



the **STEEL** centre

2024

ANNUAL REPORT

Dr. Ali Imanpour
Director



CISC Centre for Steel Structures Education and Research

University of Alberta
Faculty of Engineering
Department of Civil and Environmental Engineering

**challenge
traditional
boundaries.**



employment
collaboration
growth
start
breakthrough
excellence
creativity
skill acquisition
knowledge
continuity



empowering futures
support
on experience
growth
success
mentorship
insights
guidance
research
previous education



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from the director



2024 marked an incredible period of transition, growth, and exciting opportunities for the Steel Centre. In September, I assumed the role of Director, and this past year has been a valuable learning experience as I stepped into this leadership position. Having been involved with the Steel Centre for the past eight years – overseeing our educational programs and research projects – I am eager to build upon this strong foundation to further enhance our impact.



I am thrilled to take on this new responsibility and look forward to continuing to collaborate with our industry members, students, researchers, and the University community. The Steel Centre has long been a hub for innovation, mentorship and industry-driven research. I am excited about the opportunities ahead to expand our reach and strengthen our role in advancing the steel construction industry through cutting-edge steel structures education and research. Our industry-driven, student-centred network is uniquely positioned to tackle emerging technical and societal challenges, and I am committed to supporting initiatives that empower our members and develop transformative solutions for the future of steel construction.

Looking ahead, our key priorities include:

- Enhancing existing experiential learning and training activities.
- Developing industrial internship and experiential training programs that embed highly qualified personnel directly in industry environments
- Continued collaboration with industry members to develop solutions that address their needs and add value to their operations.
- Strengthening interdisciplinary research partnerships that benefit our members and the steel construction industry.
- Engaging students, industry members, and the University in co-creating impactful programs and initiatives.

Finally, I would like to extend my sincere gratitude to Dr. Robert Driver for his exceptional leadership during his tenure as Director. His dedication and contributions have played a pivotal role in shaping the Steel Centre's success.

As we move forward, I look forward to building on our successes and exploring new opportunities for challenging traditional boundaries!

Ali Imanpour
Director
The Steel Centre





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!**

strategic directions

Build a **culture of collaboration and trust**.

Develop a **diverse network**.

Enrich the **educational experiences** of our students.

Identify and seize opportunities that add **value to industry**.

Co-create and communicate member value.

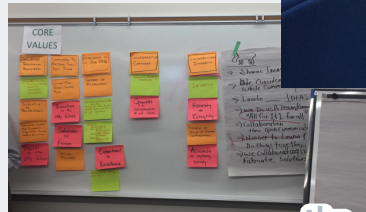


a story of growth

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.

April 2017

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



October 2016

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



December 2017

Steel Squad officially announced; first event at Collins Steel.



June 2018

Brown Paper e new areas of d the Steel Cent growth.

2016



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



SUPER TOUR

by the STEEL centre

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December 2024
Canadian Institute of
Steel Construction joins
as Investor Member

July 2018

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

SCORE

by the STEEL centre

June 2023

Students visited British Columbia
for an immersive educational
experience, exploring remarkable
structures and technological
marvels that reshaped the world
of engineering.



September 2024

Dr. Ali Imanpour is
announced as the
new director of the
Steel Centre.

2024



Exercise spurs
development for
re's continued

T3

by the STEEL centre

April 2021

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

February 2023

I.F. Morrison Structural
Laboratory reopens with
significantly expanded space
for physical testing and a new,
larger strong wall and strong
floor system—designed by our
very own S.C.O.R.E. team



learn by doing



The Steel Centre brings learning to life with hands-on experiences to frame and contextualize the design and construction process. Students see how engineers, trades workers, and general contractors work together to take buildings **from draft to delivered**.

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DIALOG®

IDEA StatiCa®

ALTAIR



TSE TSE STEEL LTD.



C.W. CARRY CHAIR
in Steel Structures

SUPREME STEEL PROFESSORSHIP
in Structural Engineering Education and Innovation

Learning from the designer, standing alongside the finished structure gives students deep insight into the holistic nature and interconnectedness of components and how design decisions are made.



Industry partners **keep students up-to-date with cutting-edge technology** that will be commonplace in the workplace of tomorrow. Students arrive to their first day with background knowledge of the tools and systems that they will encounter in their professional practice.



experiential learning



Steel Centre OutReach Engineering (SCORE) is a student-run consultancy that takes on real projects alongside industry partners, building authentic mentorship relationships and training students in **hands-on engineering**.

The Steel Squad offers unique opportunities for undergrads to **experience steel construction live and in person**: at active job sites, fabrication shops, in engineering offices, and beyond.



Steel Centre Industry Launchpad for Students (SCILS) is a unique and flexible way of matching students with industry partners for summer work experiences that give them professional skills that help them to stand out when launching their careers.

Steel for Lunch is a lunchtime series that explores topics of interest to the steel construction community. Case studies, research presentations, and professional advice are all on the menu. **Students and practicing engineers come together** to learn and share their experiences first-hand.

