comprehensive research program to provide new insights to the structural behaviour of Gerber systems is underway at the Steel Centre, comprising theoretical and experimental phases. Ph.D. student Vahab Esmaeili leads the theoretical portion, while M.Sc. student Maha Essa is undertaking the experimental phase.

The final research outcomes will underpin a proposal for a practical design procedure for overhanging girders that is versatile enough to account for a broad variety of loading and bracing conditions encountered by designers. This research is expected to have a significant impact on the upcoming revision of the Canadian Standard for the Design of Steel Structures (CSA S16-24). Naturally, this vision cannot be achieved without the support of Canadian industry experts, and this research project is working in active collaboration with the Steel Centre's members.

The research has been planned to be carried out through two main steps as follows:



A finite element model of a cantilever girder

Numerical phase: Vahab has developed a comprehensive finite-element model capable of considering material and geometric nonlinearities and initial geometric imperfections. The model has been validated against past full-scale experimental results, and will continue to be improved by future data from Zamir's work on open-web steel joists supported by Gerber girders. The results of that research can be used as input to the numerical model to improve its validity. The validated numerical model has been utilized to obtain the nominal moment capacities associated with each overhanging girder from a set of 14,175 cases. Artificial intelligence-based regression algorithms are employed to estimate the underlying relationships between the nominal capacities of the overhanging girders and influential parameters affecting the flexural capacity of the system to achieve a set of robust design equations.

Experimental phase: To fully understand the influence of various parameters on the stability response of cantilevered girders, fifteen large-scale specimens of wide-flange W410x85 single-overhanging beams are to be tested which simulate various loading and restraint conditions seen on typical Gerber girders. The intended experimental study encompasses a diversity of geometric, loading, and bracing conditions to shed light on the way they affect the stability of overhanging girders. In addition, for each of the full-scale test specimens, residual stresses as well as initial geometric imperfections will be measured so as to reduce uncertainties in the experiment.

The experimental data obtained from these tests will be used to verify the comprehensive finite-element model for overhanging girders developed in the first phase. The verification of this model will be instrumental in eventually developing a practical design method in the framework of the Canadian steel design standard for cantilevered girders.


