ADVANTAGE STEEL

NO. 57 WINTER 2017

EDUCATION AND RESEARCH ISSUE

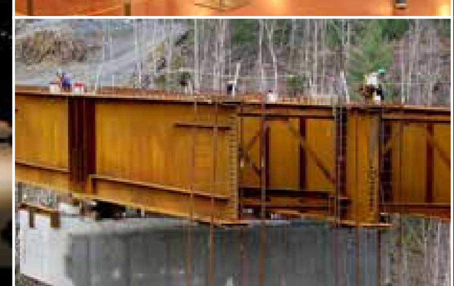
+ ARCHITECTURAL STUDENT DESIGN COMPETITION

CSCE-CISC CANADIAN NATIONAL STEEL BRIDGE COMPETITION

RESEARCH GRANT PROGRAMS

AWARDS & SCHOLARSHIPS

CISC NATIONAL STEEL SYMPOSIUM 2016



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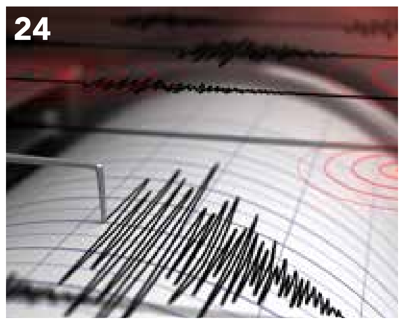
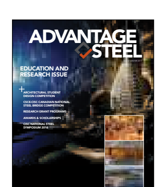


FEATURES

IN EVERY ISSUE

COLUMNS

Professional engineers, architects, structural steel fabricators and others interested in steel construction are invited to inquire about CISC membership. Readers are encouraged to submit their interesting steel construction projects for consideration for inclusion in this publication by contacting CISC.



On the Cover: 15th Annual Architectural Student Design Award of Merit winning submission, "Cocoon"

Ed Whalen, P.Eng.
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CISC Battles Illegal Trade

BY NOW, MOST of you have heard that the CISC, in partnership with our industrial steel stakeholders, has launched an anti-dumping and subsidizing case for certain industrial fabricated steel products against China, South Korea, UAE, Spain, and the UK. The case became public in September 2016 when the Canada Border Services Agency (CBSA) accepted our case and agreed to investigate our complaint. This started a process that will finish with the final hearings of the Canadian International Trade Tribunal (CITT) in April 2017 and their decision sometime in May.

The Canadian process is an interesting one, in that we have two organizations involved in a trade complaint. The CBSA's job, as I understand it, is to accept, evaluate, audit, set tariffs, and enforce a trade complaint and ultimately enforce the CITT rulings. The CITT hears the case and is the final decision maker on trade cases in Canada. Think of the CITT as the Canadian court for trade. This entity not only hears the case but also does its own investigative work as it deems necessary to fully understand the nuances of each case.

What is different in this trade case compared to other past steel trade cases is that it covers fabricated structural steel. It also covers fabricated steel in modules as well as in pieces, a practice that has become very popular of late in the industrial sector.

Steel mills in Canada have been quite successful demonstrating and proving illegal dumping and subsidizing of raw steel products. Exporting countries intent on dumping product have moved up the value chain and are now coming into Canada fully fabricated, a result that is even more damaging to the steel supply chain in that it takes down an entire sector rather than just a part.

The reasons for a country (or companies within a country) to dump and/or subsidize are many but in all cases this type of activity is deemed illegal by the World Trade Organization (WTO). The challenge to any industry facing illegal dumping and subsidizing is to recognize it for what it is and fight back.

To better understand the situation, we must first understand what illegal dumping and subsidizing are. What they are not are just cheaper products that come from some other place in the world. Dumping of a foreign product sold in Canada below fair market pricing usually takes on one of two forms: sold below the equivalent selling price in the home market of the exporter, or sold below the cost of the product plus a reasonable amount of profit. Subsidizing comes into play when it can be shown that government influence of an exporter causes prices to be different than they would otherwise be in a competitive market. It is possible to have one without the other or both. In our case, China is alleged to have engaged in both dumping and subsidizing while the remaining countries are alleged to have participated in dumping only.

The case, as set out, clearly defines the products that we are trying to defend. The product scope, in simplified terms, covers industrial fabricated steel for certain industrial applications and sectors. It does not cover steel bridges or commercial structures.

So who pays the penalty tariff? In Canada, the penalty tariff is paid by the importer and collected by the Canadian government. None of this money returns to the steel industry. What we get is relief from illegal trade. For industrial applications, the tariff would typically be paid by the EPC (Engineering, Procurement and Construction) company. It is also the importer that faces severe penalties from CBSA should a product they procure be found to be circumventing the trade rulings. The start of penalty tariffs using a preliminary CBSA set value will begin in mid January 2017. The final CITT decision, expected in May 2017, will either keep these values as is or eliminate or modify for a period of 5 years. The penalty tariffs on something as complex as fabricated structural steel will not be easily calculated so the determination on the final penalty tariff amount would most likely not be known until the CBSA has assessed each shipment.

No matter what the final outcome is this spring, the CISC along with its members and associates are committed to fully defend a free and legal marketplace. We will continue to look for unfair trading practices and will consider launching new trade actions on additional industrial products, steel bridges or steel commercial structures should the market suggest that illegal trading practices are occurring. By the way, these actions are independent of free trade agreements therefore no crazy deal with the devil will legalize dumping and subsidizing. Better yet, it is time (just look south of the border) for Canada to place permanent tariffs on countries convicted of consistently dumping into Canada. Enough is enough! AS

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Alfred F. Wong, P.Eng., FCSCE
Director of Engineering

Question 1: **I am the engineer involved with the rehabilitation of a building structure and have heard about an S16 provision for verification of load carrying capacity of open-web steel joists. Is this load testing provision in S16-14? I cannot find it.**

Answer: There had been a long-standing provision in S16 outlining a load testing procedure for verification of load carrying capacity of OWSJ. This clause was withdrawn from the Standard when S16-14 published. The provision was useful when some of the joist manufacturers arrived at the load carrying capacity of their joists by means of physical testing. This practice was discontinued in Canada about half a century ago.

It should be noted that being a destructive test procedure its application on joists in service is usually impractical. The manufacturer, however, may still incorporate the procedure in its quality control programme.

Question 2: **I understand that the pretensioning force need not be included in the tension force in the design of a high-strength bolt in tension. Can I assume that the nut is always as strong as the bolt?**

Answer: The standards require the use of nuts in conformance with the standards for high-strength bolt and nuts, currently ASTM F3125 for the bolts and the standards it specifies for the nuts. For example, nuts permitted for use with plain Type 1 Grade A490 bolts are restricted to plain ASTM A563 grade DH heavy-hex nuts or plain A194 grade 2H heavy-hex nuts. Generally, the proof load stresses specified in the mechanical testing requirements aim to fail the bolts. A table summarizing acceptable ASTM A563 nut grade and finish for use with high-strength bolts is included in Part 6 of CISC Handbook of Steel Construction 11th Edition.

Question 3: **I am a design engineer of building structures. I have always designed welded joints with matching electrodes and do not recall coming across the use of undermatched electrodes. I recently learned that S16-14 permits the use of undermatched electrodes. Is this true? Why and when should they be used?**

Answer: Yes, S16-14 explicitly permits undermatching for applications that are permitted in CSA W59. The note in Clause 19.1 suggests that undermatching provides better ductility, improves fracture resistance, minimizes lamellar tearing, and minimizes distortion of the overall built-up section. Undermatching is usually considered when welding high strength steel. Moreover, the recognition of use of undermatched electrodes provides the welding engineers and connection designers more options and choices of electrodes that lead to better speed and economy.

The design engineers of the structures may assume matching conditions. They should be prepared to consider valid undermatched connection design proposals. AS

"The recognition of use of undermatched electrodes provides the welding engineers and connection designers more options and choices of electrodes that lead to better speed and economy."

Questions on various aspects of design and construction of steel buildings and bridges are welcome. They may be submitted via email to info@cisc-icca.ca. CISC receives and attends to a large volume of inquiries; only a selected few are published in this column.

ERRATUM. In Advantage Steel #44, this column referenced the expressions for the elastic lateral-torsional buckling moment of cantilevers provided in the *Guide to Stability Design Criteria for Metal Structures, 6th Edition.* In comparison with recent studies using finite element analyses, the expression "Mc = 1.5GJ/d" gives unconservative values for plates (rectangular section) and long cantilevers of I-sections prone to lateral-torsional buckling. It should not be used for plate cantilevers significantly longer than twice their depth.

The Myths and Realities of HSS

Alfred F. Wong, P.Eng., FCSCE
Director of Engineering

Hollow structural sections are popular steel products and have been produced to mainstream standards for well over half a century. Nevertheless, some common misconceptions remain.

Myth 1: ASTM A500 is a steel grade.
A500 is an ASTM standard for HSS (structural tubing). A500 covers four grades of HSS: Grades A, B, C, and D. Both Grades B and C are used for structural applications in the USA; only A500 Grade C HSS are common in Canada.

Myth 2: ASTM A500 Grade C HSS are the equivalent of CSA G40.21 350W.
The key differences are:

1. A500 does not specify a limit on mass and permits a -10% wall thickness under-tolerance, whereas G40.21 350W HSS are produced to a -3.5% mass under- tolerance and a -5% wall thickness under-tolerance. In accordance with S16-14, the design properties for A500 products are to be determined from a wall thickness equal to 90% of the nominal value.

2. Rectangular and square A500 Grade C HSS are produced to a specified minimum yield strength, Fy = 345 MPa (50 ksi), but round Grade C HSS to Fy = 317 MPa (46 ksi). All G40.21 350W HSS are produced to Fy = 350 Mpa.

3. A500 specifies a minimum tensile strength, Fu = 427 MPa (62 ksi) for Grade C; G40.21 350W HSS are produced to Fu = 450 Mpa.

4. G40.20 Class H HSS are cold-formed then stress relieved (or hot-formed). These products have lower residual stresses and more favourable residual stress patterns with respect to axial compressive resistance. S16 and S6 permit the compressive resistance for HSS produced to G40.20 Class H to be determined from a more favourable column curve. A500 HSS are cold-formed, and the A500 standard does not include a stress-relieving procedure.

Myth 3: CSA G40.21 HSS are made in Canada, and ASTM A500 HSS are made in the USA.
Canadian producers make A500 as well as G40.21 HSS. Some HSS producers in the USA also produce to G40.20/G40.21 requirements and certify these products as such.

Myth 4: CSA G40.21 350W Class H HSS are hot-formed products.
Although Class H HSS are still defined in CSA G40.20 as either hot-formed or cold-formed then stress relieved, the production of hot-formed HSS ended many years ago.

Myth 5: CSA G40.21 350W Class H HSS are superior to Class C HSS in all applications.
CSA Standards S16 and S6 permit the compressive resistance for Class H HSS to be determined from a more favourable column curve, recognizing their lower residual stresses and more favourable residual stress patterns. There is no distinction in strength between Class C and Class H HSS other than the said difference in compressive resistance (in the intermediate slenderness range).

Myth 6: The vast majority of HSS are used for structural applications.
The majority of small HSS are not used for structural applications.

Myth 7: HSS produced to specific notch-tough requirements are readily available.
G40.21 covers enhanced notch-toughness under Type-T steels, such as Grade 350WT. Since the majority of HSS are used as compression members, which do not require superior notch-toughness, the demand for Type-T HSS is too low to warrant a regular service centre inventory. Moreover, Type-T HSS require notch-tough coil steel. A producer's minimum order is typically the entire coil of notch-tough steel. A500 has no provision for enhanced notch-toughness, but a newer ASTM Standard, A1085, does. Check availability before specifying CSA G40.21 Type-T or ASTM A1085 HSS. AS

Seismic Corner will return in future issues.


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Tareq Ali, RPM
Director of Marketing and Communications

Steel: The "material of choice" for sustainable and resilient construction

Sustainability, durability, fire resistance, structural performance, and cost-effectiveness are some of the strongest reasons for using structural steel framing in building construction. As a dependable, resilient, non-combustible material, steel-framed structures provide a wise investment for builders and the occupants who live and work in them.

Calgary's Telus Spark science museum is a testament to steel design and functionality

DESIGN VERSATILITY, EASE OF INSTALLATION, AND RESILIENCE

The versatility of steel gives architects and engineers the freedom to achieve their most ambitious visions, and provides contractors with a highly engineered, high-quality building material.

Steel offers consistently high- quality standards, precision products and guaranteed strength and durability in the most challenging environments. Steel is produced to the most exacting specifications under highly controlled conditions, eliminating the risks of on-site variability, which is an inherent disadvantage with other building materials.

Other considerations include:

- Steel is dimensionally stable and can be manufactured to very tight tolerances, making it easier for engineers to use in building design, unlike softwood products which are susceptible to shrinkage due to varying moisture content and structural design properties that have recently been downgraded by up to 30% due to changes in wood resource mix.
- Steel design benefits include longer spans, larger bays and wider frame spacing than wood or concrete construction. This allows for maximized usable floor space and large interior spaces that can be constantly adapted to cope with changing requirements of occupants.
- Steel lends itself well to prefabrication, where the assembly of the individual steel elements takes place offsite under controlled, highly regulated and safe factory conditions where leading-edge technology delivers precision engineered components.