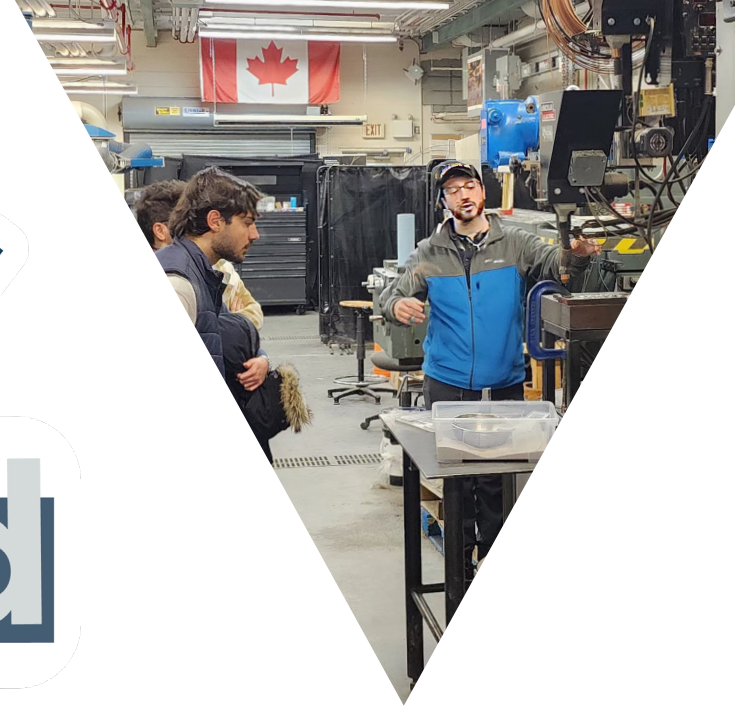


Students are **recognized for these additional experiential learning opportunities** through the Steel Centre Industry-Ready endorsement. Motivated students complete a series of learning experiences across core areas to **develop their abilities outside the traditional curriculum**, making them more "Industry-Ready" on day one of their future careers.

The Steel Centre Bridge Team is an extraordinary group of talented individuals with a shared vision of elevating traditional structural engineering boundaries. Their mission is to **engineer excellence while fostering a culture of innovation and teamwork** that empowers students to excel as the engineers of tomorrow.



The **SuperTour** is a chance for students to travel with their professors outside of Alberta and spend a week in an **immersive experience** that takes them on a comprehensive exploration of cities known for their remarkable structures. This unforgettable journey serves as a **foundation for students to witness firsthand** the awe-inspiring creations and technological marvels that reshaped the world of engineering.



The Steel Squad is a selective-entry undergraduate group for students with an expressed interest in steel construction.

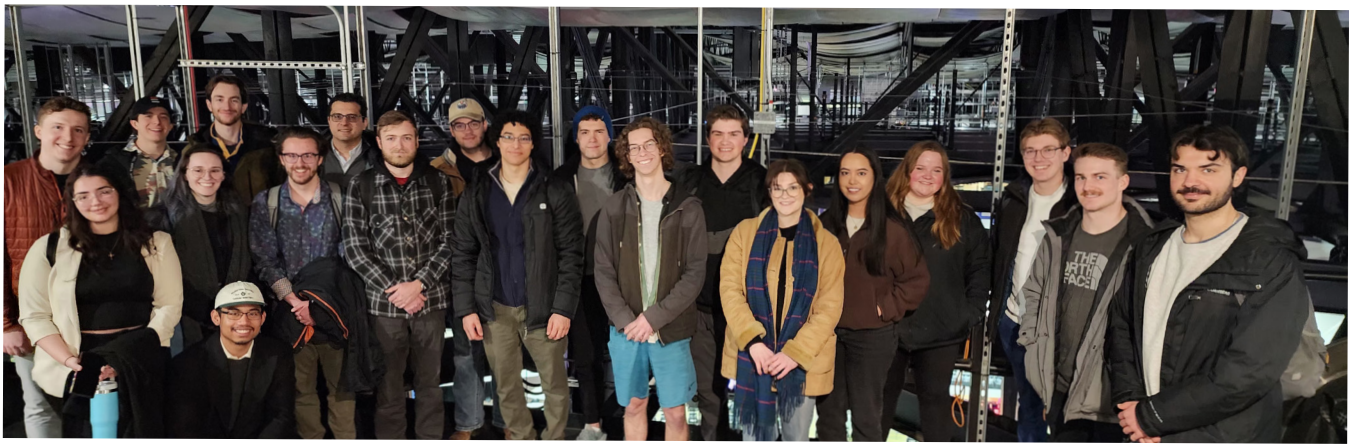
Throughout 2024, the Steel Squad embarked on a series of industry tours, providing students with firsthand exposure to steel construction practices, steel fabrication processes, and construction techniques. These tours served as an invaluable bridge between classroom learning and real-world applications, allowing students to witness cutting-edge innovations and engage directly with industry professionals.

The Steel Squad and **Canadian Centre for Welding and Joining** (*top*) toured each other's labs as a way to get an idea of the different research being done, and to see the advanced testing equipment utilized in structural and welding research. The Steel Squad also

were invited by **Krawford Construction** (*left*) to tour their construction project in Sherwood Park, which allowed the students to see the development of structural steel for a two-storey office building and a single-storey commercial retail unit building.

The tour of **Rogers Place** (*above right*) is always a highlight! This as an exciting journey to go behind the scenes (and above the scenes) to see up close the steel structure that makes up the roof of this incredible venue. This one-of-





a-kind experience provided a profound insight into the steel design and construction of the venue.

In the fall, Steel Centre member, **Supreme Steel** (*below left*), showcased their facility as part of CISC's SteelWeek 2024, and provided a shop tour! They showed steel fabrication, completed fabricated steel, and hands-on learning and interactive industry displays that were a great way to engage with the latest innovations and technologies in steel fabrication.



