ADVANTAGE STEEL

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CANADIAN INSTITUTE OF STEEL CONSTRUCTION

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STEEL: The Heart and Soul of Elegance

The 2022 CISC Quebec Awards for Excellence in Steel Construction

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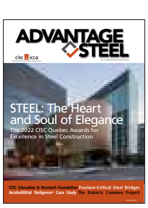

On the Cover:
STEEL: THE HEART AND SOUL OF ELEGANCE
The 2022 CISC QC Awards for Excellence in Steel Construction

The Canadian Institute of Steel Construction (CISC) is the voice for the Canadian Steel Construction industry. The CISC represents a diverse community of structural steel industry stakeholders including manufacturers, fabricators, erectors, service centres, consultants, detailers, industry suppliers, owners and developers. Steel construction industry stakeholders are encouraged to apply to become a member or associate. Visit cisc-icca.ca for more information. If you are working on a project that you think should be featured, send us an email at ciscmarketing@cisc-icca.ca.

ED WHALEN, P.Eng.
President & CEO
CISC-ICCA

Trade Shortage? Time for Changes

"Where did all the trades go?" is a sentiment heard right across the country. The apparent shortage of skilled trades and even apprentices is so great, most companies have resigned themselves to thinking that foreign work is the only cure to the problem.

We have been talking about the aging workforce for decades, and the old adage that we only care when we feel pain has truly proven true in this case. It appears we all woke up after COVID and realized that not only do we have positions we can't fill, but there is also a shortage of interested apprentices wanting to get into our trades. Additionally, every trade across Canada is having the same problem, which means that we have a national problem and a bad one at that.

COVID didn't help. Despite having some of the largest backlogs in decades, getting the new generation interested in construction trades during a lockdown was near impossible. Granted, the federal government's stay-at-home-watch-soap-operas COVID incentive programs did nothing to help us with that. Also, many trade schools were not operating due to the COVID lockdowns, removing two years of cohorts out of the pipeline. Getting kids (and their parents) interested in trades post-COVID seems like a monumental task. I recently heard someone say that kids were more interested in becoming influencers and professional gamers than they are in getting a real job. Parents and high schools are partly to blame, but during the "period of unprecedented times," social media and gaming ruled king and drowned out the real world and thus our problem.

College enrolments in trades have dropped significantly with many looking to drop programs entirely. With 2 to 3 students enrolled, running an expensive welding program is a money loser and will quickly get shut down.

Now, if you are still thinking you will have fully competent tradespersons banging on your door, think again. They are all employed (those interested in working), with only those with challenges, looking for different work or a change of scenery left. These folks are out there, but may be difficult to find and attract.

So, it seems like immigration and temporary foreign workers are the silver bullets to our problem. I would argue it is one of the tools in our toolbox, but not the silver bullet. We will still need to pull and hire from the Canadian base, but it will be more work than in days gone by. Here is my top 10 checklist for making your company more attractive to the next generation and possibly minimizing your trade shortage challenges:

1. Blow up the federal Red Seal Program and revamp trade apprenticeship qualifications in Canada

Plain and simple, to require a tradesperson that has gained their trade journeyperson status in one province to test and challenge the Red Seal exam to work in another province is just plain dumb, bureaucratic and protectionist. Don't complain you can't get workers if you support this. It is time that we pushed to overhaul the training system and recognized a welder journeyperson across Canada no matter where they were trained. A journeyperson continues to learn on the job throughout their career, and there is no one apprenticeship system that is better than the other (sorry folks, there isn't). If we want to take a good dent out of our trade shortage, then enabling full and unfettered mobility across Canada by recognizing all provincial

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MANAGING EDITOR
Hellen Christodoulou, CISC-ICCA
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trades qualifications as equal is the first place to start. A qualified CWB journeyperson welder in Nova Scotia, for example, is as good as a fully qualified journeyperson in other provinces and vice versa. The apprenticeship program is to teach basic skills – not to teach everything – just like universities don't teach engineers everything. The barriers to Canadian trades mobility must be removed now; it is silently killing the ability of our industries to compete.

2. Invest in automation

If trades are scarce, we must reduce our reliance on the number of tradespeople we employ. To do this we streamline our processes and automate. Unlike other construction products, steel is made in a manufacturing setting, not on site with a million workers. It is time to transform our businesses to become more like a manufacturer and less like a fabricator through automation. This will reduce your reliance on the trades but also attract the young generation interested in technology and equipment. The move to automation is happening quickly, and there are many new products out there to partially, or fully, automate a process.

3. Invest in the trades by training in-house

You will always, at least in the foreseeable future, need trades. That said, moving forward you will need to take a more proactive approach when it comes to training. The days of a huge pool of fully qualified and able tradespeople are gone. No longer will you be able to let some other company train for you. Whether it be through the official provincial training apprentice program, or just hiring a recent student graduate (depending on provincial apprenticeship rules), in-house trade training is now a necessity. The CISC is offering federal-sponsored incentives for companies hiring first-year provincial enrolled apprentices. Visit steeltrades.ca for more information. And yes, when the people you train become competent, they may want more money (refer to item 8).

4. Consider sponsoring a foreign worker

In some cases, this is a no-other-option decision. This is not new and has its challenges, but more and more companies are opting to bring in skilled trades from other countries. Many claim foreign workers are excellent at what they do – and work hard – unlike the Canadian youth. There are still challenges and I believe there are local youth that could be great tradespeople but need the opportunity and early guidance and education of trades as a career. Several factors to keep in mind are challenges related to language affecting safety, training and instructions along with cultural factors such as your location, and speed of getting people into the country. A company, several years back, decided to hire foreign workers to fill their local trades shortage, only to receive their first employee over a full year later. For that company, the process was slow and cumbersome, even when using an agent.

5. Consider non-traditional workers – women, new immigrants, Indigenous, etc.

I have recently been surprised in some shops. I saw women, and in those companies, not just one. Have these companies figured out what many others need to realize? Women are an untapped potential workforce resource that we are not marketing to. In addition, we may already have recent immigrants who have landed in Canada with the trade skills we are looking for. Do they know how to find us?

6. Improve your brand online

If you have a brand, the first place potential employees will look is your website. Are you properly marketing your company for your future employees as much as you are for the next job? The youth are online. Do you speak to them through your social media posts? "Social media what?", you say. As much as it pains you, the time has come to showcase your company as a progressive modern and relevant company – a company that future employees would like to see themselves working for. They want clean, high-tech, fun, environmentally responsible and flexible organizations. Now, you may not be willing to go whole hog with all of that but take it day by day and you might be surprised (refer to items 5, 7, 9 and 10).

7. Increase your local community presence

Depending on where you live, your most loyal employees will be the ones that live near you. Yes, you may confine a foreign worker to your location for the short term, but depending on a number of factors they may wish to move on. It has been proven that local people like to stay local. There is no place like home, as Dorothy put it. Take advantage of this by attracting the next gen through their parents and local schools. Having a local and active presence in the community creates awareness of local career opportunities with a brand that parents trust and respect. Don't underestimate the parents.

8. Invest in your local trades college(s)

Colleges are reducing overhead and cutting costs. Their enrolment is dropping. Make sure to be involved with your local college and ensure they know that the trades you need are still being taught. A close relationship with your local trades college teacher will also give you the inside scoop on individuals you should strongly look at (refer to 11).

9. Monitor your wages and benefits and stay locally competitive

This takes work, but if retention is a thing for your company, then you have to do this. Interestingly, it has been shown that employees have difficulty understanding the value of benefits over and above pay (a generality, but true in many cases), so be careful when designing and communicating your compensation package. Keep it simple.

10. Clean up your shop and offices

If your shop and offices look straight out of the 1950s – dark, dirty and dingy – it's time to do some renovations. Add lights, clean the floor, install ventilation or update your kitchen, for example. Do some renovations that make your organization look like it is a modern and exciting place to work. Your existing employees will thank you as well.