"Steel is a non-combustible material and, consequently, does not burn, provide an ignition source, or add fuel load that would enable a fire to spread or grow into a catastrophic event."

- Steel structures can be erected speedily. The predictability and accuracy of steel components, in addition to just-in-time site delivery, speeds up the process and allows follow on trades to get to work sooner, resulting in quicker building completion and earlier occupancy.
- With consistent chemical and mechanical properties, steel behaves in a predictable manner when subjected to the structural loads imposed by high wind and seismic events.
- Steel-framed structures are inherently ductile. Structures are designed to absorb energy produced by earthquake ground movement and wind by "flexing" or "deflecting" in varying degrees, depending upon the construction materials, design of the structure, quality of the construction, level of engineering, and the applicable building code requirements.

UNPARALLELED FIRE SAFETY

Steel is a non-combustible material and, consequently, does not burn, provide an ignition source, or add fuel load that would enable a fire to spread or grow into a catastrophic event.

Steel does not melt at temperatures typically encountered in a building fire. Its non combustibility and assembly fire ratings do not degrade over the lifecycle of a building. This provides a reduced fire risk to workers and occupants, minimizes the impact on municipal fire services, and results in less property damage and collateral damage to adjacent buildings if a fire should ever occur.

Moreoever, steel has a melting point of approximately 1,500°C (2,700°F). In a typical fire, such as in an office, residential or retail occupancy, the maximum temperature of a fully developed fire will not likely exceed a range of 800 to 900 °C (1,500 to 1,650 °F), though it could reach a peak of 1,100 °C (2,000 °F) for a short duration.

Lastly, building codes recognize the fact that buildings designed with non-combustible materials like steel pose less of a fire risk to the public than combustible systems, which are limited to six storeys in height in Canada and 85 feet in the US.

PROVEN COST ADVANTAGES

There is evidence in the field and through third-party case studies and comparative cost studies that steel building systems offer significant cost benefits over competitive building materials when the total cost of construction is considered. Building owners, developers, contractors and design professionals should consider the case for steel and its many proven or demonstrated cost advantages when selecting the best material for their project. Some specific examples of steel's cost advantages include:

- A recent comparative case study on a six storey office building that evaluated the impact of using steel framing versus cast-in-place (CIP) concrete on a project's entire construction life cycle from concept and design to costing, construction and sustainability. The result was a net cost difference of $81/m2 ($7.50/ft2) in favour of the steel building.
- Cost savings in steel buildings start at the foundations, where the loads imposed by a steel frame are up to 50% less than those of a concrete alternative.
- Time-related savings can easily amount to between 3% and 5% of the overall project value, reducing the building owner's requirements for working capital and improving cash flow.

To comply with the requirements of the new Leadership in Energy & Environmental Design (LEED v4) standard, the CISC has developed six industry average Environmental Product Declarations (EPDs) for fabricated hot rolled structural steel sections, HSS and Plate for both painted and unpainted options. CISC EPDs are available from authorized CISC Fabricators listed on the CISC website (www.cisc-icca.ca).

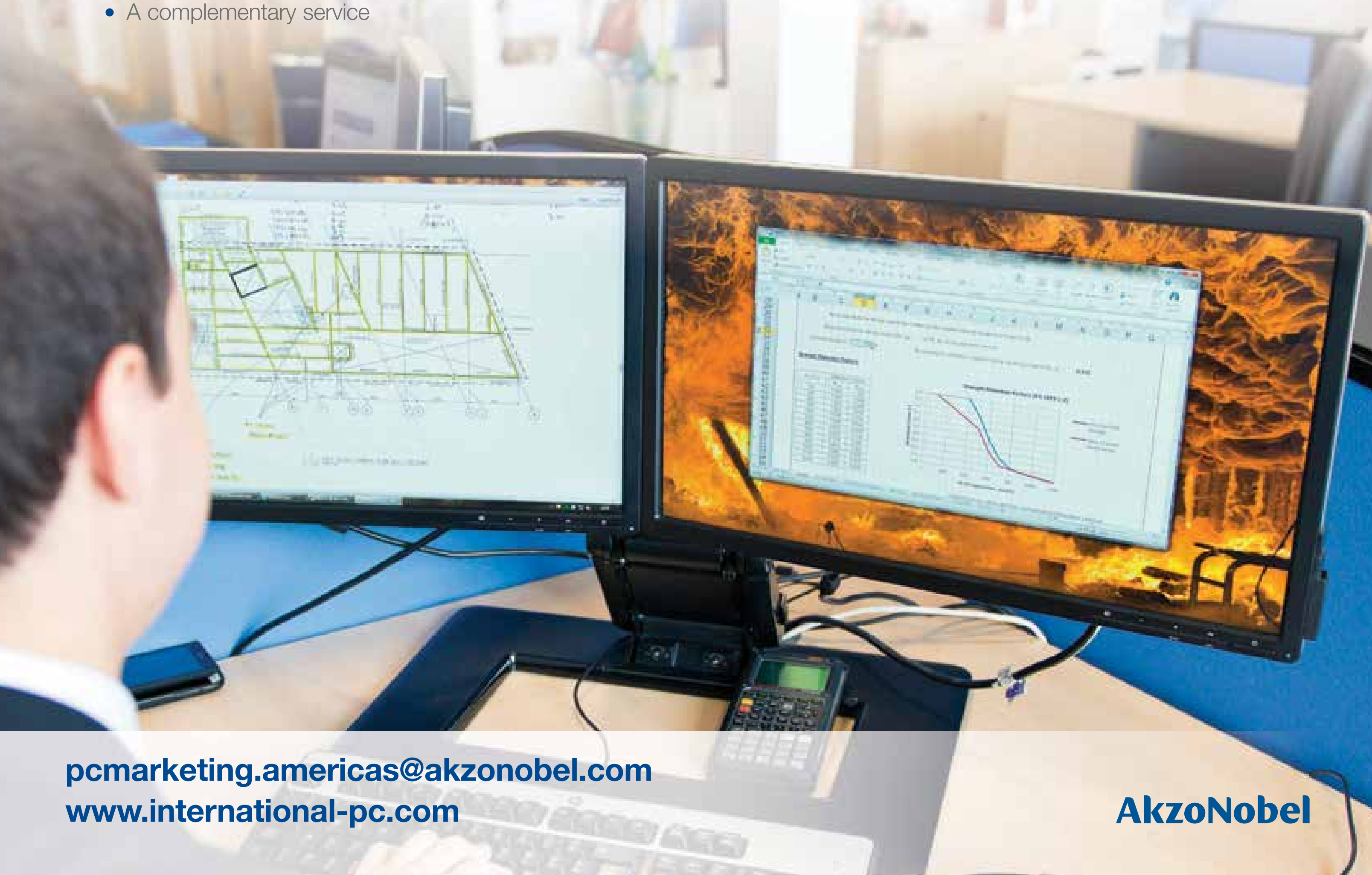
- Builders risk insurance on a four storey, 400 unit hotel built over 24 months cost $360,000 for steel framing compared with the $1.6 million it would have cost for a policy if the project had been built with wood - a savings of $1.3 million.

SUSTAINABLE STEEL AND THE ENVIRONMENT

Steel is one of the most sustainable construction materials on the planet. Its strength and durability coupled with its ability to be recycled, again and again, without ever losing quality makes it truly compatible with long-term sustainable development. Steel is the world's most recycled material. In 2013 alone, 81 million tonnes of steel were recycled in North America. Each year, more steel by weight is recycled in North America than paper, plastic, aluminum and glass combined.

Additional sustainable metrics achieved by the steel industry include:

- The North American steel industry has continually improved its energy use and levels of greenhouse gas emissions, achieving a 32% reduction in energy intensity and a 37% reduction in GHG intensity since 1990.
- Through recycling, the steel industry saves the energy equivalent to power 20 million homes for one year.
- All North American steel products have a significant amount of recycled content, including some products with more than 90 percent.
- Today, recycling rates in structural steel can be as high as 98%.
- While other building materials can only be recycled into a lower quality product (down-cycled), steel can be recycled over and over again and remade into new products (multi-cycled) without any loss of quality. This makes it the first and only true cradle-to-cradle building material.
- The steel industry has superior water resource management with a 95% water recycling rate with no external discharges.
- Every ton of steel recycled conserves 2,500 pounds of iron ore, 1,400 pounds of coal and 120 pounds of limestone.
- The use of steel building components generates very little on-site waste, since components are manufactured to tight tolerances prior to being delivered to the building site. Any on-site steel waste generated can be readily sent for recycling or reuse. AS



CISC'S FIRST ANNUAL NAT

Snapshots from the premier steel event

THE CISC'S FIRST EVER National Steel Symposium took place on September 29, 2016, with over 300 delegates in attendance.

This annual event offered a multi-track education day packed with expert led sessions featuring the latest topics in steel design & construction. Attendees were impressed with high quality sessions and top notch speakers, and enjoyed exploring all the products and services offered by exhibitors at the CISC National Tradeshow.

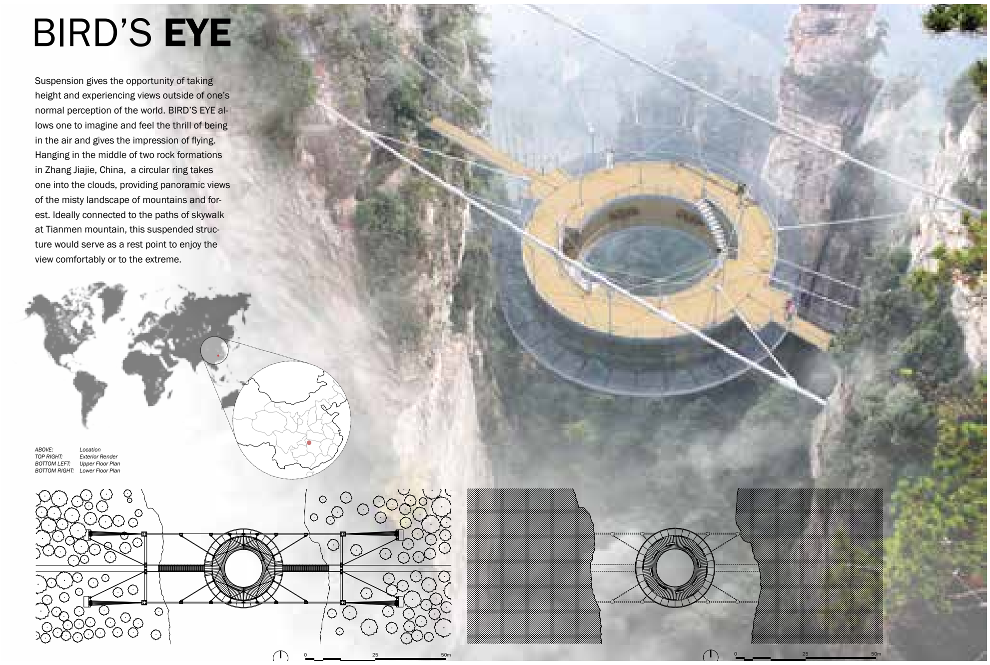
Here are just some scenes from the 2016 symposium. AS

IONAL STEEL SYMPOSIUM

15TH ARCHITECTURAL STU

Canadian teams showcase architectural expression at "suspensi

David MacKinnon, P.Eng., Director of Education and Research



2016 AWARD OF EXCELLENCE: Bird's Eye

THE 2015-2016 CISC Architectural Student Design Competition marks the 15th year that the steel construction industry has been challenging students of architecture to develop a deeper understanding of steel structures. Over the years, students have been encouraged to explore the essential relationship between architecture and structure for a given application. In 2015-2016 the theme was "suspend".

The Inca civilization is often credited with constructing the first known examples of long-span suspension architecture, yet the very notion of suspend has been woven into our everyday environment since we first learned to mimic nature in the creation of basic shelter. With the introduction of steel as a structural material, the exploration of what it means to suspend was limited only by the imagination of the architect to exploit material properties to their maximum potential. Forms that visually challenge us to suspend our disbelief, harness the tensile properties of steel in ways that infuse a sense of wonderment and even suspense, into our built environment.

Adjudication of the competition was performed by a four-person judging panel led by Loraine Fowlow, Professor of Architecture at the University of Calgary, and the competition's founder and champion. In addition, the panel was comprised of a consulting architect (Carol Kleinfledt - Kleinfeldt Mychajlowycz Architects), a consulting structural engineer (Terry Wilk - Stantec), and a steel fabricator (Tim Verhey - Walters Inc.).

2016 AWARD OF MERIT: COCOON

DENT DESIGN COMPETITION

on" themed event

> "With the introduction of steel as a structural material, the exploration of what it means to suspend was limited only by the imagination of the architect."

The judges first selected the six finalists from a field of 42 entries received from Canadian Schools of Architecture. This short-list of entries, the "Roadshow", as it is called, is available for exhibition by Canadian Schools of Architecture upon request. In the final step, the judges determined which entry would receive the Award of Excellence and which two entries would receive Awards of Merit.