Ledcor (*right*) showed us the Downtown Streetscape and Pedway project, and it was an eye-opening experience! The Squad was



able to see various construction and shoring methods used in underground construction, some of which uses great amounts of steel.



And **PCL** invited the Squad to tour one of the single largest construction projects to date for the City of Spruce Grove - Heavy Metal Place (formerly the Civic Centre). The Squad was shown various applications of structural steel, from the long-span steel structure housing hockey arena to architecturally exposed structural steel to hold the roof of the structure at one of its corners (*left*). The project involves the use of approximately 650 metric tonnes of steel!

The Steel Squad thanks all those who helped broaden our students' technical knowledge and helped them gain a deeper appreciation for the role of structural engineers and the impact of steel in modern construction!

STEEL

for lunch
by the STEEL centre

The Steel Centre hosted some enlightening **'Steel For Lunch'** seminars in 2024, that not only enriched participants' technical knowledge, but also strengthened the community between industry professionals and academia.

In March, **Andrew Neilson, M.Sc., P.Eng.**, (right, with Assistant Professor Hossein Daneshvar), of **Morrison Hershfield** (now Stantec) spoke about the design of a Steel Tilted Tied Arch Bridge. The new structure enhances durability and complements the ravine's natural beauty at the meeting point of Blackmud and Whitemud Creeks.



Steel Centre Director, Ali Imanpour (left), presented in October on lessons learned from Japan's construction industry & earthquake research. He covered highlights and lessons learned from his visit to Japan, including visits to several research and teaching institutions, steel fabrication shops, and construction sites.

Jan Kubicek, structural and product engineer from **IDEA StatiCa**, a Steel Centre member, visited the University of Alberta in November from Czechia to introduce IDEA StatiCa programs and features, with a focus on structural analysis and design of common steel and steel/concrete connections, like moment connections, bracing connections and base plate connections.





The 2024 Canadian National Steel Bridge Competition (CNSBC) was held at Université Laval in Montréal, Quebec, in May 2024, and the **Steel Centre Bridge Team** represented the University of Alberta in this high-level structural battle!

It was a tremendous learning opportunity, which helped the team to enhance their structural design and soft skills needed to work in industry. Additionally, the challenges the team faced taught them valuable lessons that will carry into next year's competition!

The team would like to thank Steel Centre members, the **Canadian Institute of Steel Construction (CISC)**, **Collins Steel**, **Niik Group**, as well as **Computers & Structures, Inc.**, and **Associated Engineering**, for their support.



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people

current students



researchers

Dr. Ali Imanpour, P. Eng.
Director
Steel Structures

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

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

Dr. Ming Lu, P. Eng.
Professor
*Construction Engineering
& Management*



support



Tyler Daignault
Student Experience
Coordinator



Greg Miller
Structural Engineering
Technician



Cam West
Structural Engineering
Technician



Dr. Ali Sadrara
Post-doctoral Fellow
Steel Structures



Dr. Yong Li
Associate Professor
*Reliability & Advanced
Analysis*

Dr. Hossein Daneshvar
Assistant Professor
*Steel/Timber Composite
Systems*

Dr. Shaghayegh 'Shay' Abtahi
Assistant Professor
*Computational Modelling &
Digital Twins*

Dr. Yuxiang Chen
Associate Professor
*Building Engineering and
Sustainable Construction*



the driving force

A Legacy of Leadership in Steel Education and Research

In 2024, our founding Director of the Steel Centre, Dr. Robert G. Driver, announced his well-earned retirement. As we look back at his time at the University of Alberta, we can see his lasting impact on structural engineering through his dedication to education, research, and industry collaboration. And we can be grateful for his pivotal role in advancing steel structures and mentoring the next generation of engineers.

Dr. Driver earned his Ph.D. from the University of Alberta in 1996 after working as a structural engineer in industry in Toronto. He later transitioned into academia, first teaching at Lafayette College in Pennsylvania before returning to the University of Alberta in 2000 as a faculty member. His industry experience and research expertise shaped his teaching approach, bridging theoretical knowledge with practical application. His transformational research on the behaviour and design of steel structures led to him receiving many prestigious international awards such as the J. James R. Croes

Research Medal and the Raymond C. Reese

Research Prize of the American Society of Civil Engineers. He has also been heavily involved in codes and standards development, including serving as Chair of

CSA Standard S16, the national standard for the design of steel buildings in Canada. For his career contributions, Dr. Driver was elected Fellow of both the U.S.-based Structural Engineering Institute and the Canadian Society for Civil Engineering.

As the founding Director of the Steel Centre, Dr. Driver established a dynamic hub for industry-driven education and research. Under his leadership, the Centre grew into a key resource for advancing structural steel design, fabrication, and construction in Canada. He fostered strong collaborations between students, researchers, and industry professionals, ensuring that research efforts addressed real-world challenges.



ng



A cornerstone of his leadership was his commitment to experiential learning. He championed hands-on research initiatives, facilitating student engagement in industry projects and laboratory testing. His efforts strengthened partnerships with steel producers, fabricators, and engineers, creating opportunities for applied research and professional development. His leadership helped position the Steel Centre as a model for how academic institutions can work closely with industry to drive innovation.