11. Work collectively through your local CISC Region to coordinate provincial and local trade hiring initiatives for the benefit of your local needs. AS

Structural Steel Management and Detailing Program (SSMD)

BY :: CRAIG MARTIN, P.Eng.
Chairman of CISC's Education & Research Council

No matter what product or service is delivered by an organization, every business relies on people to do what they do. Today, our industry faces many challenges when it comes to finding the people they need to sustain and grow. We hear almost daily about changing demographics, changing retirement patterns, skills shortages, skills mismatches, employee flexibility and many other variables that impact our industry and the wider Canadian economy. CISC and the Education & Research Council (ERC) have a key focus on attracting and retaining the great people in our industry and supporting them in upskilling and learning throughout their careers in steel.

Recently, the ERC has been working on an innovative new program for CISC members related to the Structural Steel Management and Detailing (SSMD) program at Conestoga College in Kitchener, Ont. This program is a two-year graduate certificate program designed for individuals already holding a diploma or degree in engineering, technology or another relevant field of study, and is focused on specialized training in both the management of steel construction projects and the detailing and fabrication of steel structures.

The program helps fill the demand of our industry for individuals with skills and knowledge unique to the world we operate in. Some of the areas of study include:

- Construction and industry standards;
- Building information modelling software;
- CAD and shop drawings;
- Contract and design documentation review and interpretation;
- Cost estimating; and
- Communication and teamwork.

The SSMD program also recognizes that real-world learning is a critical element in any program, allowing students to connect the dots of the theory and best practice they are learning in real industry scenarios. To accomplish this, the SSMD program has one semester designated as a co-op semester where students work in an industry setting to further develop and demonstrate their skills. It is in this area that the ERC has developed a new program, the SSMD Subsidy Program.

The SSMD Subsidy Program is designed to help support three objectives which are fully aligned with CISC and the ERC, namely:

- Ensure an ongoing source of steel professionals to the steel construction industry
- Show the value of on-the-job training of incoming steel professionals by the industry to drive success
- Safeguard the long-term stability and growth of the steel construction sector

So how does it work? All CISC members and associates may apply for a $3,000 wage subsidy to support their hiring of an SSMD student for their co-op semester. The conditions for acceptance are:

- The applicant must be a CISC member or associate in good standing;
- The student must be currently enrolled in the COOP, SSMD program; and
- At the time of application, the applicant must confirm having provided an offer/conditional offer of employment to the student for the co-op semester.

Applications will be made available to CISC members and associates approximately 3 months prior to the start of the co-op semester and will be awarded on a first come, first served basis to all acceptable applications.

I encourage all members and associates to take advantage of this new program as it both helps support the training of new workers for our industry and helps you find the great people you are looking for. Watch for the release of the application in the coming months!

On behalf of the ERC, I would also like to express our gratitude for the continued support of the CISC and our funding partners. We have accomplished a great deal with your support and are focused on expanding our support to address our industry's changing needs. If you have a passion supporting the next generation of steel professionals and for the future of the Canadian steel construction industry, I encourage you to consider becoming an ERC financial supporter. AS

THANK YOU

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CHARLES ALBERT, P.Eng.
Past Manager of Technical Publications and Services (Retired)
CISC-ICCA

CISC Engineers' Corner

CISC provides this column as part of its commitment to the education of those interested in the use of steel in construction. Neither the CISC nor the author assumes responsibility for errors or oversights resulting from the use of the information contained herein. Suggested solutions may not necessarily apply to a particular structure or application and are not intended to replace the expertise of a licensed professional engineer or architect.

QUESTION 1: In a curved box girder bridge, are the top flange horizontal bracing members required to be notch-tough?

ANSWER: The *Canadian Highway Bridge Design Code* (CSA S6:19) states in Clause 10.13.5:

"Diaphragms, cross-frames, and lateral bracing that are part of the permanent load-carrying system shall be treated as primary structural members and, as such, shall satisfy the material toughness requirements of Clause 10.23.3."

In a typical curved box girder bridge (see Figure 1), prior to composite action, horizontal bracing at the top flange level results in a quasi-closed section, which provides torsional strength and stiffness during construction. As the horizontal bracing is only effective during erection, its structural function will be taken over by the concrete slab in service and is therefore not considered permanent. In that case, the bracing members would not need to be notch-tough.

QUESTION 2: Are W-shape sections produced in Canada? And what about other hot-rolled sections such as HP, M, S, channels (C, MC) and angles (L)?

ANSWER: W-shapes have not been produced in Canada since Algoma withdrew from the rolled shapes market in 1999. Since then, the sections available from Canadian steel service centres have been imported mainly from American mills (e.g., Gerdau, Steel Dynamics, Nucor-Yamato, etc.). Likewise, HP, M and S-shapes are not produced in Canada. Also see pages 6-22 in the 12th *Handbook of Steel Construction* for further information.

Some hot-rolled channels and angles are produced by Gerdau in Whitby and Cambridge, Ont. The C, MC and L-shapes not produced by Canadian mills are identified by an asterisk in the tables of properties and dimensions in Part 6 of the handbook.

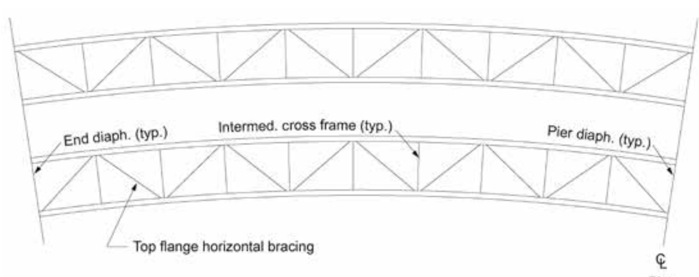


FIGURE 1
Box Girder - Horizontal Bracing.

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.

> “DEPENDING ON THE DETAILS, THE MOMENT IS RESISTED THROUGH ITS BEARING ON THE COMPRESSION SIDE AND BY THE BOLTS (OR WELDS) IN TENSION.”

QUESTION 3: Which design forces should be used for an interior column splice that is finished to bear?

ANSWER: It's assumed here that the spliced member is an axially loaded gravity column that is not part of a ductile seismic system (i.e., not required to be detailed according to S16:19 Clauses 27.1 to 27.11). The requirements of Clause 27.1.4 would apply to gravity column splices unless the structure is designed as *Conventional Construction* based on 27.12.

Clause 21.5 *(Bearing joints in compression members)* does not indicate a defined load to be resisted but states: “Where columns or other compression members bear on bearing plates or are finished to bear at splices, there shall be sufficient fasteners or welds to hold all parts securely in place to provide a satisfactory level of structural integrity…” It's also noted that some Canadian jurisdictions specify a minimum moment resistance for erection safety, such as: “Each column splice shall be designed to resist a minimum eccentric gravity load of 300 pounds (138.2 kg) located 18 inches (0.46 m) from the extreme outer face of the column in each direction at the top of the column shaft.”

In the absence of defined connection forces, Muir (2015) suggests using the moment and shear resulting from a transverse load equal to two per cent of the required compressive strength of the member applied at the location of the splice (*Steelwise, Modern Steel Construction*, AISC, December 2015).

Depending on the details, the moment is resisted through its bearing on the compression side and by the bolts (or welds) in tension. In addition, the splice should possess adequate stiffness to ensure that the column will develop its required strength, which is typically assumed for joints in bearing. AS

CSSBI Engineers' Corner

BY :: BRETT PERRAS, P.Eng.
Senior Engineer, CFS

QUESTION 1: What resources are there for architects to specify interior partitions and what design loads should be used?

ANSWER: When designing non-load bearing interior partitions, one should refer to their local building code to verify the interior wind pressure, seismic force and deflection, which all would be considered in the design of the interior partition.

Once the above criteria have been determined, we would suggest using the tables on the CSSBI website to determine which stud size, gauge and spacing is required for the design loads/criteria determined for the project. These resources can be found within the CSSBI 58-2018, Lightweight Steel Framing Member Selection Tables, "Single Span Curtain Wall Limiting Heights" (see Table 1) available in both metric and imperial.