The 15th Award of Excellence and the $3,000 prize went to "Bird's Eye" by Matthew Dlugosz and Zihao Wei, University of Waterloo. Their faculty advisors were Terri Meyer Boake and Dan McTavish.

The jury had this to say about the winning entry: "Bird's Eye was chosen for the Award of Excellence because the elegantly drawn plans of this project are reminiscent of a Dream Catcher, a traditional amulet that filters ideas, dreams and visions and allows only the good to pass and the evil to be caught, which in this case is a perfect expression of the intent of the structure. The structure has minimal impact on the natural surroundings, which is in keeping with the siting of the observation decks."

Dlugosz and Wei, were presented with their award at the CISC Annual Conference Gala in Toronto, Ontario on September 30, 2016.

The Awards of Merit and accompanying $2,000 prizes went to "COCOON" by Erik Aquino from Ryerson University, with Vincent Hui as faculty advisor; and "Pirouette" by Jinsu Park, Sugandh Gupta, and Catherine Tan from the University of Waterloo, with Terri Meyer Boake as faculty advisor.

The theme for the 2016-2017 Architectural Student Design Competition is "assemblage". It is an invitation for students to explore architectural connections, be they connections between context and structure, or the connections that allow an assemblage of materials and structural elements to come together to form a structural whole. This year the competition has been opened up to Canadian schools that offer a non-accredited program of architecture of at least three years duration. AS

2016 AWARD OF MERIT: Pirouette

CSCE-CISC CANADIAN STEEL BRIDGE COMPET

Students showcase their passion and ingenuity at the first Cana

Matthew Bradford

Judges and the UBC team

NATIONAL
ITION (CNSBC)
dian steel bridge competition

IT WAS A TEST OF TEAMWORK, creativity, and engineering skill as student teams from across Canada landed in Montreal to compete in the very first CSCE-CISC Canadian National Steel Bridge Competition (CNSBC).

The event was created in partnership between CISC and the Canadian Society for Civil Engineering (CSCE), who saw a need within the industry to give students a domestic alternative to the AISC/ASCE National Student Steel Bridge Competition (NSSBC), but one that would follow a similar structure and rules set so as to allow Canadian teams to compete in both.

"The NSSBC has been held in the US for a number of years, so it was about time for a Canadian version," says Éric Lachance-Tremblay, a CNSBC organizer associated with the CSCE who, alongside his colleague Jean-Luc Martel, came up with the idea in 2014 and began pitching it to students and organizations soon after. "We started by talking to Canadian teams who were participating in the NSSBC, and they were all very interested. Then, we brought the concept to the CISC who became a key partner and helped us make it happen."

This inaugural competition was held May 13 - 15 at Montreal's McGill University. It welcomed six teams: École de technologie supérieure, Université McGill, École polytechnique, University of British Columbia, University of Waterloo, and Ryerson University.

The framework of the event was inspired by the AISC/ASCE National Student Steel Bridge Competition for a number of reasons. Explains Lachance-Tremblay: "We wanted the teams who attend the Canadian competition to be able to attend the American competition with the same bridge. We made a couple of modifications, though, such as giving a third of a team's points to the architectural aspect of the bridge, which is not the case in the American competition."

Prior to the competition day, teams were tasked with designing a steel bridge based on a given scenario and specifications (e.g. specific length, height, and able to satisfy a vehicle clearance template). Specifically, students had to design a bridge to span over a "river", and the bridge had to be both visually appealing and structurally sound. Components and fasteners were fabricated and

> "Most university competitions in this field are held outside of Canada and this opportunity provides students a platform to showcase their talent and help put Canada on the map for innovative structural design."
>
> Melissa Mazik


CNSBC teams in action

"These competitions are important for students and practitioners. It gives the students an opportunity to develop leadership skills, practice teamwork, channel creativity, and experience real-world engineering challenges. Hopefully, this will set the course for a long and successful career. I imagine that many employers see this kind of experience as an asset when hiring new grads."

Mark Bruder

then shipped to the competition site where they were assembled by students.

These constructions were then evaluated by a panel of five judges selected by the McGill Organizing Committee. They evaluated the bridges over six core categories, including construction speed, construction economy, lightness, structural cost, stiffness, and architectural design. Judging began with a walk around of all the structures in a field, and a review of each team's poster which explained their designs and construction techniques. Teams then disassembled their bridges and transported them to a gymnasium to test for strength and speed of assembly.

"This process offered students a well-rounded perspective on how to design many aspects of an engineered structure," says judge Melissa Mazik with B+H Architects. "Math is one important component, however, the design and ease of construction are essential lessons that engineering students will face once in the working world. It's great to open their eyes to this type of challenge early on in the game."

Mark Bruder, a structural engineer with R.V. Anderson Associates Limited was also on the judging panel. Looking back on the May 2016 competition, he tells CISC's Advantage Steel that he was impressed by the students' talent, determination, and passion for the competition, adding, "I was pleasantly surprised with their creativity. Many of the bridge designs were both highly functional and architecturally beautiful. I was also relieved with their considerable depth of knowledge; after all, these students are the next generation of professional engineers."

"Of course, we were all happy to see that everyone was there to have a good time," he adds.

While winners were declared in each category, the team with the most top scores was named the overall event victor. This year, that honour went to École de technologie supérieure (ETS), followed in second place by the University of British Columbia (UBC), and in third by École Polytechnique de Montréal.

"ETS had an exceptionally light and stiff bridge. During the competition, they successfully argued a creative interpretation of the rules which permitted a unique assembly strategy," says Bruder, noting ETS has also been a strong competitor in past NSSBC competitions – a factor which likely encouraged the transfer of knowledge from one ETS team to the next.

Not only did ETS take top spot domestically, but the team moved on to win the NSSBC for the first time in the school's history, setting milestones on both sides of the border.

"They were the Canadian and North American champions, so it was pretty amazing to see that happen," says Lachance-Tremblay.

BIGGER AND BETTER

The success of the first CSCE-CISC Canadian National Steel Bridge Competition (CNSBC) has opened the door for many to come. The next iteration will take place in May 2017 and feature eight teams and an expanded schedule.

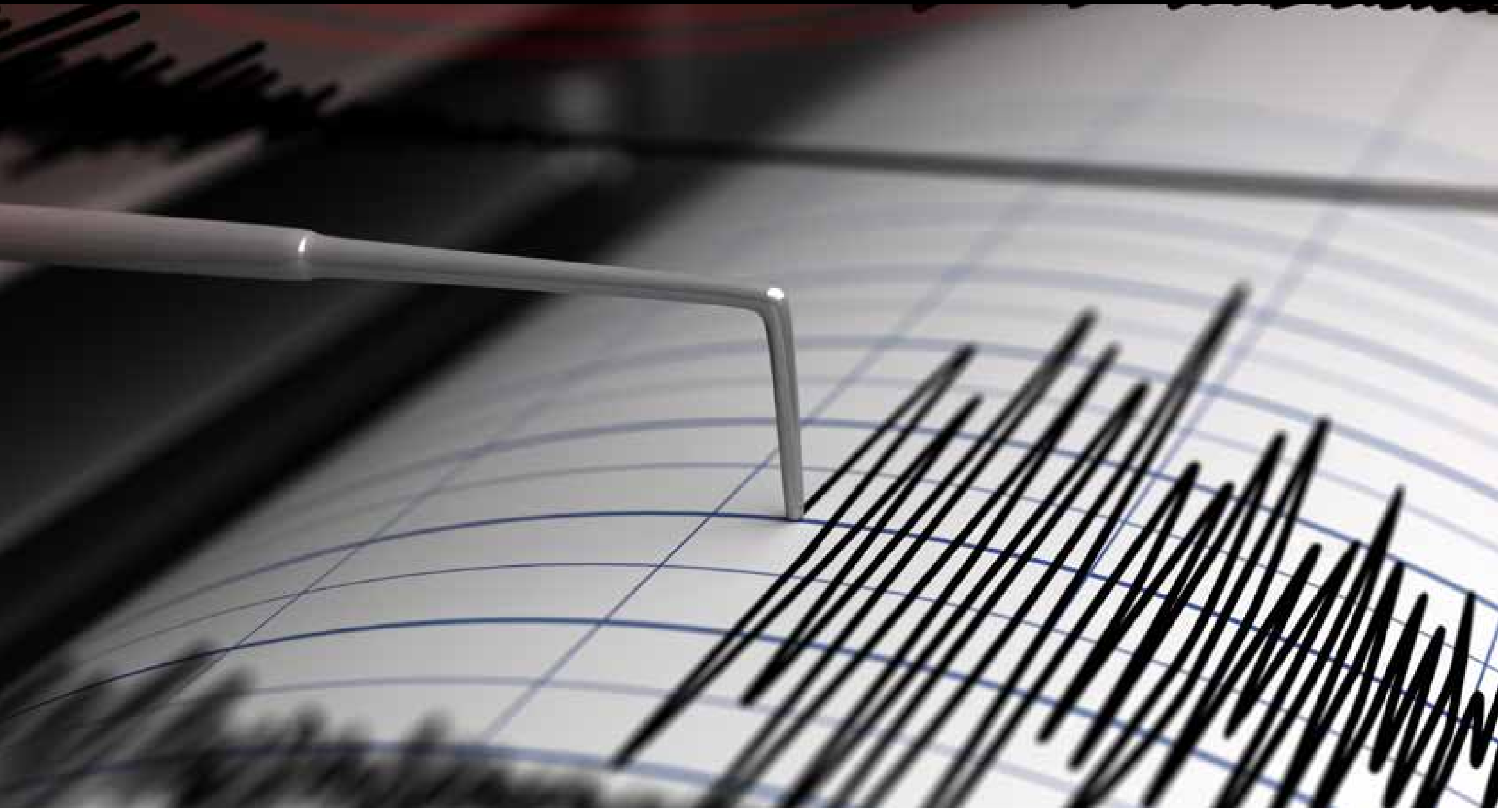
ETS named overall winner

"Last year, the competition was held in one day, and it was a pretty long day. That's why this year we're going to make it two days," reports Lachance-Tremblay, noting, "The first day will be dedicated to exhibiting the bridges, and the second will be for their evaluation. It's going to be less dense in terms of schedule, so it's going to make things a little more manageable for students and judges and give everyone more time to look at the other bridges."

Lachance-Tremblay, who was also on a student team during his university days, says it's important for him and the competition team to continue running the CNSBC not only for the experience it provides, but to make industry connections: "Canadian students will have the opportunity to meet with people from other universities and to meet their future colleagues."

As for CNSBC's value to the steel industry, Bruder adds, "When I studied steel design in university, my primary focus was understanding the theory. It was only after I entered the industry that I saw the incredible versatility of steel. You can pretty much build anything you can think of. I can only imagine how much fun I would have had in a fabrication shop with a welding torch. This competition teaches students the many benefits of steel as a construction material. The more comfortable they are in steel design, perhaps the more they'll advocate for its use." AS

DEVELOPING EARTHQU STEEL STRUCTURES



RECENT EARTHQUAKES across the world show that conventional seismic force resisting systems (SFRSs) are vulnerable to earthquake shaking. These systems focus on preventing structures from collapse without considering the performance of the structures after an earthquake. This results to significant financial losses and prolonged repair time.

The next-generation earthquake resilient structural systems shall be designed to not only provide safety, but also reduce repair cost and down time. This can be achieved using innovative structural steel fused systems.

The concept of structural fuses is similar to electrical fuses, where structural fuses are placed in a building to dissipate the sudden surge of earthquake energy and to protect the remaining structure during strong earthquake shaking. After the earthquake, structural fuses can be easily inspected and replaced without affecting the daily functions of the building. Hence, the structure can remain functional shortly or immediately after the earthquake.