Dr. Driver's influence extended far beyond the Steel Centre. As a professor, he was renowned for his ability to inspire students and make complex structural engineering concepts accessible. He taught a range of undergraduate and graduate courses, focusing on steel design and structural mechanics. His passion for education earned him numerous accolades, including the Rutherford Award for Excellence in Undergraduate Teaching and the APEGA Excellence in Education Award.

Beyond the classroom, he mentored countless graduate students, guiding them in research that has contributed to advancements in structural design. Many of his former students have gone on to become leaders in academia and industry, a testament to his lasting impact on the field. Through his leadership at the Steel Centre and his dedication to education, Dr. Driver has helped shape the future of the steel construction industry. His ability to bridge research, industry, and teaching has ensured that students graduate with not only technical expertise, but also the practical skills and industry connections needed to succeed.

As he steps away from his role as Director, Dr. Driver's contributions will continue to influence the Steel Centre and the broader engineering community. His legacy is one of innovation, collaboration, and a steadfast commitment to excellence in structural steel education and research.



2024 highlight



Steel Centre recognized at the 2024 Canadian Steel Conference

The 2024 Canadian Steel Conference, held in Calgary, brought together professionals, researchers, and students from across the steel industry with a strong focus on sustainability in steel construction. The event provided valuable opportunities for students to engage with industry leaders and learn about emerging trends and technologies.

Steel Centre alumni and leadership were honoured at the conference: former Director Dr. Robert Driver received the Alfred F. Wong Lifetime Achievement Award for his outstanding and sustained contributions to steel design, fabrication, construction, and education. Current Director Dr. Ali Imanpour and University of Alberta professor, Dr. Yuxiang Chen, were presented jointly with the H.A. Krentz Research Award, recognizing their research project that aims to advance sustainable steel structures design.



ts



Lessons from Japan's Construction Industry and Earthquake Engineering Research

In 2024, Dr. Ali Imanpour visited Hokkaido University in Sapporo, Japan as a visiting Professor with financial support provided by KAJIMA Corporation and Natural Sciences and Engineering Research Council of Canada.

Highlights of his visit included Nippon Steel Corporation's blast-furnace and mill, steel fabrication and structural testing facilities, Hokkaido University, Nagoya University, Nagoya Institute of Tech, Kajima Corporation, Three-Dimensional Full-Scale Earthquake Testing Facility (E-Defense) and E-Isolation - Japan's first full-scale seismic isolation testing facility.

The visit offered new perspectives on cutting-edge steel design, fabrication methodologies, and large-scale testing techniques.

McGuire Award for Junior Researchers to Dr. Ali Imanpour

In March of 2024, the Structural Stability Research Council (SSRC) presented Dr. Ali Imanpour with the McGuire Award for Junior Researchers (MAJR) Medal during the 2024 North American Steel Construction Conference in San Antonio. Ali was selected for his high-quality research focused on structural stability, his strong record of professional engagement seeking to translate research into practice, and his investment in the structural engineering profession through service to SSRC.



2024 graduated stu



Mahdi Mokhtari, Ph.D.
**Development of Steel Moment-Resisting Knee-Braced
Frame for Multi-Storey Buildings**
Dr. Imanpour

Hana Chaya, M.Sc.
**Alternative Design of Column Web Doubler Plates in
Steel Pipe Rack Modules**
Dr. Imanpour & Dr. Driver

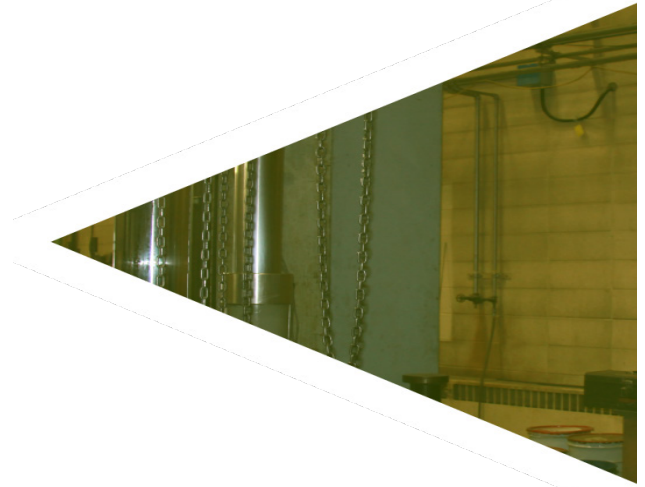


Maha Essa, M.Sc.
**Experimental Evaluation of Stability of Single-Overhanging
Steel Beams**
Dr. Driver, Dr. Imanpour

Bardia Mahmoudi, M.Sc.
**Seismic Response and Design of Chevron and Split-X
Steel Concentrically Braced Frames**
Dr. Imanpour



Students



Sepehr Pessiyan, M.Sc.

Surrogate Models for Hysteresis Response Prediction of Steel Braces under Seismic Loading

Dr. Imanpour

Jeff Chan, M.Eng.

Evaluation of Canadian Beam Design Curve for I-shaped Welded Steel Girders

Dr. Imanpour



Ibrahim El-Jabali, M.Eng.

Seismic Assessment of an Existing Bridge Pier

Dr. Imanpour

Wilson Reyes Alvarez, M.Eng.