Additionally, CSSBI Technical Bulletin Volume 7, Number 10, Limiting Height Tables for Composite Non-Structural Walls, utilizes the findings in the ASTM C754, Standard Specification for Installation of Steel Framing Members to Receive Screw-Attached Gypsum Panel Products, to provide limiting height tables. Of note, the tables were derived to account for the composite action of the gypsum panel and the steel framing members. Also, the walls must meet the criteria outlined in the table notes.

Finally, though the architect specifies the depth and spacing of the steel framing member within the interior partition assembly, a qualified engineer must provide all remaining design specifications. Typical partition wall design specifications provided by the engineer are stud flange width, material thickness, bridging requirements and connections.

Table 1: Maximum Application, m, Single Layer of 15.9 mm (5/8 in.) Type X Gypsum Board, Vertical Application, on Each Side of Minimum 0.455mm (0.0179 in.) Base Steel Thickness Steel Studs

Member Designator	Stud Spacing (mm)	0.25 kPa			0.375 kPa			0.50 kPa		
		L/120	L/240	L/360	L/120	L/240	L/360	L/120	L/240	L/360
162S125-18	305	3.89f	3.33	2.95	3.17f	2.91	2.58	2.75f	2.64	
	406	3.37f	3.03	2.68	2.75f	2.64		2.38f	2.38	
	610	2.75f	2.64							
250S125-18	305	4.88f	4.25	3.84	3.98f	3.72	3.35	3.45f	3.38	3.05
	406	4.22f	3.86	3.49	3.45f	3.38	3.05	2.99f	2.99f	2.69
	610	3.45f	3.38	3.05	2.82f	2.82f	2.55	2.44f	2.44f	
362S125-18	305	5.56f	5.00	4.37	4.54f	4.37	3.82	3.93f	3.93f	3.46
	406	4.81f	4.55	3.97	3.93f	3.93f	3.46	3.40f	3.40f	3.11
	610	3.93f	3.93f	3.46	3.21f	3.21f	2.97	2.78f	2.78f	2.68
400S125-18	305	5.75f	5.26	4.60	4.69f	4.60	4.02	4.06f	4.06f	3.65
	406	4.98f	4.78	4.18	4.06f	4.06f	3.65	3.52f	3.52f	3.31
	610	4.06f	4.06f	3.65	3.32f	3.32f	3.17	2.87f	2.87f	2.87
600S125-18	305	6.91f	6.85	5.98	5.64f	5.64f	5.22	4.88f	4.88f	4.74
	406	5.98f	5.98f	5.43	4.88f	4.88f	4.74	4.23f	4.23f	4.23f
	610	4.88f	4.88f	4.74	3.99f	3.99f	3.99f			

QUESTION 2: Are you aware of any standards/details for cutting holes through the webs of cold-formed steel studs?

ANSWER: With respect to a standard for cutting holes in lightweight steel framing studs, there are few resources which can be referenced.

First off, there is a difference between the standard punch-outs found in lightweight steel framing. In both the AISI S220 and S240 standards, Section A5.9 outlines the limitations of punch-outs respectively. Punch-outs must not have a width exceeding half of the member width to a maximum of 64 mm (2-1/2") and must not have a length exceeding 114 mm (4-1/2") (refer to Figure A4-1, AISI S230-19 Standard for Cold-Formed Steel Framing-Prescriptive Method for One- and Two-Family Dwellings).

Holes in the web, however, are outlined in the AISI S220 and S240 under section C2.1. This indicates that web holes must be performed meeting an "approved design/standard." Additionally, in section C2.2, the cutting of framing members must be completed by sawing, cutting or by approved cutting methods to create the web holes.

In AISI S230-19 Standard for Cold-Formed Steel Framing-Prescriptive Method for One- and Two-Family Dwellings section A4.5 Web Holes, the acceptable web holes are defined as holes in the webs of joists which must not be larger than 38 mm (1-1/2") and be a distance of 254 mm (10") from the bearing edge (See Figure A4-2). If holes exceed the conditions outlined in Section A4.5, then sections A4.6 and A4.7, for Hole Reinforcing and Hole Patching, must be followed.

Within AISI S230-19 sections A4.6 web holes are deemed repairable rather than replaceable if the following conditions are satisfied: a) the hole is located within the middle 40 per cent of the span, and b) the length and depth of the hole is less than 65 per cent of the width of the web. Reinforcing is achieved using C-shape sections or steel plates when the hole size does not exceed the member limitations. The minimum thickness to be used for the reinforcing shall match the member being repaired, at a minimum, and must extend a minimum of 25 mm (1") beyond all sides of the hole. The reinforcing must also be fastened to the member under repair with No. 8 screws spaced at a maximum of 25 mm (1") on center around the hole and with a minimum edge distance of 13 mm (1/2") to the hole.

For Hole Patching requirements, refer to AISI S230-19 Section A4.7. Members must be replaced or designed with acceptable engineering principles if the hole exceeds 70 per cent of the web width or if the length of the hole exceeds 254 mm (10") or the depth of the web.

Lastly, the CFSEI Technical Note: Design Methodology for Hole Reinforcement of Cold-Formed Steel Bending Members (Tech Note G900-15) outlines how to design/repair unreinforced web holes. AS

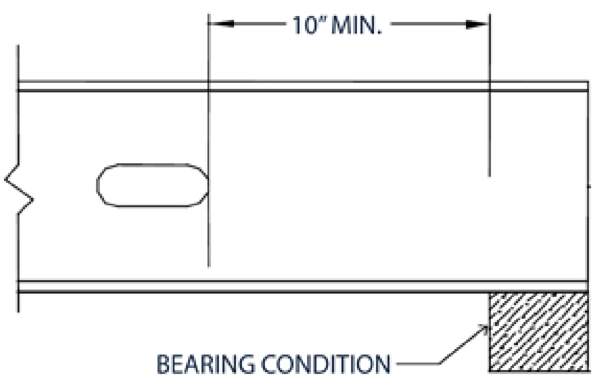


FIGURE A4-2 Web Hole Limitation Adjacent to Bearing (AISI S230-19 Standard for Cold-Formed Steel Framing-Prescriptive Method for One- and Two-Family Dwellings).

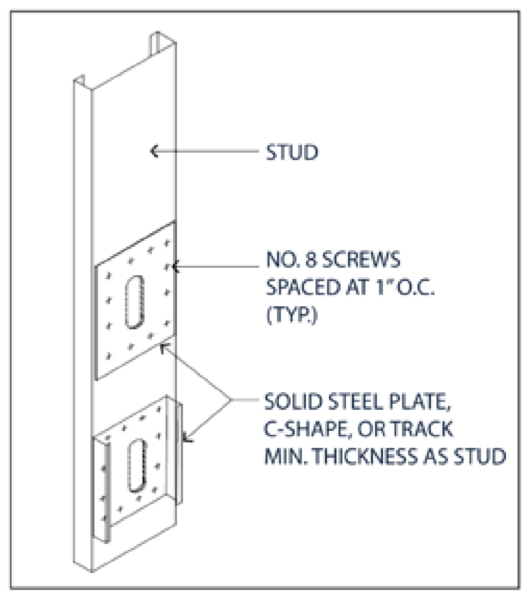


FIGURE A4-3 Stud Web Hole Patch (AISI S230-19 Standard for Cold-Formed Steel Framing-Prescriptive Method for One- and Two-Family Dwellings).

"THE MINIMUM THICKNESS TO BE USED FOR THE REINFORCING SHALL MATCH THE MEMBER BEING REPAIRED, AT A MINIMUM, AND MUST EXTEND A MINIMUM OF 25 MM (1") BEYOND ALL SIDES OF THE HOLE."

CISC'S COMMITMENT TO EDUCATION & RESEARCH

The CISC Education & Research Foundation is a firm believer in investing in our tomorrow today. We are committed to excellence in design and construction in the steel industry, as well as ensuring quality for the future. We remain dedicated to supporting the next generation of steel professionals through various programs and direct funding for research and education at leading Canadian educational institutions.