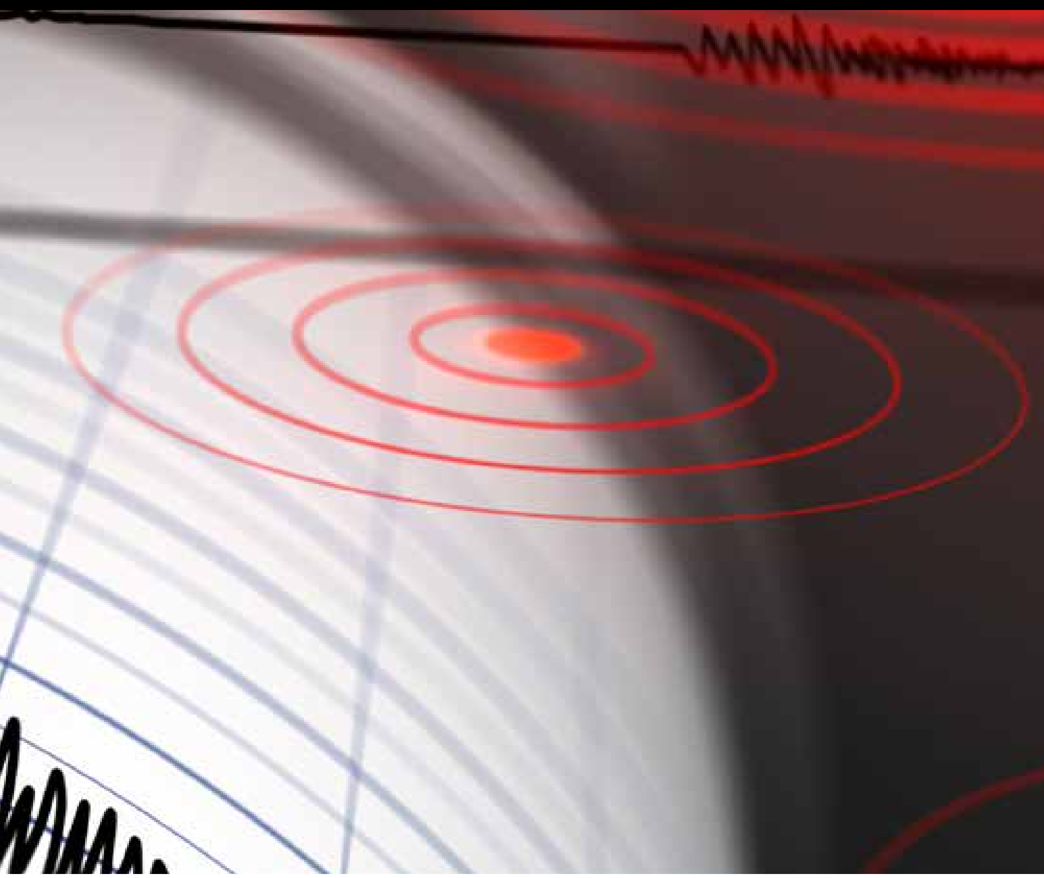
Thanks to the generous financial support from the Canadian Institute of Steel Construction (CISC), Prof. T.Y. Yang and his research team at the University of British Columbia (UBC) have been leading the research on the development of innovative earthquake resilient steel structures. The team has collaborated with many world renowned universities including University of Michigan (US), University of Washington (US), Portland State University (US), Tongji University (China), Tsinghua University (China), Central South University (China), King Mongkut's University of Technology (Thailand), and Indian Institute of Technology Kanpur (India).

One of the innovative earthquake resilient SFRSs, named the fused truss moment frame

AKE RESILIENT

Fused Truss Moment Frames

T.Y. Yang, Y. Li, D.P. Tung



(FTMF), has been developed and is presented in this article. FTMF uses a configuration similar to conventional moment frames (MFs), but steel trusses are used instead of beams. Steel trusses are efficient to span long distance, which can create large open spaces. However, conventional steel trusses lack energy dissipation capacity, which is not ideal for seismic applications. FTMF adds specially designed buckling-restrained braces (BRBs) to the steel trusses to dissipate the earthquake energy. Figure 1 shows the proposed configuration of the FTMF. The BRBs are strategically designed to be placed under the steel trusses so that they can be repaired or replaced without affecting the functionally of the structure. This reduces the repair cost and repair time, and makes the FTMF more efficient and resilient towards future earthquakes.

DESIGN PROCEDURE

Since the proposed FTMF is a new SFRS, a novel seismic design method, named equivalent energy design procedure (EEDP), is developed to design the FTMF. EEDP uses an energy balance concept that allows structural engineers to design the FTMF to achieve different performance objectives at different shaking intensities. At the low shaking intensity (service level earthquake - SLE), the structure is expected to remain elastic. The structure shall have no damages and hence achieves the immediate occupancy (IO) performance objective. During the design based earthquake (DBE), the structural fuses are designed to yield, while protecting the remaining structure. Under the maximum considered earthquake (MCE), the moment frame (MF)

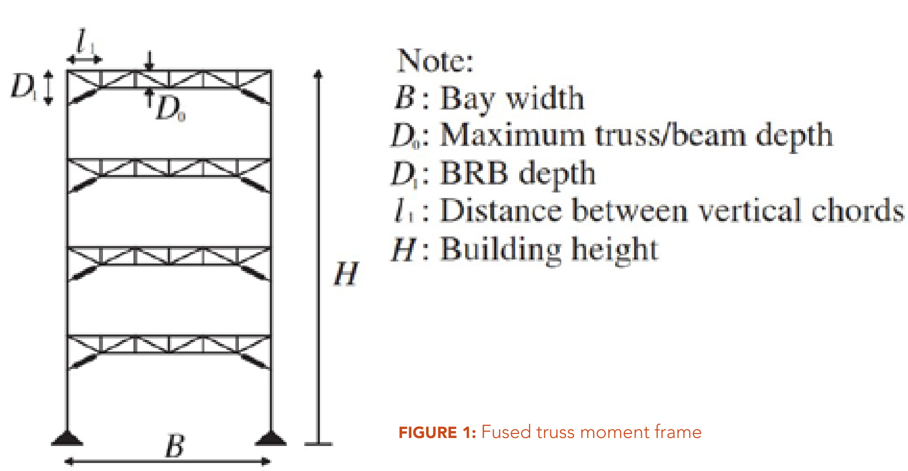


FIGURE 1: Fused truss moment frame

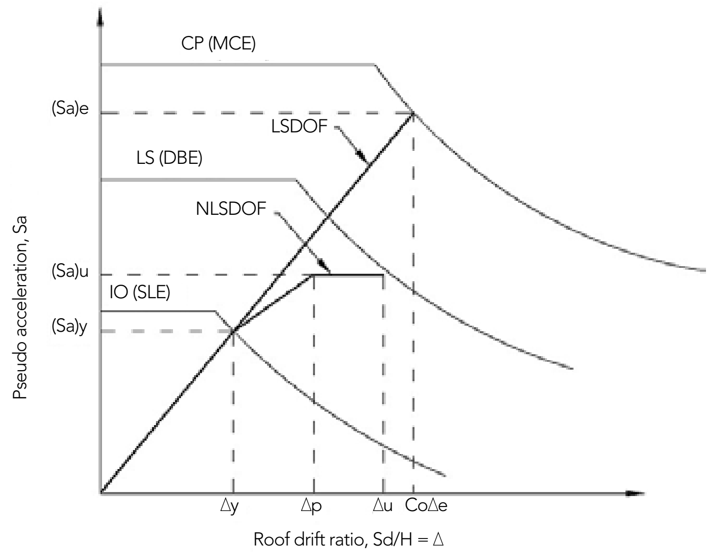


FIGURE 2: EEDP energy balance concept

> "As a novel experimental testing methodology, HS combines the advantages of experimental sub-assembly testing with finite element applications to analyze the nonlinear response of a complex structural system under extreme loads."

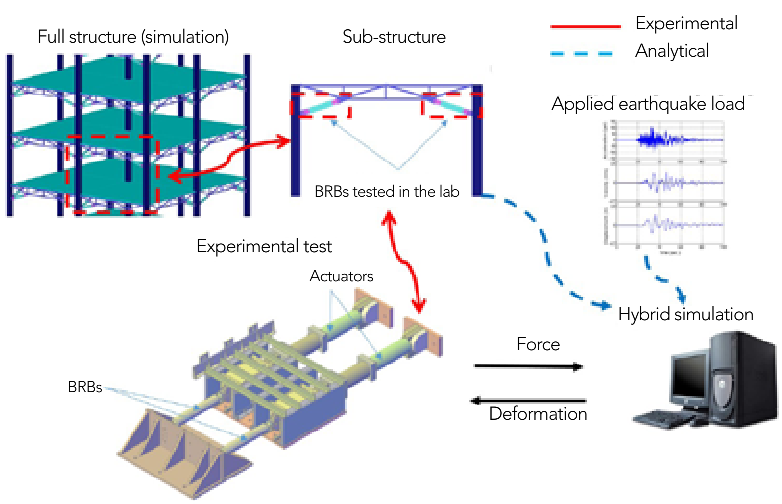


FIGURE 3: Hybrid simulation testing scheme

FIGURE 4: Experimental sub-assembly at UBC

is designed to yield, prevent the structure from collapse, and hence achieve the collapse prevention (CP) performance objective. The proposed EEDP creates a tri-linear design force-deformation curve as shown in Figure 2 for the FTMF. EEDP allows designers to efficiently select structural member sizes that achieve the desired structural period, strength, and deformation with only simple hand calculations and without iterations. Hence, it is practical to the engineering community.

EXPERIMENTAL VALIDATION

In order to validate the seismic performance of the proposed FTMF, full-scaled hybrid simulation (HS) tests were conducted at UBC, Vancouver. These tests were sponsored by CISC and steel fabricators (including George Third & Son, Pacific Bolt Manufacturing, Star Seismic, and Samuel, Son & Co.).

HS is the state-of-the-art technology to study the system-level response of a structure. As a novel experimental testing methodology, it combines the advantages of experimental sub-assembly testing with finite element applications to analyze the nonlinear response of a complex structural system under extreme loads.

Figure 3 shows the schematic of the proposed HS. In this HS, the BRBs were tested in the laboratory (Figure 4), while the remaining FTMF were modeled using a finite element program.

The finite element model calculated a trial displacement and applied this displacement using the laboratory actuators. The forces in the BRBs were then measured in real time and assembled in the finite element program. The finite element software iterated the applied

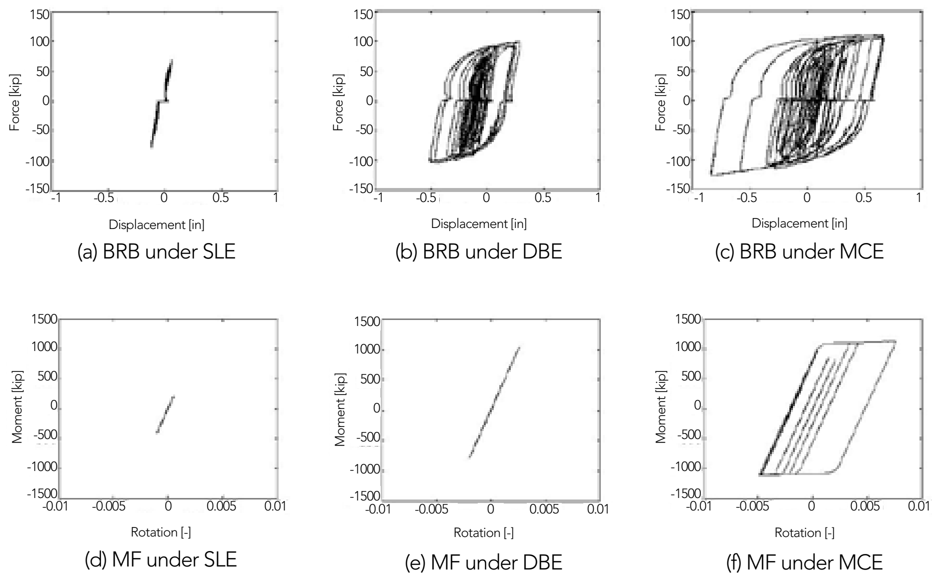


FIGURE 5: Hybrid simulation results

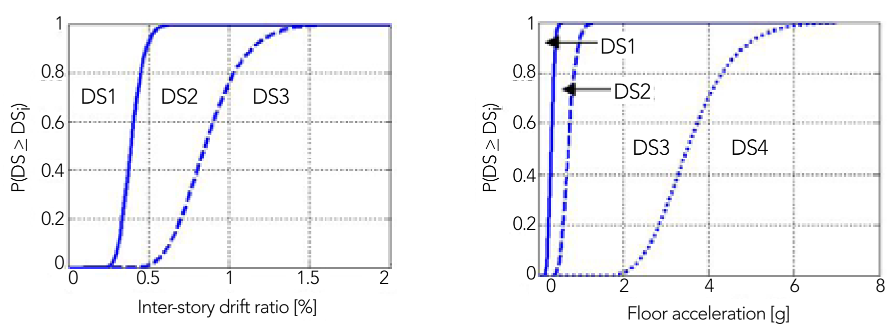


FIGURE 6: Sample fragility relations

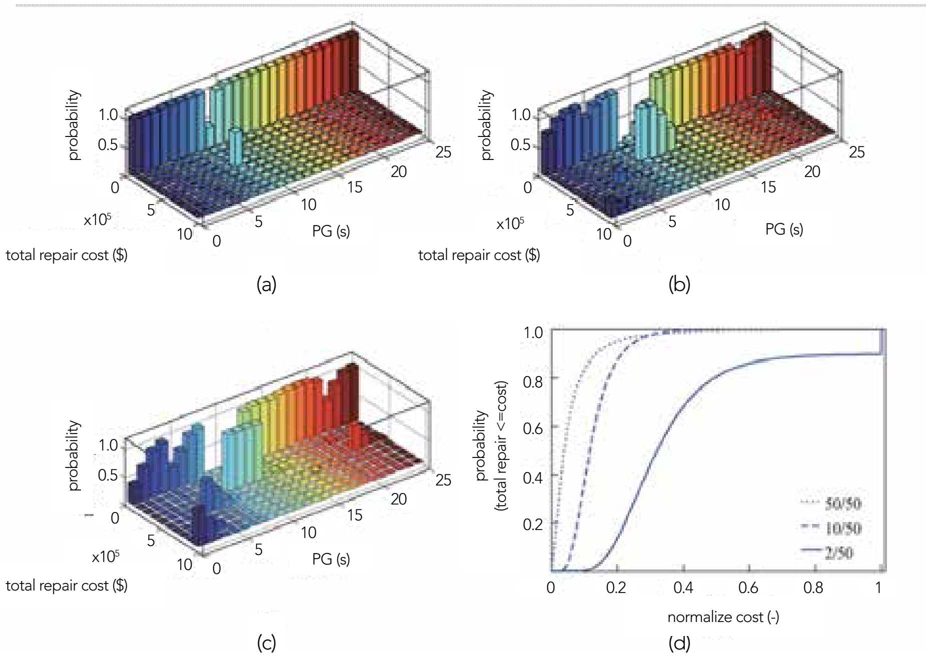


FIGURE 7. Repair cost break down under 2% in 50 year hazard. (a) SLE hazard level; (b) DBE hazard level; (c) MCE hazard level; (d) cumulative distributed cost function

displacement to the BRBs until the dynamic equilibrium of the system is satisfied. Once satisfied, the process is repeated for the next time step. A total of three tests were conducted corresponding to the earthquake shaking intensities of SLE, DBE, and MCE. Figure 5 shows the results of the HS tests. During SLE, the FTMF remained elastic and hence damage free. At DBE, the BRB yielded, but the MF remained elastic. The BRB could be efficiently repaired to minimize down time and enhance earthquake resilience. During MCE, both the BRB and MF in the FTMF yielded, but not fractured, to prevent the FTMF from collapse.