Evaluation of Uniaxial Material Models in Predicting Hysteresis Response of Hollow Structural Section Braces

Dr. Imanpour



student awards 2024

Steel Centre students are top performers, receiving a number of honours and awards each year for academic and research accomplishments. In 2024, students were awarded scholarships totalling \$73,000. The Steel Centre's excellent students have attracted direct support from outside organizations, like the **Alberta Government**, given to top-tier graduate students. We are honoured by this support, and proud of our students and their accomplishments.



\$73,000 total awards & scholarships in 2024

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CISC Alberta Region G.L. Kulak Scholarship (\$15,000)



Alberta Graduate Excellence Scholarship (2 recipients; \$12,000 each)



Norman and Tess Reid Graduate Scholarship (2 recipients, \$5,000 each)



Graduate Student Support Award (4 recipients; \$3,000 each)



J. Gordin Kaplan Graduate Student Award (\$2,000)



Gordon F. Anderson DIALOG Graduate Scholarship (\$5,000)



CWB Foundation Welding Advancement Award (\$5,000)



engaging industry

In 2024, the Steel Centre deepened its **engagement with the steel and construction industry** through active participation in key events. These gatherings provided valuable opportunities to share research, foster collaboration, and stay at the forefront of innovation in steel design and construction.



At the **Altair Architecture, Engineering, and Construction (AEC) Conference** in August, faculty and graduate students showcased how advanced

computational tools and optimization techniques can enhance structural steel design and analysis. The event brought together professionals from architecture, engineering, and construction to explore the application of advanced simulation techniques offered by ALTAIR in structural engineering.



Later in the year, the Steel Centre took part in the **CSCE Steel Structures Symposium**, hosted in conjunction with the Canadian Society for Civil Engineering, Edmonton chapter. The symposium offered a platform to share recent research developments, discuss emerging challenges in steel construction projects, and connect with leaders from academia and industry.



The Steel Centre is looking forward to future training events, seminars, and workshops with our members and broader structural and civil engineering communities.





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 large-scale testing in the I.F. Morrison Structural Engineering Laboratory, computer simulations, and application of machine learning-based tools. Steel structures research carried out at the University of Alberta has been influential in the development of design codes and standards world-wide.

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

research topics

sustainability in steel construction

Structural Design Recommendations for Sustainable Steel Building Practice

structural stability

Stability Response and Design of Steel Cantilever Systems

Alternative Design of Column Web Doubler Plates in Steel Pipe Rack Modules

Experimental Evaluation of the Stability Response of Double-Overhanging Steel Beams

decision support systems for steel construction projects

Data-Driven Decision Support System for Design of Steel Girder Bridges

Decision Support System for Cost Estimation of Steel Construction Projects

Performance Prediction of Shear Connections using Artificial Neural Networks

seismic design

Seismic Response and Design of Chevron and Split-X Steel Concentrically Braced Frames

Design Methods for Steel Multi-Tiered Concentrically Braced Frames considering Base Flexibility

Development and Performance Evaluation of the Steel Moment-resisting Knee-braced Frame System Under Seismic and Wind Loads

Stability and Design of Wide-Flange Columns in Steel Frame Structures under Earthquake Loading

Development and Experimental Validation of Machine Learning-based Model Updating Techniques for Steel Braced Frames

Cyclic and Fatigue Performance of Steel Buckling-Restrained Braces Subjected to Earthquake Displacement History

Pseudo-dynamic Hybrid Simulation of Steel Eccentrically Braced Frames with Unbraced Links

Seismic Response of Steel HSS Braces of Conventional Construction Concentrically Braced Frames

Friction-based Connection for Multi-Hazard Design of Steel Braced Frames

structural connections

Decision Support System for Steel Gusset Plate Connections

Finite Element-based Design of Steel Bracing Connections

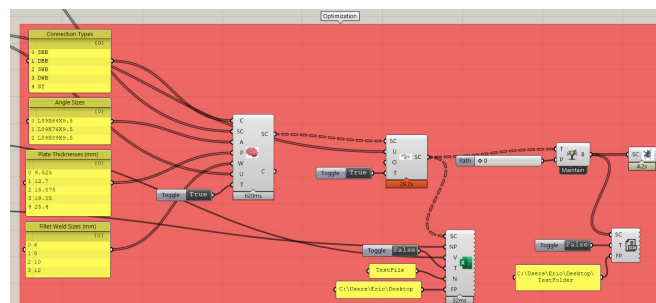
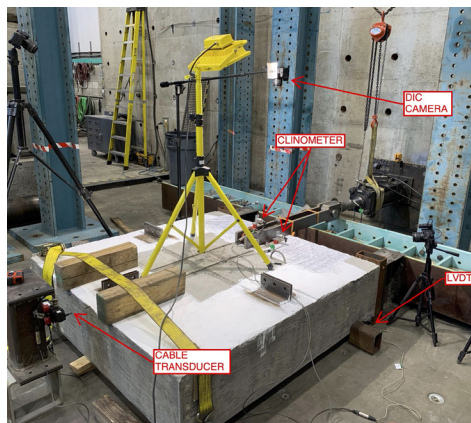
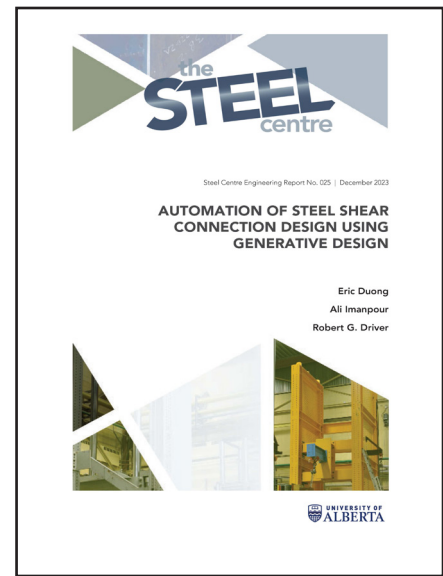
Steel Centre Engineering Reports (SCERs)

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 research projects, their work is compiled and published as an SCER available to the public.