Our Education & Research programs continue to help students and steel professionals discover innovative steel solutions to solve the most complex design and construction challenges while positioning steel as the material of choice.

The competition aims to introduce architecture students with the use of exposed structural steel and show them the design potential in terms of formal expression, detail and surface finish. The design must demonstrate an understanding of the properties and possibilities steel has to offer. The competition theme requires students to elaborate a structural grid with steel elements, design buildable connections and collaborate with a steel fabricator to choose the steel members and the connections.

In 2022 there were three winners. For all the three projects the advisor was Terri Meyer Boake, BES BArch MArch LEED AP, Professor, School of Architecture, University of Waterloo.

CONGRATULATIONS TO THE 2021-2022 CISC ARCHITECTURAL STUDENT DESIGN COMPETITION WINNERS

1st Prize: FIRE BIRD
$8,000 (team) - $2,000 (sponsor)
Owen Gideon Melisek and Silas Clusiau

2nd Prize: THE GRAND CROSSING
$4,000 (team) - $1,000 (sponsor)
Cindy Ma and Luna Hu

3rd Prize: BRIDGE NO. 4
$2,000 (team) - $500 (sponsor)
Jeffrey Yau and Ernest Lee

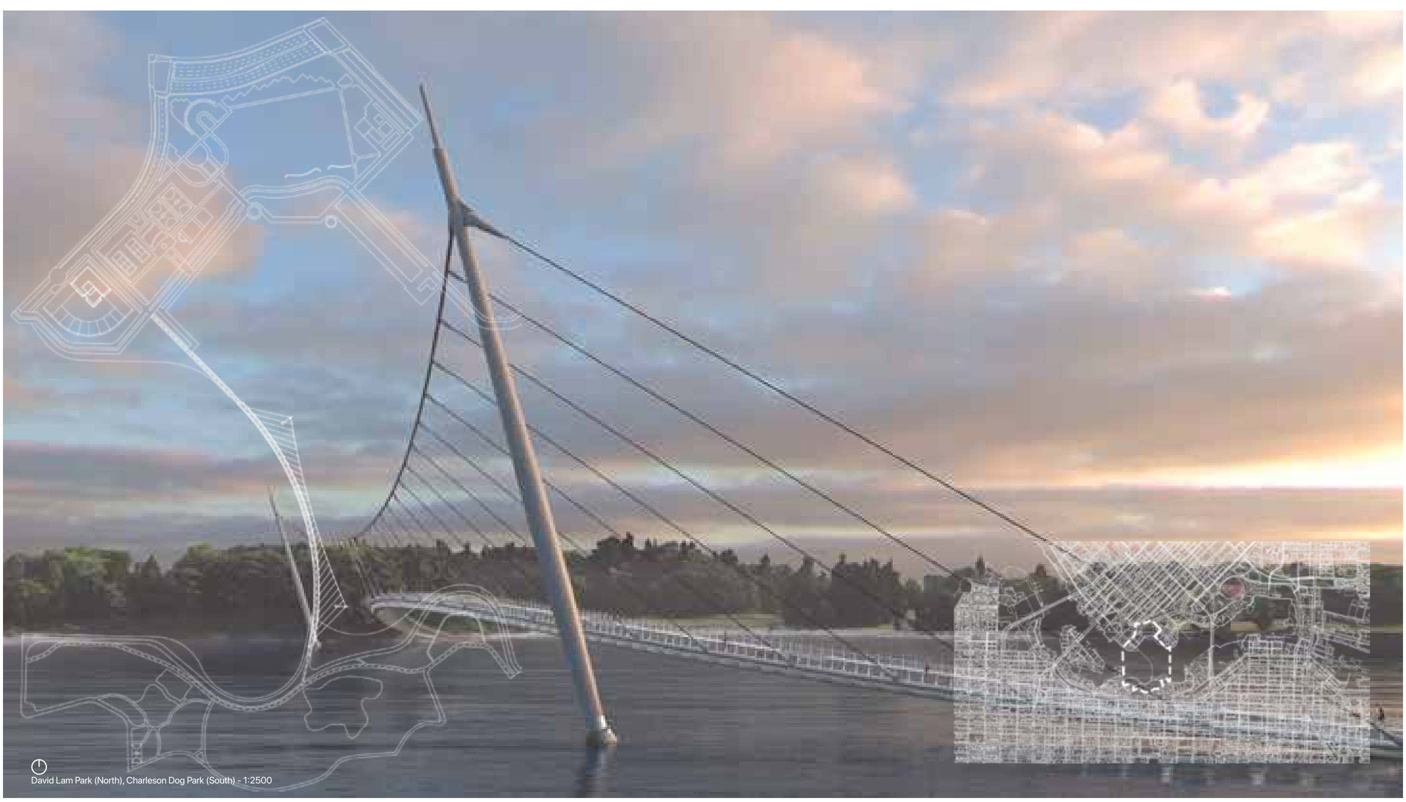
2022 - CANADIAN NATIONAL STUDENT BRIDGE COMPETITION

Canadian Institute of Steel Construction (CISC)'s Education & Research Council offers Canadian team sponsorship, awards and prizes, all with the support of industry sponsors and major sponsors as the CWB. The 2022 competition was held May 13-15, 2022, at the University of Sherbrooke in Québec.

This year **$1,000** was given to each of the following teams:

University of Western Ontario
UBC Steel Bridge
University of Saskatchewan Bridge Team
University of Waterloo
Université de Sherbrooke
École Polytechnique de Montréal
University of Manitoba
University of Calgary

In addition, two new **$2,500** awards for a total of **$5,000** were presented at this year's National Steel Bridge Competition to recognize both the Canadian team with the highest combined scores in construction economy and structural efficiency and the overall best Canadian team. Both prizes went to UBC Steel Bridge.

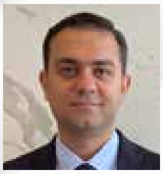


Bridge No. 4

Lined with lively parks, pedestrian paths and bike-ways, the past century has seen False Creek transform from industrial port lands into one of the most sought after residential and recreational areas of Vancouver. However, bridge infrastructure in the area has not kept up. False Creek is serviced by three high-level bridges, all of which are car centric in design and pre-date the area's transformation into an art, culture, and civic centre. Pedestrians and cyclists are pushed to the far edges of these freeways, and their height necessitates long and steep ramps, which takes up valuable civic space, detracts value from an increasingly sought after location and deters pedestrians and cyclists from using them. It has been argued that low-level bridges are not suitable for False Creek due to the inability for sailboats to pass through. However, as demand for sustainable connectivity through False Creek continues to rise, the need to provide enhanced pedestrian and cyclist circulation may begin to supersede the priority of sailboats. Bridge No. 4 explores this possibility of a more connected False Creek, whilst simultaneously serving as a potential new landmark for Vancouver.

2022 G.J. JACKSON FELLOWSHIP

The G.J. Jackson Fellowship is awarded annually in memory of the late Geoffrey Jackson. Mr. Jackson was a leader in the Canadian structural steel fabrication industry for many years and was a founding member of the Steel Structures Education Foundation (SSEF) now overseen by CISC Education & Research Council. This prestigious award is currently valued at $25,000 over a one-year period and is presented annually to an engineering student who, in the following academic year, will be registered in the first to fourth year of full-time graduate studies in structural engineering, with major emphasis on the study of steel structures.



CONGRATULATIONS TO THE 2022 WINNER OF THE G.J. JACKSON FELLOWSHIP

Bashar Hariri
Winner: $25,000
Ph.D. candidate (4th year)
Polytechnique Montréal
Supervisor: Robert Tremblay, B.Sc.A. (Laval), M.Sc. (Laval), Ph.D. (UBC), Professor, École Polytéchnique

G.L. KULAK SCHOLARSHIP

The G.L. Kulak Scholarship is an annual award available to post-graduate students doing research in structural steel. After careful consideration of six applications, the Alberta region's Education & Research committee selected Baha Essa as the winner of the $15,000 scholarship.