Vahab Esmaeili


Maha Essa


Zamir Datoo

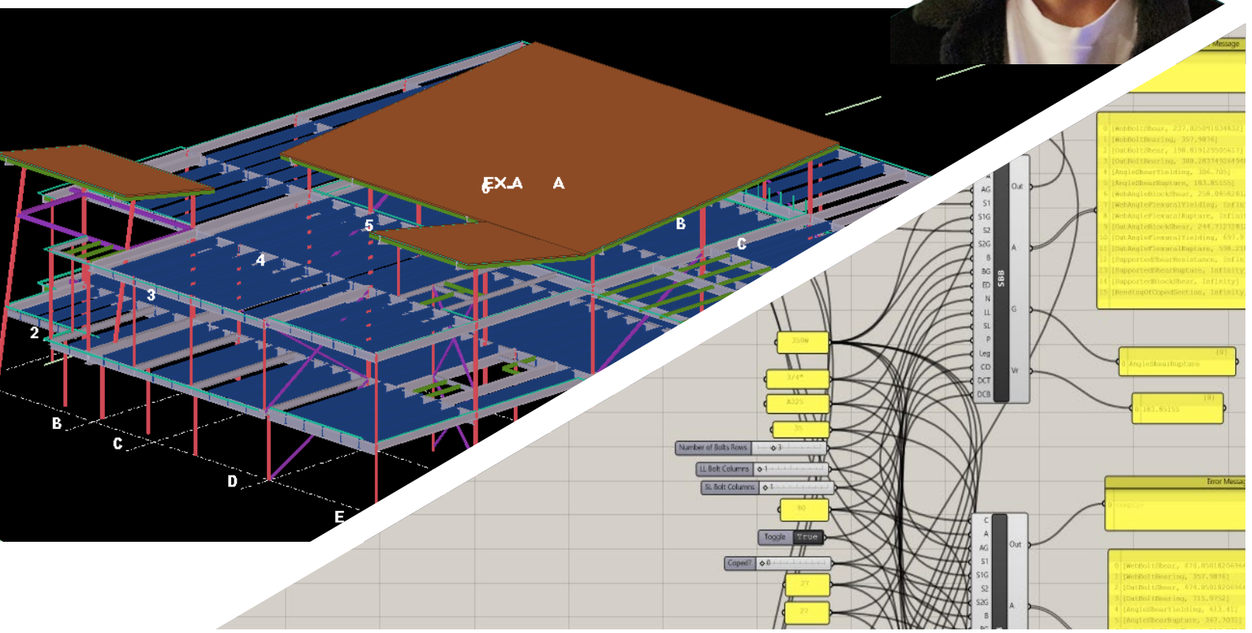
automating connection design

Eric Duong (M.Sc.) Supervisor: Dr. Ali Imanpour, Dr. Driver

Engineers typically design connections through the use of spreadsheets, commercial software, and hand calculations. Once these connections are designed, they are sketched and sent to the detailer who then must interpret the sketch and manually input the parameters of the connection into the 3D model. This process can be tedious and time consuming even though the majority of the connections are fairly simple (i.e. shear connections). On top of this, optimizing connection designs to account for factors such as product inventory, labour productivity, and material costs can be difficult in conventional workflows.

This research project uses C# and Python programming in conjunction with Tekla, Rhino3D and Grasshopper to create a parametric generative tool to help automate connection design. The final tool will help designers to streamline the connection design process and allow them to generate multiple connection design options for an entire building. By having multiple design choices, it will allow the designer to choose options that best suit the fabricator's preferences, leading to savings in overall fabrication costs.

Eric Duong



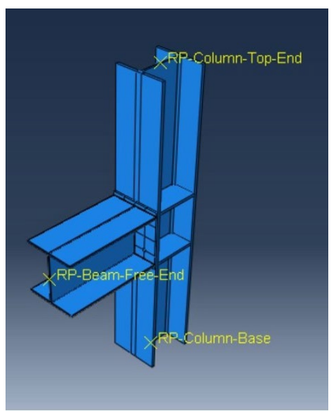
alternative design for web doubler plates

Hana Chaya (M.Sc.) Supervisors: Dr. Robert Driver, Dr. Ali Imanpour

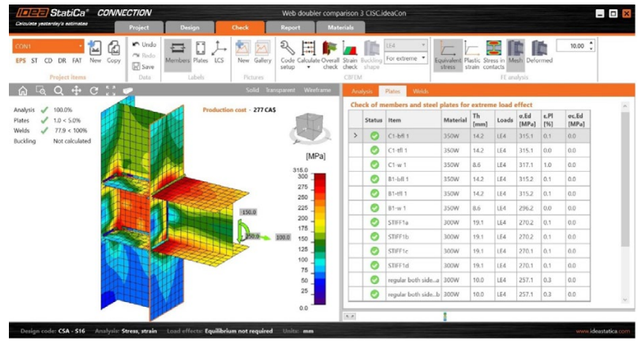
Hana Chaya

Heavy industrial structures are commonly constructed using structural steel. Pipe-supporting structures which are also referred to as pipe racks are an example of this type of structure. They carry the anticipated loads using a gravity load-resisting system combined with concentrically braced frames and moment-resisting frames. Due to similar loading conditions along the network, pipe rack structures are broken into several repetitive volumetric modules that can be prefabricated off-site.

Beam-to-column moment connections are used in each module to resist the anticipated loads for these structures, incorporating continuity plates and complex welding applications. To transfer flexural bending from beams to the column in these connections, web doubler plates are often required when the thickness of the column web is not sufficient to carry the moments.



This project's target is the development of an alternative design for steel moment connections used in modular pipe racks to improve the fabrication efficiency of such connections. Physical laboratory testing and advanced numerical simulations are used to design and test the proposed designs. The analytical model is tested with different doubler plate sizes using software from ABAQUS and Steel Centre member IDEA StatiCa. The expected outcome of this research is to design a doubler plate and its corresponding welds to create a cost-efficient design that is easy to fabricate yet can carry all the required loads.



Determining the correct design procedure for such structures can be challenging, since they are non-building structures and most of the building code focuses on design criteria for building structures. New connection designs validated by physical testing can ensure performance while lowering fabrication costs.

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