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

Steel Centre students underlined.

2024

- Sadrara, A., Epackachi, S., Imanpour, A., Kabir M.Z. (2024). "Hybrid Data-driven and Physics-based Simulation Technique for Seismic Response Evaluation of Steel Buckling-Restrained Braced Frames Considering Brace Fracture", Earthquake Engineering and Structural Dynamics, 2024:1-23.
- Mowafy, A., Imanpour, A., Chui, Y.H., Daneshvar, H. (2024). "Development and Experimental Validation of a Hybrid Timber-Steel Beam-to-Column Connection with Replaceable U-Shaped Fuses." Journal of Structural Engineering, ASCE, 150(11): 04024171.
- Bani, M., Imanpour, A. (2024). "Seismic Performance Assessment of Multi-Tiered Steel Buckling-Restrained Braced Frames Designed to 2010 and 2022 AISC Seismic Provisions." Journal of Structural Engineering, ASCE, 150(9): 04024113.
- Bani, M., Imanpour, A., Tremblay R., Saxey B. (2024). "Full-Scale Testing of Two-Tiered Steel Buckling-Restrained Braced Frames." Journal of Structural Engineering, ASCE, 150(10): 04024130
- Ashrafi, A., Imanpour, A. (2024). "Analysis and Design Methods for Improved Stability of Two-Tiered Steel Eccentrically Braced Frames with Wide Flange Links." Journal of Structural Engineering, ASCE, 150(9): 04024112.
- Bani, M., Imanpour, A. (2024). "Seismic Response and Design of Steel Multi-Tiered Buckling-Restrained Braced Frames." Journal of Constructional Steel Research, 216 108574
- Mowafy, A., Imanpour, A., Chui, Y.H., Daneshvar, H. (2024). Experimental Evaluation of a U-shaped Steel Plate as a Seismic Fuse." Journal of Constructional Steel Research, 215, 108525.
- Mokhtari, F., Imanpour, A. (2024). "Hybrid Data-driven and Physics-based Simulation Framework for Seismic Analysis of Steel Structural Systems." Computers and Structures, 295, 107286.
- Mowafy, A., Imanpour, A., Chui, Y.H., (2024). A New Hybrid Steel-Timber Rocking Seismic Force Resisting System Equipped with U-shaped Fuse Connections." Canadian Journal of Civil Engineering, 51(7).
- Peng, Y., Lu, M., Imanpour, A. (2024). "Analysis of the Rationality of Extending LOD Standards from the Design Phase to the Production and Construction Phases", International Conference on Computing in Civil and Building Engineering (ICCCBE), ÉTS, Montréal, QC, Canada, August 25 – 28,
- Capettini, B., Imanpour, A. (2024). "Cumulative Ductility and Strain Demands of Steel Buckling-Restrained Braces Subjected to Simulated Earthquake Displacement Histories." 11th International Conference on Behavior of Steel Structures in Seismic Area, STESSA, Salerno, Italy, July 8 – 10.
- Mahmoudi, B., Imanpour, A. (2024). "Damage Concentration and Column Flexural Demands in Steel Chevron Braced Frames Designed to Canadian Provisions." 11th International Conference on Behavior of Steel Structures in Seismic Area, STESSA, Salerno, Italy, July 8 – 10.
- Moammer, O., Imanpour, A., Tremblay, R. (2024). "Nonlinear Modelling of Steel Wide-Flange Columns: Frontiers and prospects for future developments." 18th World Conference on Earthquake Engineering, Milan, Italy, June 30 – July 5. WCEE Proceedings (proceedings-wcee.org)
- Sadrara, A., Epackachi, S., Imanpour, A. (2024). "Seismic Performance of Steel Buckling-Restrained Braced Frames Designed to the Canadian standards." 18th World Conference on Earthquake Engineering, Milan, Italy, June 30 – July 5. WCEE Proceedings (proceedings-wcee.org)
- Imanpour, A. (2024). "Design Guidelines for Improved Stability of Steel Systems." Annual Stability Conference, Structural Stability Research Council, San Antonio, TX, U.S., March 19 – 22.
- Essa, M., Driver, R., Imanpour, A. (2024). "Experimental Testing of Single-Overhanging Girders Subjected to various Moment Gradients and Restraint Conditions." Annual Stability Conference, Structural Stability Research Council, San Antonio, TX, U.S., March 19 – 22



A Data-driven-based Multi-element Technique for Seismic Response Assessment of Steel BRBFs

Anahita Hosseini (Ph.D.) Supervisor: Dr. Ali Imanpour

Seismic hybrid simulation techniques, which is widely used in earthquake engineering, combine the accuracy of experimental testing with the efficiency of numerical modelling to examine both overall structural behaviour and the responses of individual elements under realistic loads and boundary conditions.