CONGRATULATIONS TO THE 2022 WINNER OF THE G.L. KULAK SCHOLARSHIP:

Maha Essa, E.I.T.
Structural Engineering M.Sc. Student
Department of Civil and Environmental Engineering, University of Alberta
Winner: $15,000
By CISC Alberta region
Supervisor: Dr. Ali Imanpour, Ph.D., P.Eng.
Assistant Professor: Faculty of Engineering - Civil and Environmental Engineering Dept.

CISC RESEARCH GRANTS

The Research Grants program was created to support the research at Canadian universities and technical colleges on topics that are of interest and importance to the steel industry. Over 100 research grants have been awarded since 1995 to full-time members of engineering faculties of Canadian universities. As of 2016, the program has been opened to qualified technical colleges.

Total amount granted in 2022: **$90,400**

2022 Recipients
McMaster University
Polytechnique Montréal
University of British Columbia
Dalhousie University
University of Victoria

CISC's Education & Research Foundation

The CISC research grants have an immeasurable value to the advancement of the use of steel in construction

BY :: HELLEN CHRISTODOULOU, PH.D. Ing., B.C.L., LL. B, M.B.A.
Director, Steel Market and Industry Development
Canadian Institute of Steel Construction (CISC-ICCA)

In partnership with the steel industry, the CISC's Education & Research Foundation awards research grants that have an immeasurable value to the advancement of the use of steel in construction. The Research Grants program was created by the CISC to support research at Canadian universities and technical colleges. This commitment to research on topics that are of interest and importance to the steel industry is critical for building the future of the steel construction industry. Over 100 research grants have been awarded since 1995 to full-time members of engineering faculties of Canadian universities, and as of 2016, the program has been opened to qualified technical colleges.

The CISC remains at the forefront of technical knowledge by supporting innovative, pertinent and industry-leading research advancements that address industry needs for development, geared towards providing support to those who are dedicated to the improvement of steel construction. This support, with direct funding for research targets, works to solve complex design and construction challenges, and continues improvements for the design of steel structures.

One of these grants was for the DESIGN OF SINGLE-SIDED FILLET WELDS IN TENSION to Professor Dr. Kyle Tousignant, Department of Civil and Resource Engineering, Faculty of Engineering. The full published paper is available and can be viewed here: ascelibrary.org/doi/abs/10.1061/%28ASCE%29ST.1943-541X.0003415

Brief Synopsis: **Excerpts used from original paper authored and published by Justin H. Thomas and Kyle Tousignant, Ph.D., P.Eng., A.M.ASCE.**

In North America, fillet welds connecting structural elements can be designed using a "directional strength increase" factor ($1.00+0.5\sin1.5\theta$) that permits engineers to take advantage of a 50-per-cent "strength increase" when load is applied perpendicular (i.e., at $\theta = 90°$) to the weld axis. This factor is included in CSA S16-14 Clause 13.13.2.2, AISC 360-16 Section J2.4b, and AWS D1.1-15 Clause 2.6.4.2 [1-3]. The directional strength-increase (or "sinθ") factor is based on testing of lapped splice and cruciform connections, where fillet welds were made on both sides of a plate loaded in tension (Figs. 1a, b) [4-11]. Recently, CSA S16 and AISC 360 code committees have re-opened discussion about the applicability of the sinθ factor in design codes, due to concerns that it may be unsafe for single-sided fillet welds (i.e., welds made on one side of a structural element) connected to an element in tension (Fig. 1c).

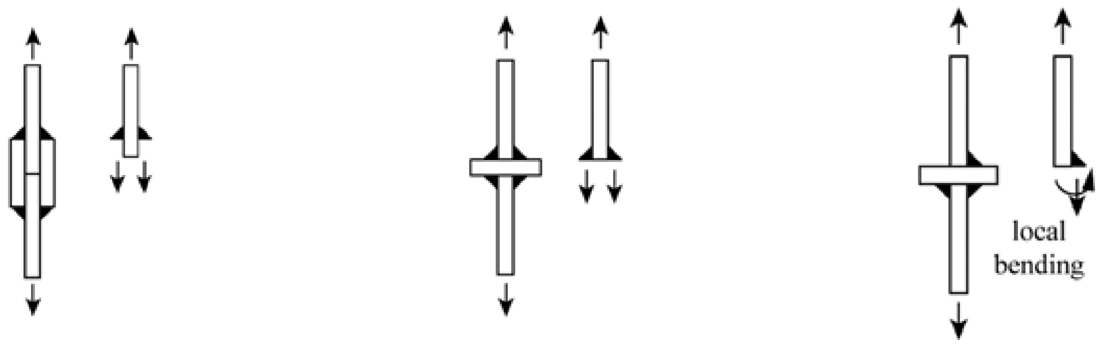
Unlike their two-sided counterparts (Figs. 1a, b), single-sided fillet welds are inherently "eccentrically loaded," and prone to local bending about their axis (or rotation about the weld toe) (Fig. 1c). This can subject the weld to additional tensile stress at its root, and significantly reduce its capacity [3,12]. Cautionary (but vague) comments addressing this issue are found in modern steel design codes. For example:

AISC 360-16 [2] Commentary to Section J2b: "The use of single-sided fillet welds in joints subject to rotation around the toe of the weld is discouraged."

AWS D1.1-15 [3] Section 2.6.2: "In the design of welded joints, the calculated stresses shall include those due to eccentricity

THIS RESEARCH WAS AIMED TO HELP RESOLVE THE DISPARITY BETWEEN RECENT RESTRICTIONS TO THE SINθ FACTOR IN CSA S16-19 AND AISC 360-22, AND POTENTIALLY ALLOW FOR MORE LIBERAL USE OF A "DIRECTIONAL STRENGTH-INCREASE" FOR SINGLE-SIDED FILLET WELDS.

FIG. 1: FILLET-WELDED CONNECTIONS



(a) Lapped splice connection, welded on both sides.

(b) Cruciform connection, welded on both sides.

(c) Cruciform connection, with a single-sided fillet weld.

caused by alignment of the connected parts, size and type of weld(s).”

CSA W59-18 [13] Clause 4.1.3.3.2: “Single fillet and single partial joint penetration groove welds shall not be subjected to bending about the longitudinal axis of the weld if it produces tension at the root of the weld.”

EN 1993-1-8 [12] Clause 4.12: “Local eccentricity should be taken into account where a tensile force transmitted perpendicular to the longitudinal axis of the weld produces a bending moment, resulting in a tension force at the root of the weld.”

Recent experiments and numerical (finite element) analysis on single-sided fillet welds around the ends of hollow structural sections (HSS) have confirmed that bending about the weld axis occurs when the HSS is in tension [14,15]. Furthermore, it has been shown that such welds, to rectangular HSS, do not develop the 50-per-cent strength increase at failure predicted by the sinθ factor [15]. Based on this evidence, the CSA S16 Code Committee has opted to exclude/prohibit the (1.00+0.5sin1.5θ) factor for the design of all single-sided fillet welds to an element in tension (i.e., not just those to the ends of rectangular HSS members) in CSA S16-19 [16].

In contrast, AISC Task Committee 6 (Connection Design) has recommended to exclude the sinθ factor only for the design of fillet welds to tension-loaded rectangular HSS walls in AISC 360-22. While both restrictions are rational, the speculative one being imposed by CSA (covering all single-sided fillet welds) stands to increase weld sizes in a great number more connections (by up to 50 per cent) – possibly without merit. What clearly is now needed as a long-term objective is to understand the behaviour of single-sided fillet welds – to resolve this disparity between CSA S16 and AISC 360. A succession of projects will follow to examine the effect of several factors that affect weld strength, including loading angle (θ); however, it is proposed to initially target research towards single-sided fillet welds loaded in "tension" (i.e., transverse fillet welds, with $\theta = 90°$), as such welds will be indicative of the behaviour of single-sided fillet welds under other loadings (i.e., $\theta < 90°$).