PERFORMANCE-BASED COST ASSESSMENT

Seismic performance of the proposed FTMF under different earthquake intensities was evaluated using the state-of-the-art seismic performance assessment procedure outlined in the ATC-58 procedure. Major structural and non-structural components in the building were grouped into performance groups (PGs), each consisting of a collection of the building components whose performance was similarly affected by a particular engineering demand parameter (EDP). For examples, the structural component performance group consisted of drift-sensitive components, whereas the non-structural group consisted of acceleration and drift sensitive components.

Multiple damage states (DSs) were defined for each PG. The DSs were established at points along the damage continuum for which significant repair action would likely to be triggered. For each DS, a damage model (fragility relation) defined the conditional probability of damage being less than or equal to the threshold damage at a given EDP value. Figure 6 shows sample fragility relations. The horizontal axis represents EDP, such as peak inter-storey drift ratio or floor acceleration experienced by a component. The vertical axis represents the probability of the component in each DS.

Figures 7(a)-7(c) show the deaggregation of the total repair cost of the prototype building under the SLE (50/50), DBE (10/50), and MCE (2/50) hazard levels, respectively. Figure 7(d) shows the cumulative distribution function (CDF) of the total repair cost for the three hazard levels considered. Note that the cost simulation also considered the collapse probability. If collapse were detected, the building replacement cost was used as the total repair cost. The result shows that the repair cost became higher as the earthquake intensity increased. The information presented here could

be used to make risk management decisions. For example, the prototype building has a median (50% probability of exceedance) repair cost of 35% of the building replacement value under the 2/50 hazard level. The median repair costs (50% probability of exceedance) of the proposed FTMF are 2%, 10%, and 35% of the total building replacement value at the 50/50, 10/50, 2/50 hazard level, respectively.

"To efficiently design the FTMF, a novel energy-based design procedure named EEDP is developed. EEDP takes structural strength and ductility into consideration directly."

CONCLUSION

With an increasing trend towards building resilient communities for future earthquakes, resilient structures are being developed. In this article, a novel earthquake resilient steel structure, named Fused Truss Moment Frame (FTMF) is presented. FTMF uses specially designed structural fuses to dissipate the sudden surge of earthquake energy. The fuses are de-coupled from the gravity system and hence can be repaired or replaced efficiently to expedite recovery effort. To efficiently design the FTMF, a novel energy-based design procedure named EEDP is developed. EEDP takes structural strength and ductility into consideration directly. It allows structural engineers to design the FTMF to achieve multiple performance objectives at different earthquake shaking intensities. More importantly, EEDP is non-iterative to achieve the design strength, stiffness, and deformation limit. This makes EEDP very efficient and attractive to the design community. To demonstrate that the FTMF designed using EEDP can achieve the performance objectives, novel experimental tests were conducted. These tests used the state-of-the-art hybrid simulation technology, where the FTMF was tested at three shaking intensities. The result shows that during the SLE intensity, the FTMF remained elastic. At the DBE intensity, the BRB yielded. During the MCE intensity, both the BRB and MF yielded. Detailed performance-based assessment was conducted using the state-of-the art performance assessment procedure. The result shows that the proposed steel FTMF can be used efficiently and effectively for seismic application. AS

T.Y. Yang is with the International Joint Research Laboratory of Earthquake Engineering, Shanghai, China and the Department of Civil Engineering, University of British Columbia, Vancouver, Canada. Y. Li and D.P. Tung are also with the Department of Civil Engineering, University of British Columbia.

CISC Research Grant Program 2016-2017

Maura Lecce, Ph.D., CISC Research Grant Manager and Professor, Civil Engineering Technology, Seneca College of Applied Arts and Technology

The CISC is committed to supporting research programs at leading Canadian schools of engineering and engineering technology as part of its mandate to support the development of expertise, knowledge and innovation in steel design and construction. The objectives of the CISC Research Grants Program are to support the research needs of the structural steel industry as they relate to building structures and bridges, and to foster excellence in steel education and research.

AREAS OF RESEARCH include the behaviour of steel components and systems as they relate to maintaining safe and cost effective codes and standards, advancing the sustainability of structural steel construction, improving design methodologies, and exploring innovative structural solutions that will keep steel construction competitive. Topics for research come from codes and standards committees, stakeholders in steel construction, and from the Canadian research community.

The CISC recently awarded five research grants, totalling $99,600, for the 2016-2017 academic year. The research projects that began in September 2016 are described below:

Research Title:
Performance Based Seismic Design of Steel Bridges According to CHBDC S6-14

Researcher:
Dr. Carols E. Ventura, Professor, Department of Civil Engineering, University of British Columbia

Description of Research: The latest release of the Canadian Highway Bridge Design Code S6-14 incorporates for the first time Performance Based Seismic Design (PBD) provisions for bridges in Canada. As this is a significant departure from the traditional Force-Based Design approach, practicing engineers are facing a number of challenges associated with the implementation of PBD for seismic design of bridges. Although the decision to incorporate PBD requirements on the bridge code is a step in the right direction, there are a number of "gaps" in S6-14 that may create confusion on how the performance criteria for different types of bridges can be met or demonstrated.

This study is concerned with the manner in which the performance criteria for seismic design of steel bridges can be met through the different types of analyses recommended by the code. The emphasis here is to apply the PBD methodology to different types of steel bridges and determine what are the necessary steps and additional analyses that need to be conducted by bridge designer to assess the performance criteria required by the new code. These studies will be useful for incorporating them into a set of practical guidelines for implementation of S6-14 to ultimately assist practicing bridge engineers to better understand the PBD design approach.

Research Title:
Development of Innovative Steel Diagrid High-Rise Structures for Seismic Applications

Researcher:
Dr. Tony T.Y. Yang, Associate Professor, Department of Civil Engineering, University of British Columbia

Description of Research: This research aims to create an innovative steel diagrid structure for high-rise building applications in areas of high seismicity. This system utilizes the high stiffness and strength of steel to create a diagonally integrated mega steel grid structure that can transfer lateral loads to the foundation efficiently and effectively. The combination of the mega steel grid system with the gravity system allows the designers to create new architectural flexibility, achieving new buildings heights and shapes that cannot be achieved using conventional structural systems. Thus far, the use of diagrid structure has not been implemented in areas of high seismic zones because the dynamic behaviour of diagrid structures under seismic loads are not fully understood.

The proposed steel diagrid structure will utilize the efficiency and energy dissipation capacity of steel, so it can be built in areas of high seismicity. In this research, detailed nonlinear finite element models will be developed. They will be used to study the dynamic behaviour of steel diagrid structures under different earthquake shaking intensities. The model responses will be used to develop efficient seismic energy dissipation devices. To improve construction and cost efficiency, steel modular construction methods will be utilized. The seismic performance of the proposed steel diagrid structure will be validated using the advanced experimental testing technique, hybrid simulation, at the state-of-the-art Structural Laboratory at the University of British Columbia (see Figure 1 for a schematic of the hybrid simulation framework). Once the performance of the steel diagrid structure has been systematically validated, detailed seismic design procedures will be developed, allowing structural engineers to efficiently and effectively design steel diagrid structures for high-rise construction.

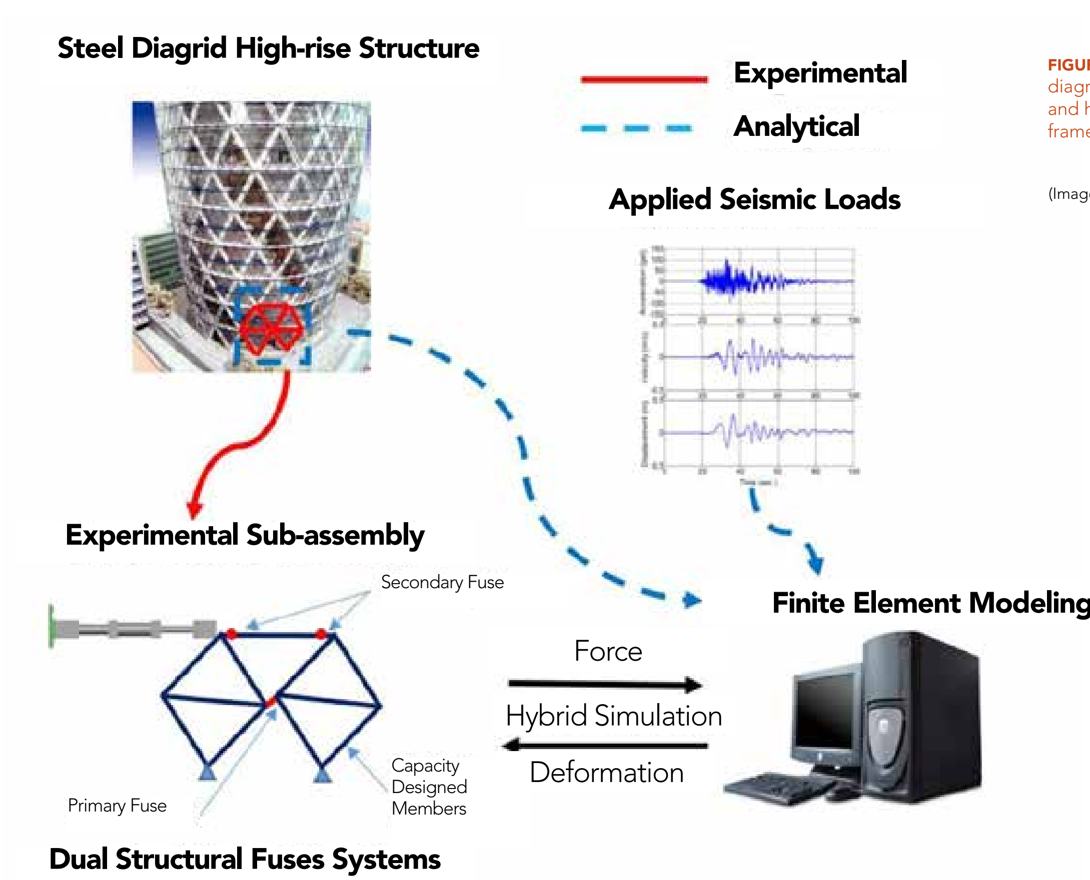


FIGURE 1. Proposed steel diagrid high-rise structure and hybrid simulation framework

(Image courtesy of T.Y. Yang)

Research Title:
Completing the Load Path for Controlled Rocking Steel Braced Frames

Researcher:
Dr. Lydell Wiebe, Assistant Professor, Department of Civil Engineering, McMaster University

Description of Research: The aim of this research is to develop and validate feasible connection details between floor diaphragms and Controlled Rocking Steel Braced Frames (CRSBFs). Connection details will be designed to achieve desired performance criteria while also minimizing costs associated with construction and fabrication, and the proposed connections will be tested experimentally under cyclic loading (see Figure 2 for a schematic of the proposed test set up). The laboratory results will be used to validate the finite element models that were used to design the connections, and to develop simplified design guidance for implementing CRSBFs in practice.