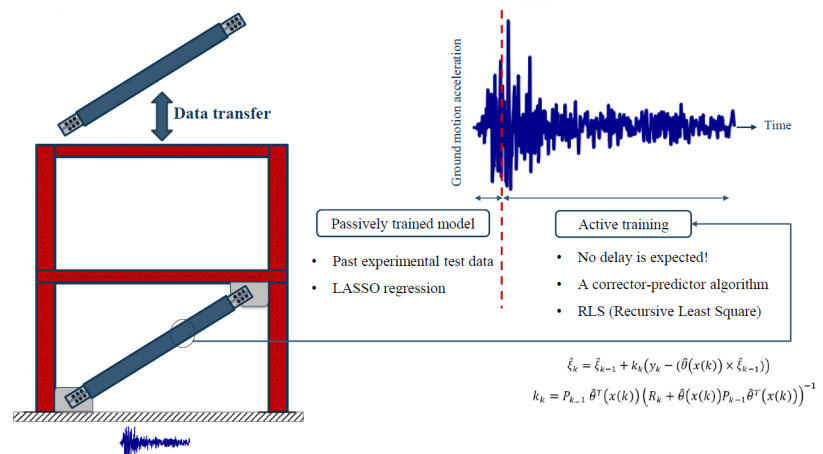
Anahita's Hosseini's research focuses on developing advanced hybrid simulation methods to evaluate the seismic response of steel braced frames under earthquake loading, with particular emphasis on Buckling-Restrained Braced Frames (BRBFs), one of the most widely used seismic force-resisting systems across North America. The project aims to enhance existing methods for seismic response evaluation of multi-storey steel braced frames by integrating AI-based techniques with traditional hybrid simulation approaches, enabling the development of efficient and reliable multi-element hybrid simulation frameworks.

Anahita developed a data-driven model by Python programming to reproduce the nonlinear hysteretic response of steel Buckling-Restrained Braces (BRBs), inspired by research conducted by Fardad Mokhtari, a former Steel Centre student, and

incorporated the model into the hybrid simulation framework. In conventional hybrid simulation techniques, well-understood parts of the structure expected to remain elastic or experience limited inelastic response are simulated numerically, while the members with high uncertainty are physically tested in the laboratory. This approach often involves a single seismic fuse as the representative physical element for testing. In the method developed by Anahita, all elements expected to remain in the elastic range are modelled numerically using a finite element model, while the seismic fuses are modelled using the developed data-driven model in Python (see figure below). The integration of this data-driven model, trained on previously recorded or real-time observed data, enables the framework to predict the nonlinear hysteretic behaviour of seismic fuses that have not been physically tested, enhancing laboratory testing efficiency compared to hybrid

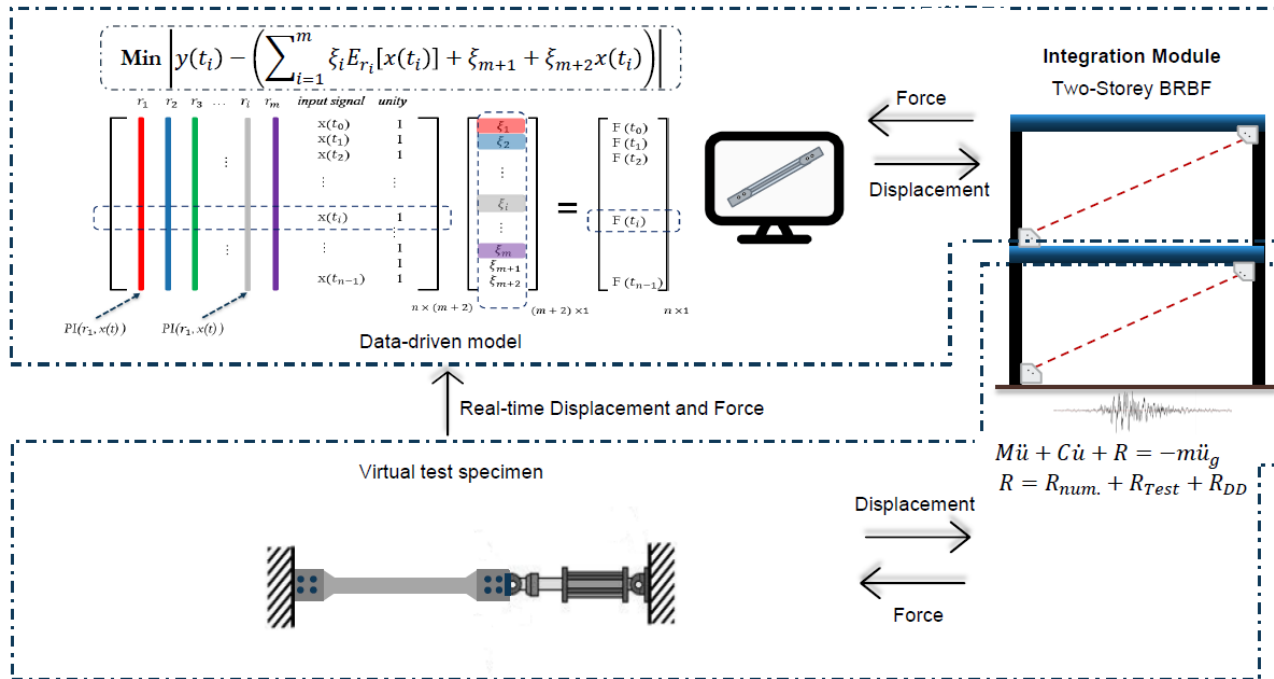


Anahita Hosseini



ement Hybrid Simulation

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simulations requiring multiple physical tests, and improving computational efficiency over finite element model-based approaches. Additionally, incorporating insights from the behaviour of a single representative tested element as a reliable data source for real-time training of similar components within a dynamic model updating process ensures the accuracy of the hybrid simulation by mitigating biases associated with testing a limited number of elements.