Scope and objectives of the research project

The primary objectives of the proposed research project were:

1. To determine the effect of key connection parameters on the strength of single-sided fillet welds loaded in tension.
2. To compare the strength of such welds to those made on both sides of the same structural element.
3. To determine the inherent reliability (safety index) of current code equations (with and without the sinθ factor) for the design of single-sided fillet welds loaded in tension (across a range of connection parameters); and
4. To recommend economical, yet safe, rules for their design that are calibrated to currently expected safety index levels (e.g., safety index ≥ 4.5 in Canada, per Annex B of CSA S16-14 [1]).

The Goal

This research was aimed to help resolve the disparity between recent restrictions to the sinθ factor in CSA S16-19 and AISC 360-22, and potentially allow for more liberal use of a "directional strength-increase" for single-sided fillet welds. This will enhance fabrication economy by reducing required weld sizes and, in turn, welding labour and material costs [17,18], and help maintain the competitiveness of steel structures.

Results

As published in the ASCE J. Struct. Eng., 2022, 148(9): 04022118, the results of this study showed that current North American fillet-weld design provisions meet/exceed the target safety index (i.e., θ ¼ 4.0) specified by North American codes (e.g., CSA S16 and AISC 360) for linear (as opposed to curved elements) provided that (1) the sin θ factor is not used, and (2) tension due to bending at the weld root is avoided. Moreover, single-sided fillet-welded joints that are tensile stresses at the root are strongly discouraged. AS

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FEATURE

ArcelorMittal Steligence® Case Study: 22-Storey Residential

Breaking down barriers between flexibility, economics, sustainability and creativity

BY :: KELLY PARKER

In several areas of Canada, demand for housing outstrips supply and cost exceeds the budgets of many, underscoring the urgency with which cost-effective, easily erected residential solutions need to be identified. Steel can be used to build multi-storey residential buildings quickly, economically and sustainably, but how does it stack up against a concrete-based design in terms of speed of erection, cost and environmental impact? To compare the merits of primarily steel construction versus concrete, ArcelorMittal Dofasco conducted a Steligence® case study, evaluating a hypothetical 22-storey residential building within the Greater Toronto and Hamilton Area (GTHA), a region where housing issues are becoming increasingly acute.

Steligence is a science-based philosophy that proposes an approach to construction which considers buildings holistically, breaking down barriers between competing issues such as flexibility, economics, sustainability and creativity. Steligence evaluates the cost of the building, the weight of the structure, speed of construction and the environmental impact," explains ArcelorMittal Project Manager Capucine Lardinois, who adds, "the goal of Steligence is to promote the advantages of steel for construction, but the ultimate goal is to bring a construction team together to collaborate and to consider alternative building solutions as compared to today's traditional ways of building. The case study demonstrated the benefits of using steel in this type of construction."

The study compared two unique building scenarios: a steel-based design versus concrete, with only the structural elements significantly altered; the appearance, size, floors and number of units remained the same. Evaluating aspects including construction time, cost to build and environmental impact, the study concluded that the steel-based design took less time to build, realized cost savings, and its environmental impact was reduced.

Although steel construction isn't new, pinning down even an estimated ratio of concrete buildings versus steel buildings relative to current design and construction practices is difficult. "We tried to find those values," notes Lardinois, "but unfortunately, they are difficult to find. There's also the fact that when we refer to steel buildings, we might only be referring to the structure itself, or maybe just a steel-concrete component floor integrated into a concrete structure, so it's difficult to refer to it as a steel building, since most buildings are truly based on a hybrid of construction materials."

"WE WANTED TO EVALUATE ALL OF THESE ASPECTS COMPARED TO CURRENT PRACTICES, AND WHEN WE LOOKED AT THE RESULTS, WE WERE QUITE PLEASED TO SEE THAT WE WERE COST-COMPETITIVE AND THAT THE SPEED OF ERECTION WAS FASTER."

– CAPUCINE LARDINOIS

Lardinois points out that geographical location plays a role. In New York City, for instance, new construction is mainly done in steel, whereas in Ontario steel is used for commercial, industrial and community-use buildings. "We know that the ratio is lower for steel in the multi-family residential market; those structures are mainly concrete. That's one of the reasons we wanted to conduct this case study, which is to gain some understanding about why that is and to demonstrate why steel is competitive compared to concrete."

"We didn't know what the results might reveal," stresses Lardinois, "and we were wondering, was steel too expensive, or was erection too slow? We wanted to evaluate all of these aspects compared to current practices, and when we looked at the results, we were quite pleased to see that we were cost-competitive and that the speed of erection was faster. Regarding the environment, we were guessing that we would be better than concrete, and in the context of improving on the embodied carbon of buildings, I think the study reveals that steel buildings are positioned well."

This particular study was a virtual showcase, although the ArcelorMittal Steligence® team has plans to realize an actual building project using the Steligence® evaluation concept. "More specifically," details Lardinois, "the case study was designed and conducted as though these were real projects, evaluating the full building, including all of the different aspects of a real build such as architectural, structural, mechanical and electrical design. We also established a cost estimate and construction schedule as though these were to be real-life builds, but for this study, everything was virtual."

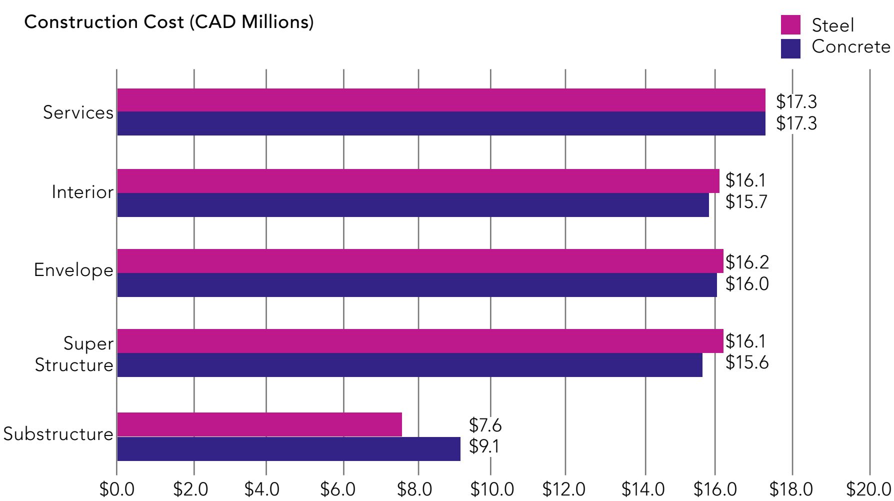
The study established that each building measured 441,000 sf, contained 288 units and included two levels of parking. The architect with whom ArcelorMittal was collaborating has been working on a variety of similar structures

	Steel	Concrete
Structure	225	275
Façade	294	315
Overlap	-88	-132
Structure + Facade	431	458
Building Overall	616	641

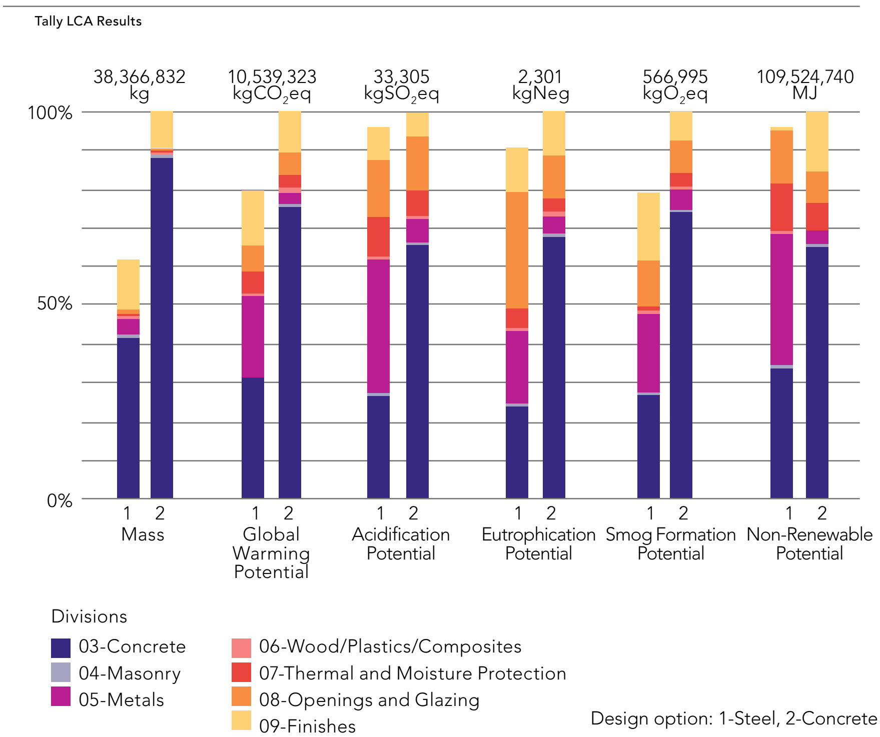
The steel building has a five-week advantage (units are in days).
Construction Schedule Source: MPa Project Consulting.