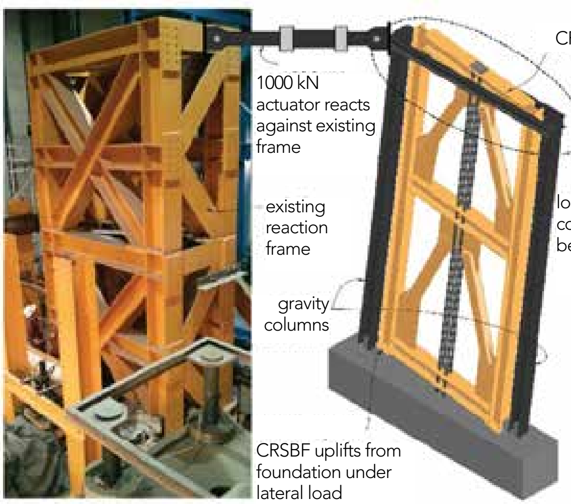


FIGURE 2: Proposed test configuration
(Image courtesy of L. Wiebe)

"The aim of this research is to develop and validate feasible connection details between floor diaphragms and Controlled Rocking Steel Braced Frames (CRSBFs)."

Research Title:
Hot-Dip Galvanized Hollow Structural Sections – Crack Prevention and Mechanical Behaviour

Researcher:
Dr. Min Sun, Assistant Professor, Department of Civil Engineering, University of Victoria

Description of Research: This research aims to investigate the conditions which lead to cracking of hot-dip galvanized cold-formed Hollow Structural Sections. More specifically, the following will be investigated: (i) the prerequisites of cracking; (ii) if hot-dip galvanizing-induced embrittlement is a concern for Rectangular Hollow Sections (RHS) with different cross-sectional dimensions and produced to different specifications; (iii) the thresholds of wall thickness above which different levels of pre-galvanizing countermeasures for brittle cracking are needed; and (iv) the detrimental/beneficial effects of hot-dip galvanizing on the mechanical behaviours of RHS.

The long term goals of this project are to provide guidelines to engineers, fabricators and galvanizers to minimize the risk of cracking in RHS during hot-dip galvanizing; generate supplemental rules to HSS manufacturing specifications and crack control guidelines; and, provide a better understanding of the characteristics and structural performance of hot-dip galvanized RHS to facilitate its application.

Research Title:
Promoting Steel as a Material of Choice for Bridge Infrastructures: Current and Future Innovations

Researcher:
Dr. Khaled Sennah, Professor, Department of Civil Engineering, Ryerson University

Description of Research: With increased prices of steel, bridge owners and design engineers have become more reluctant to using steel in bridge superstructure, as it may be cost prohibitive. In this research, some countermeasures and innovative techniques are proposed that can be considered to (i) reduce the steel material content in bridge superstructure; (ii) enhance the constructability of steel I-girder and box-girder bridge systems in both straight and curved alignments, leading to a significant cost saving; (iii) increase the awareness of bridge designers to important issues in design of new bridges and evaluation of old ones for rehabilitation, replacement, or retrofit; and (iv) erect fully-prefabricated bridge superstructure to rapid construction, with steel as a material of choice. Specific objectives for the first phase of this research are to: (i) establish ready-to-use design tables of steel I- and box-girder bridges based on simplified analysis; and (ii) predict the minimum required cross-bracing spacing to limit warping stresses in compression flanges for both I-girder and box-girder bridges at construction stage. Overall, the aim is to develop steel or composite concrete-steel designs that are cost-effective and easy to design, thereby promoting the use of steel in bridge construction.

Since 1995, the CISC's support of research and education has led to the development of design guidelines, innovation in structural steel solutions, and maintaining safe and cost-effective codes and standards. AS

2016 H.A. Krentz Award

Maura Lecce, Ph.D., CISC Research Grant Manager and Professor, Civil Engineering Technology, Seneca College of Applied Arts and Technology

H.A. Krentz recipient, Dr. Carlos Ventura (left), together with CISC Research Committee Chair, Michael Holleran (right).

THE H.A. KRENTZ RESEARCH AWARD is made in appreciation of the contributions made by Hugh Krentz to the engineering profession, the development of codes and standards, the education of engineers and to the development of the Canadian steel industry. The award, made in addition to the research funds granted to the recipient through the CISC Research Grant Program, is presented annually to the researcher whose project has special merit and interest with promise that it will make a significant contribution to understanding the behaviour of steel structures, advances in the economy, and safety or reliability of steel structures. A gift of $5,000 is part of this notable award.

The recipient of the 2016 H.A. Krentz Award is Dr. Carlos E. Ventura, Professor and Director of the Earthquake Engineering Research Facility, Department of Civil Engineering, University of British Columbia for his research on "Performance Based Seismic Design of Steel Bridges According to CHBDC S6-14". The CISC granted Dr. Ventura $25,000 for this research through the Research Grant Program.

Dr. Carlos Ventura, Ph.D., P.Eng., has more than 30 years of experience as a structural engineer and his areas of research are in Structural Dynamics and Earthquake Engineering. He has done extensive experimental and analytical research on the seismic response of civil engineering structures and has written over 300 technical papers and reports related to the seismic behaviour of structures.

Dr. Ventura was presented the H.A. Krentz award at the CISC Annual Conference on September 30th 2016, in Toronto, Ontario. AS

Past Recipients of the GJ Jackson Fellowship

Where are they now?

David MacKinnon, P. Eng., Director of Education and Research

THE GJ JACKSON FELLOWSHIP has been awarded by the CISC annually since 1988 to the student who best meets the published criteria for academic excellence, leadership, vision and a research topic that promotes the use of steel. The selection is made by a committee of experts in steel design and fabrication, and is typically challenging because of the many qualified applicants competing each year. It is hoped that most recipients will follow a career path related to structural steel construction and this has primarily been the case. A few past recipients are highlighted in the following paragraphs and the variation in their employment experiences is noteworthy.

Robert Driver (1993)

Robert is the Supreme Steel Professor of Structural Engineering Education and Innovation and Director of the CISC Centre for Steel Structures Education and Research at the University of Alberta. The Steel Centre is a unique partnership between the construction industry and the university that aims to create a much tighter and more collaborative interaction between industry firms that either design or fabricate steel structures and the academic and research environments within which the future engineering work force is trained. The founding members of the Steel Centre are the Canadian Institute of Steel Construction, Collins Steel, Supreme Steel, Waiward Steel, DIALOG, Price Steel, and TSE Steel.

The Shell Info Centre, Mississauga, ON, is the first steel structure designed by Prof. Driver in 1990. As stated on www.mississaga.ca, "Good examples of well-designed highway architecture are few and far between on Canadian Highways. The Shell Info Centre on Highway 401 is a rare exception. … The building is well-designed with a richness of form inside and out with detail and provides well integrated opportunities for signage." Sadly, the building was recently decommissioned after serving for nearly a quarter century as the "welcome centre" for east-bound travellers entering Toronto on Hwy. 401.

Susan Guravich (1995)

Susan has been working with Skarborn Engineering Ltd for 24 years, since receiving her Masters in Engineering at the University of New Brunswick, and continuing through her Doctorate program at the same institution. The pursuit of a second graduate degree would not have been possible without the support of the CISC and the GJ Jackson Fellowship. Her research on simple shear connections in combined shear and tension loading with the late Dr. John Dawe involved a large number of full scale laboratory tests (107), and demonstrated significant capacity of certain standard types of connection. It also gave her a lasting appreciation for the ductility and strength of steel.

Jewetts Creek Bridge: Design by Hillcon Ltd; Fabrication by Canam; Erection by MQM Quality Manufacturing Ltd; Bridge erection procedure by Skarborn Engineering Ltd & MQM

Susan started with the company as a design engineer, using STAAD Pro and the Canadian Highway Bridge Design Code to assess existing steel transfer bridges at major ferry terminals in Atlantic Canada. She has worked on many steel projects over the years, primarily associated with bridges and industrial buildings and components. Susan became qualified as a Canadian Welding Bureau recognized welding engineer and International Welding Engineer (IWE) through self-study, outstanding mentoring by Stig Skarborn (company president, P. Eng., IWE), and experience consulting for over 30 steel and aluminum fabricators. Recent projects have included development of welding procedures for heavy offshore steel fabrication, and design of aluminum tubular arches for cover supports at waste water treatment facilities in the US and Australia.

"The selection of the GJ Jackson Fellowship is made by a committee of experts in steel design and fabrication, and is typically challenging because of the many qualified applicants competing each year."

Hebron Offshore Oil Drilling Platform: ExxonMobil; Structural and project engineering

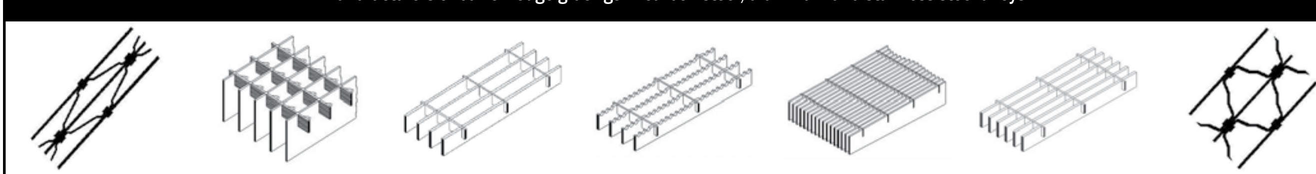
Audain Art Mueum: Design by Patkau Architects; Fabrication by George Third & Son; Cast Connex Scorpion Yielding Connectors

Scott Benson (1998)
Scott is a senior structural / subsea engineer with over 25 years of experience in the consulting and academic fields. Scott began his career as a project / design engineer, gaining design office and field experience on a variety of industrial and commercial projects, including the Hibernia and Terra Nova developments off eastern Canada. Scott later returned to university and completed a Ph.D. in structural engineering. He was able to do so, in part, due to the generous funding provided through the GJ Jackson Fellowship by the Canadian Institute of Steel Construction.

Since 2002, Scott has worked for several leading offshore energy, engineering and construction companies including Technip, Husky Energy, Aker, ExxonMobil and Kvaerner. Positions included lead manifold / subsea structures design engineer, engineering manager, project manager, concept development / FEED team member, technical assurance lead and civil field engineer on the White Rose, Hibernia and Hebron developments. Scott is currently finishing construction on the Hebron Project, in Bull Arm, Newfoundland. This mammoth 500,000 Tonne structure will be towed offshore next spring to become the fourth oil production platform on the Grand Banks. It will sit on the seabed in 93m of water, producing up to 150,000 barrels of oil per day, house 220 workers and is designed to withstand a direct iceberg impact.

Michael Gray (2006)
After completing his doctorate at the University of Toronto, Michael took the position of vice president at Cast Connex, a company he co-founded. At Cast Connex, one of Michael's roles has been the development of the Scorpion Yielding Connector, the subject of his Jackson Fellowship supported Ph.D. research. In 2014, the technology was used in its first project, the Audain Art Museum in Whistler, B.C. Since then, the technology has been used in the seismic retrofit of the St. Aubin High School in Baie-Sainte-Paul, QC, and is being specified in several other projects.

Michael has also worked on the design and production of numerous other Cast Connex projects across North America. Through his work at Cast Connex, Michael has had the opportunity to work on steel building projects of all types, from sports venues, to transportation infrastructure, to industrial energy structures. In addition Michael is giving back to the industry as a member of the CISC's Education and Research Council. AS



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Stawamus Pedestrian Bridge, Sea-to-Sky Hwy 99, BC - 20" O.D. x 3/8" wall

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The 2016 Kulak Scholarship

Building on the Shoulders of Giants

Logan Callele, P.Eng.
Waiward

I NEVER HAD THE PRIVILEGE of attending one of Dr. Kulak's classes, but I understand that he was a stickler for starting the class right on time. Well, the theme of this year's Kulak Scholarship is, "It's about time!", so it's about time that we start to directly tie our steel industry into the education and research at the University of Alberta. It's about time that we consider how to maximize the rate of return for our industrial investments into research and education, and it's about time that we see a promotion of research projects that directly tie to two of steel's strengths in the construction market: speed and durability.

This past October marked the launch of the Steel Centre at the University of Alberta. Much will be said about the Steel Centre in other articles so I will instead focus on just one word - interstitial. In the same way that interstitial molecular bonds hold steel together, the Steel Centre represents the bonds that will strengthen our industry for today and tomorrow by forging a multi-disciplinary team that will tackle industry challenges from the different perspectives of our stakeholders.

The CISC and local Alberta steel industry stakeholders strongly believe that the only way to see our industry continue to grow and gain more market share is to have direct industry participation in education and research at the university undergraduate and graduate levels. This year's co-recipient Ms. Victoria Buffam is working on a project that is finalizing three separate research initiatives sponsored by Alberta CISC member and Steel Centre Investor Company Waiward Steel. Further growth of the Steel Centre will serve to form similar long-term bonds between industry and academia, which will keep injecting focused steel solutions into our industry.

This year the terms of reference that govern the award of the Kulak scholarship were changed. The CISC Alberta regional committee agreed to allow co-recipients of the Kulak scholarship if it was deemed that splitting the award would lead to a greater benefit for the students and the overall structural steel program at the University of Alberta. This change recognizes the need to maximize the benefits of our investments into the education and research, and the co-recipients are to be congratulated for being selected to bring progress to this goal.

This year's award winners, Ms. Safa Masajedian and Ms. Victoria Buffam, are working on projects that will enable steel designers to capitalize on steel's inherent durability as well as increase the speed of construction by using single sided connections. Both are points of emphasis that the steel industry can leverage to gain greater market share as the construction material of choice.