Anahita has conducted numerical research using nonlinear response history analysis of a four-storey prototype BRBF located in Vancouver, subjected to ground motion accelerations from various seismic hazard sources through a series of virtual hybrid simulations to numerically validate the proposed framework. Additionally, a novel all-steel short BRB has been proposed for the seismic design of

steel BRBFs and for use in a down-scale hybrid test. In collaboration with Dr. Ali Sadrara, a postdoctoral fellow at the Steel Centre, she has designed a small-scale hybrid simulation test setup at the Steel Centre Cyber-Physical Structural Systems Simulation Laboratory at the University of Alberta Construction Innovation Centre. The experimental test program will be used to validate the proposed hybrid simulation technique (*see figure above*). Furthermore, the proposed BRB will be experimentally evaluated for applications in seismic design

The final key outcome of this research project is

Decision Support System of Steel Gusset Plate

Oscar Zhou (M.Sc.)

Supervisors: Dr. Yong Li & Dr. Ali Imanpour

Oscar Zhou joined the Steel Centre in 2023 and has been actively developing his academic and professional skills. Currently a second-year M.Sc. student, his research focuses on the design of bracing connections (see below) in steel structures, particularly emphasizing design automation and improved constructibility.

To enhance his research and professional skills and gain hands-on experience, Oscar has undertaken several internships with the Steel Centre partners that have provided him with valuable practical experience. In fall 2023 and winter 2024, he completed an internship at Steadfast Engineering Ltd., an engineering consulting firm specializing in connection design. This role allowed him to gain a strong foundation in steel connection design.



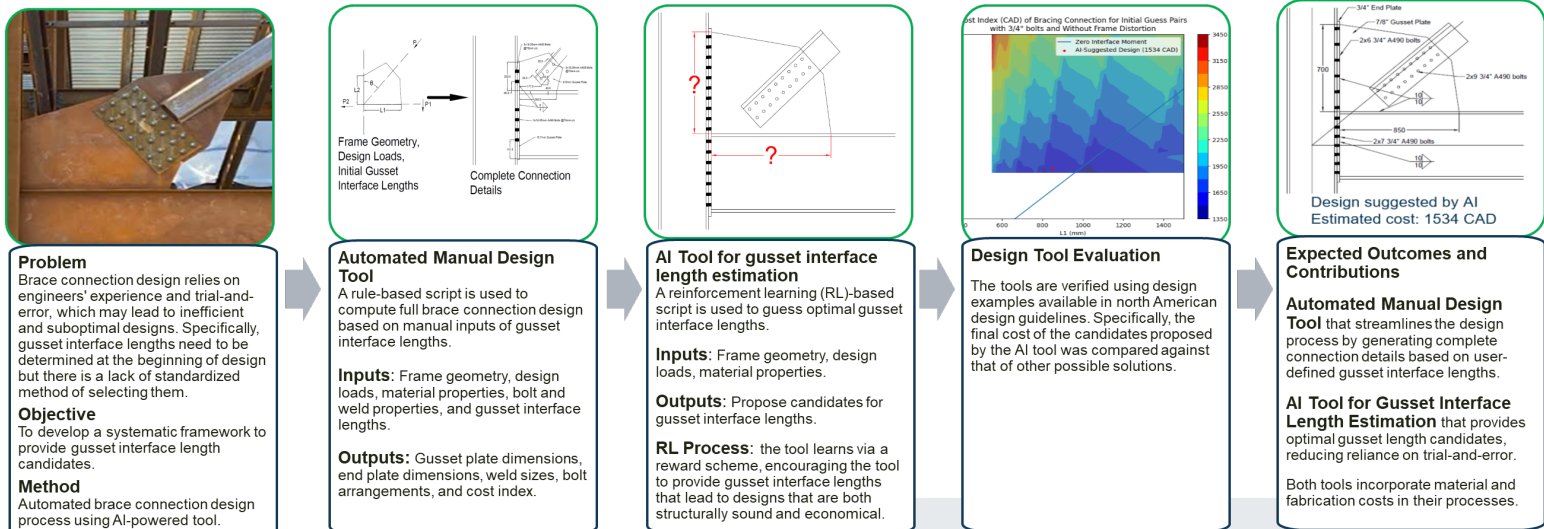
Oscar Zhou



System for Design e Connections

During the summer of 2024, Oscar also worked full-time at Niik Steel, a steel fabricator, where he contributed to cost estimation for various steel construction projects. This experience provided him with key insights into the economic considerations of steel fabrication and further shaped his research by highlighting the challenges engineers face in estimating costs effectively.

Oscar's current research aims to address a problem in the field: the heavy reliance on engineers' experience for determining brace gusset plate design parameters and cost-related considerations, which can be challenging for less-experienced engineers. He is developing a decision support tool for steel gusset plate connections to assist engineers in overcoming this issue by providing optimized design candidates (see *below*). By integrating his practical industry experience with advanced computational methods, Oscar is working towards a solution that will help engineers—regardless of experience level—enhance gusset plate connection design.



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