and was asked to provide a design that was reflective of the current market, and which would resonate with the typical developer approach. "That would include the type of material that would be competitive with steel," details Lardinois, "which is usually cast-in-place concrete in the GTHA. As far as the exact numbers regarding square footage, number of units and parking, those would be based on the market knowledge on their end. With respect to the affordability aspect, I know that the design was focused on the efficiency of the floor plans, and of land use in addressing housing needs."

The team wanted the two buildings studied to be very comparable, with the only difference between the two being the structure. "With respect to the floors, for instance," explains Lardinois, "instead of cast-in-place concrete, we used a composite steel joist system – composite being a concrete-steel floor – combining steel joists, steel deck as permanent form and reinforced concrete. The structure, including the columns, beams and bracing systems, are made with structural steel sections. The same exterior façade was used for both structures in the study and that's a steel panel façade for both. The interior walls for both structures are the same, using the typical light steel framing."



Source: Preliminary Construction Cost Estimate by Altus Group.



Lardinois stresses that the steel building in the study did not employ decarbonized steel because the team wanted the study to be representative of the current market. "With the environmental analysis, for example, we used industry average data for all materials, and 20-per-cent reduction of global warming potential (embodied carbon) was obtained for the steel design building compared to the concrete design. If we had used decarbonized steel such as ArcelorMittal XCarb™ in the study, the global warming potential that is reflected in the graph relating to the steel structure would be lower in the Tally® Life Cycle Assessment result. However, we needed to be fair and to compare apples to apples."

The goal was not to optimize the steel building over concrete in the study, although Lardinois emphasizes that the next phase is going to be taking things a step further and using decarbonized materials, including steel. The Tally® LCA graphic illustrates that a large portion – almost a third – of the steel building consists of concrete (indicated in dark blue in the graph) because the study model deployed concrete in the foundation and flooring. "For the steel building," notes Lardinois, "if we wanted to decrease the global warming potential, we'd have to use low-carbon steel and concrete. Of course, we do need to head in that direction in promoting the use of low-carbon steel like XCarb™."

Turning to the areas that the study wanted to assess, regarding the comparative construction time of the two structures, steel won out. The construction schedule was determined by calculating the working days per floor, including the crane activity – the number of lifts per day – and the average working time required for the different steps, like concrete casting, slab installation, decking, wall panelling or other members. "In this design," says Lardinois, "the steel structure is not using a concrete core, so the installation of the steel structure didn't have to wait for the concrete core to be erected. Sometimes, when you have a concrete core, the steel team has to be demobilized, and that's not the case in this concept. Everything is done in steel, so the steel erection can be done with continuity. When comparing floor systems in the study, each one of the steel-based designs was erected in fewer days than ones with the concrete design."

Lardinois adds that the number of days that trades were required on site was also lower in comparison to the concrete construction.

The cost estimates in the study were based on architectural BIM models and structural drawings, thus tapping into a very detailed bill of materials. Overall, the steel building cost $0.4M less than concrete, which totaled $73.7M. "When you look at the results of the study," Lardinois points out, "they demonstrate a cost advantage for the steel substructure, because the steel building is a lighter structure than the concrete one, providing a cost advantage, while concrete has an advantage on the upper floors in superstructure costs. When you're looking at the full picture, the steel design is competitive with concrete for the net construction, so while there was limited construction cost advantage, steel was still a viable alternative for this market."

For the study, the environmental impact was assessed using the Tally® software add-on for Revit that is used to do a full-building analysis to quantify environmental impacts over a whole building's entire lifespan. Tally uses critically reviewed GaBi Life Cycle inventory databases that provide industry average data representative of the market.

"One important conclusion the data showed was that the building mass has a big impact on the environmental result," points out Lardinois, "and because the steel building is lighter, [with] a 36-per-cent reduction in weight, there was an impact on the environmental results. For instance, the steel structure provides a 20-per-cent improvement in the global warming potential, which is the environmental impact category that gets the closest attention. The concrete in both designs is the largest contributor to global warming potential and other impact indicators."

Lardinois says that both cost and environmental results were positively impacted by the fact that the completed steel building is lighter. "The study used high-strength steel, meaning that when we were able to, we used ArcelorMittal HiStar® Grade 70 wide-flange sections for columns instead of the Grade 50 that is commonly used, and thanks to the use of high-strength steel, we were able to reduce the quantity of steel in the building for a saving of 7.6 tonnes."

Given that this study demonstrated that building in steel over concrete results in faster building erection and reduced environmental impact, with overall cost factors being a wash, the obvious question is why isn't steel construction being used more? Lardinois acknowledges that it's a question that is increasingly being asked. "I think that it's a habit in Ontario to build multi-family residential buildings in concrete, and I think that the current design practices should now be challenged by these results and the analysis of alternative design, cost competitiveness and environmental impact. I also think the number of trades available in Ontario is a factor, but I think it will switch – it needs to. I think we need to push a little bit more and promote steel more to demonstrate to the AEC community that steel could be used as an alternative to concrete." AS

FEATURE

FRACTURE-CRITICAL STEEL BRIDGES

Not business as usual

BY :: CARLOS SOUBRIER, P.ENG. G.M., EQUADRON CONSULTANTS INC., CSA W178.2 WELDING INSPECTOR LEVEL 3, NACE COATING INSPECTOR LEVEL 3

HELLEN CHRISTODOULOU, PH.D. ING., B.C.L., LL.B, M.B.A., DIRECTOR, STEEL MARKET AND INDUSTRY DEVELOPMENT CANADIAN INSTITUTE OF STEEL CONSTRUCTION (CISC-ICCA)

Canada's Top Steel Fabricators in 2022

Ranking	Company Name	Total Number of Plants	Maximum Capacity Output (tons / year) - All Plants
1	Canam Group Inc./ Groupe Canam inc.	11	327,500
2	Walters Inc.	3	60,000
3	Brunswick Steel	1	26,000
4	Supreme Steel LP	3	23,000
5	Vulcraft Canada Inc.	2	16,000
6	Ocean Steel & Construction Ltd.	2	15,000
7	Norgate Métal 2012 inc.	1	12,000
8	Algonquin Bridge Limited	1	10,000
9	Cherubini Metal Works Limited	2	10,000
10	Constructions PROCO inc.	2	10,000
11	MQM Quality Manufacturing Ltd.	2	10,000
12	RIMK Industries Inc.	1	10,000
13	Telco Steel Works Ltd.	1	10,000
14	Burnco Mfg. Inc.	1	9,000
15	MSE Inc.	1	8,000
16	WF Steel & Crane Ltd.	2	8,000
17	AI Industries	1	7,500
18	Rapid-Span Structures / Bridges	2	7,500
19	ACL Steel Ltd.	1	6,400
20	Benson Steel Limited	1	6,000
21	Lainco inc.	1	6,000
22	Marid Industries Limited	1	6,000
23	Quirion Métal inc.	1	6,000
24	Structures XL	1	6,000
25	Tresman Steel Industries Ltd.	1	6,000
26	Métal Perreault inc.	1	5,500
27	Pittsburgh Steel Group	1	5,200
28	Hans Steel Canada	1	5,000
29	Lambton Metal Service	1	5,000
30	RKO Steel Limited	1	5,000
31	Victoria Steel Corporation	1	5,000
32	Charpentes d'acier Sofab inc.	1	4,800
33	M&G Steel Ltd.	1	4,550
34	Abesco Ltd.	1	4,500
35	Niik Steel Inc.	1	4,500
36	Acier Sélect inc.	1	4,000
37	Modular Fabrication Inc.	1	4,000
38	Sperling Industries Ltd.	1	4,000
39	TSE Steel Ltd.	1	4,000
40	Carry Steel (a Div. of C.W. Carry Ltd.)	1	3,800
41	Les Structures GB ltée	1	3,500
42	Métal Moro inc.	1	3,500
43	Acier Métaux Spec. inc.	1	3,200
44	Central Welding & Iron Works	1	3,200
45	Acier MYK inc.	2	3,120
46	Metal-Fab Industries Ltd.	1	3,000