Ms. Buffam's research project is an investigation of the effects of stability and axial loading on extended shear tabs. A parametric study, using ABAQUS finite element analysis software, is being conducted to determine the length at which buckling of the plate governs the behaviour and capacity as opposed to strength. Previous research on extended shear tab connections has focused on strength governed failure modes, therefore instability is not well understood and stiffeners are commonly added as a precaution. Additionally, industrial applications are commonly subjected to axial loads in addition to shear and bending. Little research has been completed on the effect that this additional load has on the connection and this is reflected in its omission from current design equations. Therefore, the effect of axial compression on the connection stability is being investigated by applying loads ranging from 0% to 75% of the plate cross-sectional yield capacity. Once critical stability limits are known, equations can be developed to simplify the design procedure and reduce unnecessary fabrication costs.

Safa Masajedian's 2016 Kulak Scholarship Presentation

Victoria Buffam 2016 Kulak Scholarship Presentation

Ms. Masajedian's project is focused on assessing the inherent robustness of conventional designed composite steel framed structures using a combination of analytical and full scale experimental techniques. Recent building progressive collapses have affirmed the need for certain buildings to accomplish an evaluation of building robustness to ensure that a localized failure will not lead to an extent of collapse that is disproportionate to the initial failure. The results of this research will provide significant improvements in understanding the level of the design and the integrity of a composite steel frame structure under a corner column removal loading scenario. Findings of this research can notably enhance the ability of engineers to design and evaluate steel structures against progressive collapse and can also support the provision of more accurate information. Providing engineers with this information can lead to a more resilient society in the face of a progressive collapse scenario by localizing the initial failure and will augment the steel structure's safety against this scenario.

As a graduate student, Dr. Kulak encouraged me to take a job with a local steel fabrication company (Waiward Steel) as, in his words, "you can learn a lot of things there that you won't learn here or in a design office". Well it's about time that the steel industry starts sharing some of the specialized knowledge available within our different niches. It is through the holistic structural steel solution that considers our industry's stakeholders perspectives that we will gain market share within the Canadian construction industry. This year's launch of the Steel Centre and the work of our Kulak award winners is the start of the journey to achieve this goal. No one individual will accomplish this task; rather, we must continue the steel industry's tradition of supporting each other as we hope to build a strong foundation for future growth. AS

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MISSION: POSSIBLE

2017 NORTH AMERICAN IRON WORKERS/IMPACT CONFERENCE

Eric Dean
General President
Iron Workers

Bill Brown
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CEO
IMPACT

Sheraton San Diego Hotel & Marina, March 19 - March 22, 2017

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- Fab Shops – Health Care Writ Large!
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CISC Short Course Development and Delivery

David MacKinnon, P. Eng., Director of Education and Research

IN THE PAST 10 YEARS, CISC's continuing education programs have shifted from technical, design oriented courses for consulting structural engineers to education and training for numerous stakeholder groups involved in the construction of steel structures, including structural design and fabrication engineers and technologists, architects, steel detailers, steel inspectors and building officials.

CISC has also transitioned from classroom style delivery of short courses to live, online delivery of courses and webinars between 1 and 60 hours in length. Live online course delivery started with the first Steel Handbook course in 2010 and came to an end in October 2016 with the Seismic Design of Industrial Steel Structures. At the same time, self-paced learning was launched using the recordings of these sessions packaged with assignments, quizzes, exams and offline Q&A with the Course Leaders.

Today, all CISC courses are developed off-line using eLearning tools and hosted in the CISC Self-Paced Learning Centre. The quality of the end-product is noticeably higher since content and delivery are polished during the development stage. With modules now divided into topics rather than blocks of time, the learner has the ability to tailor the session to the priority topics and time available. eLearning tools also allow the use of interactive educational techniques along with integration of video and examination. Although it can be a challenge to provide the same Q&A experience of live deliveries, CISC has implemented one-on-one tutoring with the subject matter experts and is developing a knowledge base of questions and responses for the ongoing benefit of course registrants.

With the introduction of updated building and bridge design standards in 2014, and the 2015 National Building Code of Canada in early 2016, the schedule for updating existing courses is very full. Current activities and plans are described briefly in the following paragraphs.

In late 2015, the four design examples in **"Steel Bridges – Design, Fabrication and Construction"** were reworked based on the 2014 CSA Canadian Highway Bridge Design Code and the updated course was delivered to 66 bridge engineers in May 2016. It is now available in Self-Paced Learning. The course is being translated into French and will be developed using eLearning tools by the spring of 2017.

"What's New: CISC Handbook and CSA S16-14" is the first course produced using eLearning tools and available without a live delivery. This course covers the changes in CSA S16-14 and the design of steel members and elements connections using the recently published 11th Edition of the Handbook of Steel Construction. The course is comprised of 9 modules totalling approximately 8 hours of material. It will be available in the CISC Self-Paced Learning Centre in January 2017.

"Connections I" is being updated and re-recorded using eLearning tools but given its length of approximately 40 hours, it will not be ready until the second quarter of 2017. The new CSA S16-14 necessitated the update but the objective is to have it available on a platform where progress can be monitored. The goal of this course is to assist steel industry personnel in their understanding of basic connection design principles, and to design simple welded and bolted connections suitable for fabrication. A French language version of this course will be developed following the English release.

"Connections II" is the second course in the three-level Connections Design Series and intended to develop the skills necessary for the design of more complex welded and bolted steel connections suitable for fabrication. It is also the basis for CISC accreditation as a conventional steel connections designer. A new course leader is in place and will begin the updating and recording in early 2017.

"Seismic Connections for Steel Framed Buildings" is the third course in the Connections Design Series and scheduled for updating in 2017 and release in early 2018. It will be the basis for CISC accreditation as a ductile steel connections designer. The objective is to assist design and fabrication engineers in their understanding of energy-absorbing and elastic connections in Seismic Force Resisting Systems.

"Inspection of Steel Building Structures" is a 4-day classroom style course providing requirements, recommendations and resources for the inspection of the steel-framed buildings. It is also the basis for CISC accreditation as a steel inspector. Now that this course needs to be updated to CSA S16-14, NBCC 2015 and numerous material and welding standards released in the past 2 years, it will be developed using the eLearning platform. This is a perfect course for the integration of video showing all aspects of steel construction onsite. Development work is scheduled to start in January 2017 and the French language version of this course will be updated and developed following the English release.

"Single Storey Building Design" was developed and last delivered live, online in the fall of 2015. Unfortunately, the 2015 NBCC was not published at that time so an incremental update and development for the eLearning platform will begin in the second quarter. A French language version of this course will be developed following the English release.

New webinars in the 1 to 1.5-hour in length range will continue to be produced by CISC and delivered live, online by subject matter experts prior to being added to the Self-Paced Learning Centre. An initial live delivery is in keeping with the timeliness of these focused topics. One of the first will be **"NBCC 2015 Low Hazard and Low Seismicity Procedures", followed by "Bolting Fundamentals"** and **"Welding Symbols"**.

CISC has a significant number of courses undergoing cyclic updates and transitioning to the eLearning platform over the next 2 years. The end result will be better educational products on more convenient and easier-to-use platforms, including mobile devices. And with the knowledge and experience of our hand-picked course leaders and their ability to field question and suggest practical solutions, CISC will continue to be the provider of choice for steel structures education. AS cisc icca

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Continuing Education Courses

SEISMIC DESIGN OF INDUSTRIAL STEEL STRUCTURES + CSA S16-14 ANNEX M

– NEW SELF-PACED LEARNING COURSE –

This 4-hour course presents the seismic design requirements of the National Building Code of Canada 2015 and Clause 27 of CSA S16-14 as these requirements apply to industrial buildings. Seismic base shear calculations are presented for an example mill-type industrial building in Vancouver, Edmonton and Montreal. The results of Equivalent Static Force Procedure and Dynamic Analysis Procedure (Response Spectrum Analysis) for the example building are presented and compared. The choice of Seismic Force Resisting Systems for industrial buildings is discussed and the requirements for each is highlighted.

Annex M of CSA S16-14 is introduced. The provisions of Annex M extend and modify the requirements of Clause 27 of CSA S16-14 as these requirements apply to industrial structures which do not resemble buildings. Seismic Force Resisting Systems, redundancy, damping, effective mass, methods of analysis and vertical earthquake effects are reviewed.

Course Leader:

R. Mark Lasby, B.Sc., P.Eng.

CISC continues to increase the number of courses and seminars available in the Self-Paced Learning Centre, which offers online education that qualifies for Continuing Education Units (CEUs) using video presentations packaged with notes, design guides, assignments, tutoring and examinations where available. Newly added to the portfolio is the updated Industrial Building Design course and the updated Steel Bridges – Design, Fabrication, Construction course. In addition, look for the discounted bundles of Hot Topic Webinars.

For full course and seminar schedule, information, online registration and the latest updates, please visit our website at www.cisc-icca.ca/courses.

WHAT'S NEW: CISC HANDBOOK AND CSA S16-14

This 9-module course covers the changes in CSA S16-14 and the design of steel members and elements connections using the recently published 11th Edition of the Handbook of Steel Construction. It will be available in the CISC Self-Paced Learning Centre in January and optionally, a copy of the new Steel Handbook can be purchased at a discount. Upon completion, the learner will be awarded 0.8 CEUs.

The Handbook of Steel Construction contains detailed information on the design and detailing of structural steel in metric units. The new 11th Edition is intended to be used together with the National Building Code of Canada 2015. Member design tables are based on steel grades ASTM A992, A572 Grade 50, A913 Grade 65, A500 Grade C and CSA G40.21-350W.

The 9 modules will cover:

1. Handbook Overview
2. Part 1 - Changes to CSA S16-14
3. Part 2 - CISC Commentary on CSA S16-14
4. Part 3 (a) - Bolt and Weld Data
5. Part 3 (b) - Framed Beam Shear Connections
6. Part 4 - Compression Members
7. Part 5 - Flexural Members
8. Part 6 - Properties and Dimensions
9. Part 7 - CISC Code of Standard Practice and Miscellaneous Data

Course Leaders:

Stephanie D'Addese, M.Eng., P.Eng., Engineer, Solutions Centre, CISC

Charles Albert, M.Sc.E., P.Eng., Manager of Technical Publications and Services, CISC

STEEL BRIDGES – DESIGN, FABRICATION, CONSTRUCTION

– NEW SELF-PACED LEARNING COURSE –

This 16-hour course covers the design, fabrication and construction of steel bridges based on CAN/CSA-S6-14, Canadian Highway Bridge Design Code. The course provides understanding of design theory and the rationale behind Code provisions as well as the application of specific Code formulae and requirements. The practical and economical aspects of fabrication, erection, choice of material and their impact on design have been emphasized.

The presentations and the Course Notes include four updated design examples illustrating extensive design calculations for I-girders and box girders of straight and curved configurations. Topics include fatigue and brittle fracture, integral abutments, aesthetics, design process and economics, highway bridge loads and methods of analysis, I-girder design, straight and curved box girder design, wind and seismic effects, fabrication and economical details, construction and erection methods, and an architectural perspective on pedestrian bridges.

Major changes and new provisions that were introduced in the 11th edition of CAN/CSA-S6 and their effect on the design of steel girders are highlighted.

Course Leaders:

Gilbert Grondin, Ph.D., P.Eng., Senior Bridge Engineer, AECOM

Paul J. King, M.S., P.Eng., VP Engineering, Rapid-Span Structures Ltd.

James Montgomery, Ph.D., P.Eng., Principal, DIALOG

Terri Meyer Boake, M.Arch., LEED AP, Professor of Architecture, University of Waterloo

COMMON CODES AND STANDARDS FOR DESIGN AND CONSTRUCTION OF STEEL STRUCTURES

Current Status and Future Publication Targets

Code/Standard/Supplement/ Commentary/Referenced Document	Current Edition	Next Edition/Revision	Publication Target
National Building Code of Canada (NBC)	NBC 2015	NBC 2020	Dec. 2020
NBC Structural Commentaries (Part 4 of Div. B)	NBC 2010 Str. Comm.	NBC 2015 Str. Comm.	Early 2017
CSA S16 Design of Steel Structures	CSA S16-14	CSA S16-19	2019
CISC Commentary on CSA S16 (Part 2 of CISC Handbook of Steel Construction)	CISC Handbook 11th Edition[1]	TBA	
CISC Moment Connections for Seismic Applications	2nd Edition[2]	TBA	
CSA S6 Canadian Highway Bridge Design Code	CSA S6-14	CSA S6-19	
CSA S6.1 Commentary on Canadian Highway Bridge Design Code	CSA S6.1-14	CSA S6.1-19	
CSA G40.20/G40.21 General Requirements for Rolled or Welded Structural Quality Steel/Structural Quality Steel	G40.20-13 G40.21-13	TBA	
CSA W59 Welded Steel Construction (Metal Arc Welding)	CSA W59-13	CSA W59-18	2018
CSA W47.1 Certification of Companies for Fusion Welding of Steel	CSA W47.1-09 (R2014)	TBA	
CSA S136 North American Specification for the Design of Cold-Formed Steel Structural Members	CSA S136-16	TBA	
CSA S136.1 Commentary on CSA S136	CSA S136.1-16	TBA	

[1]*CISC Handbook of Steel Construction - 11th Edition includes CSA S16-14, its Commentary, CISC Code of Standard Practice - 8th Edition (new), and design and detailing aids in accordance with CSA S16-14*

[2]*Adopted in S16-14 by reference*

CISC Atlantic Region Steel Design Awards recognize excellence and innovation in steel design and construction!

Two outstanding projects were awarded the CISC Atlantic Region Steel Design Awards of Excellence in Structural, Architectural, and Bridge categories in 2016. Congratulations to the following:

HALIFAX PUBLIC LIBRARY (2 AWARDS)
CATEGORIES: Structural & Architectural

Opened in December 2014, the stunning Halifax Central Library in Nova Scotia, Canada, is the hub of the city's library system. CNN ranked it as one of the world's top 10 eye-popping new buildings of 2014. Structural and civil engineers found novel and sustainable solutions to successfully deliver the building's complex, cantilever geometry. This vital centre for learning and culture blends the best of traditional library services with innovative spaces and the latest technology.

OWNER: HALIFAX REGIONAL MUNICIPALITY **ARCHITECT:** FOWLER BAULD AND MITCHELL LTD. ARCHITECTURE & INTERIORS **STRUCTURAL ENGINEER:** SNC LAVALIN INC.**GENERAL CONTRACTOR:** ELLISDON **FABRICATOR, DETAILER & ERECTOR:** CHERUBINI METAL WORKS LIMITED

STRANDHERD ARMSTRONG BRIDGE ERECTION
CATEGORY: Bridge

The Strandherd Armstrong Bridge is a vital link across the Rideau River. The bridge provides the missing link between the southwest and southeast transit corridors in the city of Ottawa and is a necessary piece of infrastructure to reduce the increasing pressure on existing bridges. Innovative construction and erection designs coupled with the efficient use of steel was essential for this project as access below the bridge was restricted during construction.

OWNER: CITY OF OTTAWA **ERECTION/CONSTRUCTION ENGINEERS, PSS CABLE SPECIALISTS, BRIDGE SPECIALIST QUALITY ASSURANCE ENGINEER:** HARBOURSIDE ENGINEERING CONSULTANTS **BRIDGE DESIGNER:** PARSONS (FORMERLY DELCAN) **GENERAL CONTRACTOR:** HORSESHOE HILL CONSTRUCTION **STEEL ERECTOR:** MONTACIER INTERNATIONAL **STEEL FABRICATOR:** CHERUBINI METAL WORKS **STEEL DETAILER**: TENCA STEEL DETAILING **PSS CABLE SUPPLIER:** FREYSSINET INTERNATIONAL

CISC STRUCTURAL STEEL EPDS

The CISC has developed six verified and registered industry average Environmental Product Declarations (EPDs) for the following primary products for both painted and unpainted applications:

- Fabricated Hot Rolled Structural shapes
- Fabricated Hollow Structural Sections (HSS)
- Fabricated Structural Plates

These EPDs are available from authorized CISC Fabricators. For more information and a list of authorized fabricators visit: http://cisc-icca.ca/sustainability/epd

SAVE THE DATE- CISC NATIONAL STEEL CONFERENCE, CALGARY SEPT 27-29, 2017

With a new format open to the entire Canadian construction industry, the CISC National Steel Conference has been redesigned to offer more leading edge educational, networking and business development opportunities. Stay tuned for more details!

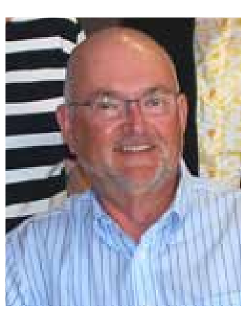
CISC HOSTS SOLD OUT SEMINAR, "BUILD IT BETTER WITH STEEL" AT CONSTRUCT CANADA ON NOVEMBER 30, 2016!

Our well attended seminar made the case for why steel should be the material of choice from a design, performance, sustainability, cost, and safety perspective with presentations from our panel of architectural, engineering, manufacturing, and sustainability experts. We had great traffic at our booth and connected with various stakeholders ranging from government, builders/owners to consultants and students.

CHANGING OF THE GUARD AT CISC EDUCATION & RESEARCH

David MacKinnon, CISC Director of Education & Research, has retired, with Mark Lasby joining us as the new manager.

David MacKinnon, a 30-plus year veteran of the CISC who has held progressive roles in various capacities during his tenure, went on his well deserved retirement at the end of last year. We wish Dave all the best as he begins this new chapter in his life.



David MacKinnon, P.Eng.

The CISC is pleased to announce the appointment of R.Mark Lasby, P.Eng as our new Manager of Education & Research. Mark has been a senior structural engineer and project lead, and has 36 years of experience in the planning, design, sub-consultant coordination, construction, and contract supervision of a variety of industrial, civil, commercial, recreational, and institutional projects.

Mark graduated from the University of Alberta in 1977 with a B.Sc. Honors in Civil Engineering. He has worked for a number of consulting engineering firms and EPC (engineering, procurement and construction) firms in Alberta and British Columbia. Mark recently retired from Fluor Canada. Welcome to the CISC, Mark!

R. Mark Lasby, P.Eng.

CONGRATULATIONS TO THE WINNERS OF THE 2016 CISC NATIONAL STEEL DESIGN AWARDS OF EXCELLENCE

COGECO AMPHITHEATRE
CATEGORY: Architectural

Photo © Marc Gibert / adecom

PROJECT TEAM

OWNER: CITY OF THREE RIVERS, QUEBEC **ARCHITECT:** PAUL LAURENDEAU/ FRANCOIS BEAUCHESNE / CONSORTIUM OF ARCHITECTS **ENGINEER:** STANTEC / DPHV **FABRICATOR:** CANAM-BUILDING, A DIVISION OF CANAM GROUP **DETAILER:** GENIFAB **ERECTOR:** MONTACIER

STRANDHERD – ARMSTRONG BRIDGE
CATEGORY: Bridge

PROJECT TEAM

OWNER: CITY OF OTTAWA **ERECTION/CONSTRUCTION ENGINEERS, PSS CABLE SPECIALISTS, BRIDGE SPECIALIST QUALITY ASSURANCE ENGINEER:** HARBOURSIDE ENGINEERING CONSULTANTS **BRIDGE DESIGNER:** PARSONS (FORMERLY DELCAN) **GENERAL CONTRACTOR:** HORSESHOE HILL CONSTRUCTION **STEEL ERECTOR:** MONTACIER INTERNATIONAL **STEEL FABRICATOR:** CHERUBINI METAL WORKS **STEEL DETAILER:** TENCA STEEL DETAILING **PSS CABLE SUPPLIER:** FREYSSINET INTERNATIONAL

QUEEN RICHMOND CENTRE
CATEGORY: Engineering

PROJECT TEAM

OWNER: ALLIED PROPERTIES REIT **ARCHITECT:** SWEENY & CO. ARCHITECTS INC. **STRUCTURAL ENGINEER:** STEPHENSON ENGINEERING LIMITED **PROJECT MANAGER / GENERAL CONTRACTOR:** EASTERN CONSTRUCTION **FABRICATOR:** WALTERS GROUP INC. / CASTCONNEX **DETAILER AND ERECTOR:** WALTERS GROUP INC.

JEANNE AND PETER LOUGHEED PERFORMING ARTS CENTRE
CATEGORY: Sustainability

PROJECT TEAM

ARCHITECT: BR2 **STRUCTURAL ENGINEER:** READ JONES CHRISTOFFERSEN **GENERAL CONTRACTOR:** CLARK BUILDERS **FABRICATOR:** WHITEMUD IW AND CANAM GROUP

For more, visit www.cisc-icca.ca/awards/national/2016

THE 9TH QUÉBEC STEEL SYMPOSIUM

"The Sky is the Only Limit for Steel" during the 9th Québec Steel Symposium. This year's event will be divided into four days, incorporating 4 seasons, 4 conferences, and 4 themes – all about steel.

This new approach includes 3, half-day conferences with 3 hours of continuing education credits and a 4th conference with 5 hours of continuing education credits in the format of "speed meetings".

The first conference is scheduled for Friday, February 17, 2017, 8 am-12 noon at the Montreal Centre-Ville Hotel Europa. For more information, email quebec@cisc-icca.ca, call (514) 909-6186, or visit www.rendezvousacier.com.

2017 CISC MANITOBA & NW ONTARIO STEEL DESIGN AWARDS

Celebrating 21st Century Steel Construction!
Apr 5 – Apr 6, 2017 in Winnipeg, MB. Winnipeg, MB
Plan to join us! Connect and celebrate with the people of steel construction. For information regarding award nominations, sponsorship and tickets – contact Gordie Tumilson at gtumilson@cisc-icca.ca or call 204-297-6275.

NEW CISC MEMBERS AND ASSOCIATES (SINCE SEPTEMBER 16, 2016)

MEMBERS

Fabricator:
Pacific Industrial & Marine Ltd
5105 Tzouhalem Road
Duncan, BC

Livingston Steel Inc.
21 Ottawa Street
Summerside, PEI

Detailer:
Dessins de structures DCA Inc.
788 Chemin Pintendre
Lévis, QC

ASSOCIATES

Builder/Stakeholder:
Paul Daoust Construction & Associates Ltd.
560 Lacolle Way, Suite 101
Ottawa, ON

Manitoba Infrastructure (Water Management and Structures)
600-215 Garry St.
Winnipeg, MB

Consultant Company:
Groupe iGL
1900, rue Royale
Trois-Rivieres, QC

Tower Engineering Group Limited Partnership
1 - 1140 Waverley St.
Winnipeg, MB

Supplier:
Buffalo Inspection Services
8403 Davies Road
Edmonton, AB
(1 Region – AB)

SGS Canada Inc.
3420 boul. St-Joseph Est
Montreal
(1 Region – QC)

Professional Individual:
Ovidiu Serban, P.Eng,
Bone Structure
Laval, QC

Professional Professor:
Abdul Hameed, P.Eng.
Mechanical Engineering
Sheridan College, ON

Ahmed Hamada P.Eng, Civil Engineering
University of Western, ON

Technical Professor:
Jeff Baker
Civil Engineering Technology
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www.cherubinigroup.com

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Charlo, NB 506-684-2765
www.dbminc.ca

MacDougall Steel Erectors Inc. B, P, S
Borden-Carleton, PE 902-855-2100
www.macdougallsteel.com

Marid Industries Limited B, S
Windsor Junction, NS 902-860-1138
www.marid.ca

Modular Fabrication Inc. Br, S
Miramichi, NB 506-622-1900
www.modularfab.com

MQM Quality Manufacturing Ltd. P, S
Tracadie-Sheila, NB 506-395-7777
www.mqm.ca

Ocean Steel & Construction Ltd. - Fredericton Plant
Fredericton, NB 506-444-7989
www.oceansteel.com

Ocean Steel & Construction Ltd. - Saint John Plant B, Br, P, S
Saint John, NB 506-632-2600
www.oceansteel.com

Prebilt Structures Ltd.
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www.prebiltsteel.com

RKO Steel Limited B, Br, S
Amherst, NS
www.rkosteel.com

RKO Steel Limited B, P, S
Dartmouth, NS 902-468-1322

RKO Steel Limited - Plant 2
Dartmouth, NS
www.rkosteel.com

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Riverview, NS
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Tek Steel Ltd. S
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www.teksteelltd.com

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www.groupecanam.com

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Lainco Inc. B, Br, S
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Les Aciers Fax inc. B, S
Charlesbourg, QC 418-841-7771

Les Charpentes d'acier Sofab Inc. S
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Ste-Marie de Beauce, QC

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www.structurescdl.com

Les Structures G.B. Ltée P, S
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www.structuresgb.com

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www.metalperreault.com

Mometal Structures Inc. B, S
Varennes, QC 450-929-3999
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www.nga.qc.ca

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www.pmistructures.com

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www.tecnometal.ca

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www.aclsteel.ca

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Brampton, ON 905-458-7555
www.akalsteel.ca

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www.arkbrostructures.com

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www.coremetal.com

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www.canam-construction.com

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www.centralwelding.ca

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www.cooksvillesteel.com

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www.cooksvillesteel.com

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www.eaglebridge.ca

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Ottawa, ON 613-821-4014
www.fortransteel.com

G & P Welding and Iron Works P, S
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www.gpwelding.com

Gensteel - Division of Austin Steel Group Inc. S
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www.gensteel.ca

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www.iblsteel.com

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www.lambtonmetalservice.ca

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www.laplantewelding.com

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www.linesteel.com

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www.lorvinsteel.com

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www.migsteel.com

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www.marianimetal.com

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www.miragesteel.com

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www.noraksteel.com

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www.behlen.ca

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www.avantisteel.com

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www.arcweld.ca

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www.acierpicard.com

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Daam Galvanizing Inc.
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www.meta-for.ca

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www.ironworkers.org

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