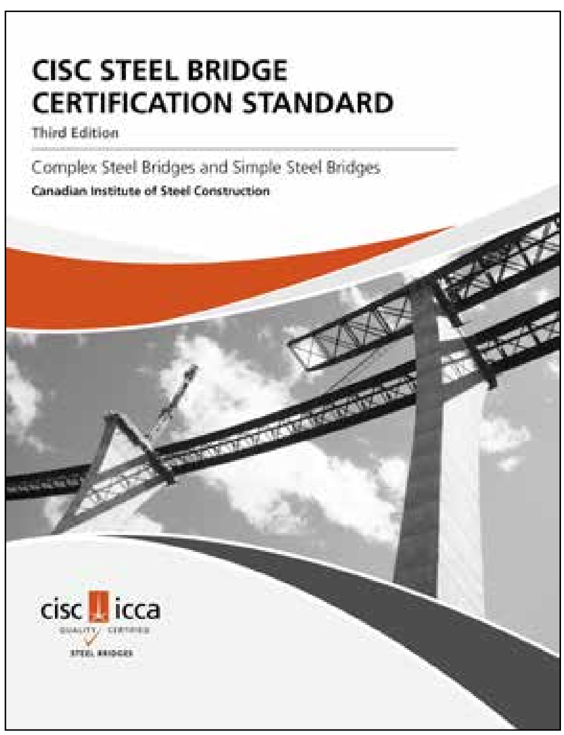
CISC ICCA
CANADIAN INSTITUTE OF STEEL CONSTRUCTION
INSTITUT CANADIEN DE LA CONSTRUCTION EN ACIER

Canada's Top Steel Fabricators in 2022 Continued

Ranking	Company Name	Total Number of Plants	Maximum Capacity Output (tons / year) - All Plants
47	Sturo Métal inc.	1	3,000
48	Tecno-Métal inc.	1	3,000
49	Wesbridge Steelworks Limited	1	2,700
50	Weldfab Ltd.	1	2,520
51	Elance Steel Fabricating Co. Ltd.	1	2,500
52	Les Industries V.M. Inc.	1	2,500
53	Steelcon Fabrication Inc.	1	2,500
54	United Steel	1	2,500
55	Impact Ironworks Ltd.	1	2,400
56	Norak Steel Construction Limited	1	2,300
57	Linesteel (1973) Limited	1	2,200
58	Kubes Steel Inc.	1	2,100
59	Coastal Steel Construction Limited	1	2,040
60	C_ore Metal Inc.	1	2,000
61	G & P Welding and Iron Works	1	2,000
62	Gensteel - Division of Austin Steel Group Inc.	1	2,000
63	Les Aciers Fax inc.	1	2,000
64	Les Structures CDL inc.	1	2,000
65	Mirage Steel Limited	1	2,000
66	Tek Steel Ltd.	1	2,000
67	M.I.G. Structural Steel	1	1,875
68	Arkbro Structures	1	1,800
69	Trevco Steel Ltd.	1	1,600
70	Garneau Manufacturing Inc.	1	1,560
71	Livingston Steel Inc.	1	1,560
72	JCT Metals Inc.	1	1,500
73	Les Réparations Marc Marine inc.	1	1,500
74	Warnaar Steel Tech Ltd.	1	1,500
75	Maple Industries Inc.	1	1,400
76	Solid Rock Steel Fabricating Co. Ltd.	1	1,300
77	IBL Structural Steel Limited	1	1,200
78	Magnum Fabricators Ltd.	1	1,200
79	Norfab Mfg (1993) Inc.	1	1,200
80	Akal Steel (2005) Inc.	1	1,000
81	Design Built Mechanical Inc.	1	1,000
82	EZ-Steel (A division of Quirion Metal)	1	1,000
83	Mariani Metal Fabricators Limited	1	1,000
84	Northern Steel Ltd.	1	1,000
85	Lorvin Steel Ltd.	1	900
86	Outrider Steelworks Ltd.	1	900
87	IWL Steel Fabricators Ltd.	2	867
88	JP Metal Masters 2000 Inc.	1	800
89	Summa Métal Architectural et Structural Inc.	1	800
90	MacGregors Industrial Group	1	750
91	Trade-Tech Industries Inc.	1	700
92	Bourque Industrial Ltd.	1	600
93	ARDY Rigging Ltd.	1	300
94	Times Iron Works Inc.	1	100

Fracture-critical steel requirements for bridges have been around since the 70s. Research on the fatigue and fracture limit states for steel bridges triggered relevant updates to the 1974 American Association of State Highway and Transportation Officials (AASHTO) bridge design specification. Specifically, the specification required a minimum toughness at the lowest service temperature. Toughness is the capacity of a material to prevent fracture due to the propagation of defects. It is measured using the Charpy v-notch (CVN) tests.

The famous AASHTO fracture control plan (FCP) was not published until ASTHO released the guide specifications for fracture-critical non-redundant steel bridge members in 1978. This guide introduced the term fracture critical and further characterized such members with higher toughness requirements, reduced fatigue stress ranges and introduced a higher benchmark for fabrication and weld quality requirements.



The Canadian approach

The requirements of CSA S6 Canadian Highway Bridge Design Code in the fracture control section form, in essence, a "Fracture Control Plan" and apply to fracture-critical and primary tension members. Fracture-critical members are those tension components of a single load path bridge structure whose failure would be expected to result in the collapse of the bridge. Identification of such components must, of necessity, be the responsibility of the engineer. A fracture-critical member may be either a complete bridge member or a part thereof.

Materials

Bridge components defined as fracture-critical or primary tension members must be subject to the fracture control plan. The fracture-control plan also cascades to all parts utilized to build up fracture critical or primary tension members. Therefore, traceability between mill test certificates, heat numbers, subproducts (i.e., mother plates) and parts is essential to developing and implementing a thorough base metal testing program.

The fracture control plan also involves welding consumables. It is recommended to select consumables certified by CSA W48 or AWS A5 series with toughness properties (i.e., test temperatures and absorbed energy) equal to or more stringent than the requirements detailed in CSA S6 tables for different base metals and service temperatures. Fabricators may select consumables certified with lower toughness properties so long as a welding consumable testing program is executed to match the project-specific CVN impact test requirements. The consumables testing program must be done in accordance with CSA W48

Annex K and the procedure must be qualified by a welding procedure qualification test in accordance with CSA W47.1.

Welding procedures

Certified steel fabricators have welding procedures suitable for the project. Welding procedures are suitable for a specific project if the welding code and the essential variables meet the project requirements. Fabricators that have certified fabrication plants to CISC Complex Steel Bridges have a document fracture control plan complying with CSA S6 or AWD D1.5 as applicable to the work undertaken. The fabricator shall have welding procedures for Submerged Arc Welding (SAW) process and any other processes that are required by the contract specifications and the requirements of CSA W47.1, CSA W59 and AWS D1.5 as applicable. In the case of Simple Steel Bridges, a Fracture-Critical Endorsement is an available extra add-on to meet project requirements with fracture-critical members.

As a result, certified steel fabricators demonstrate their capacity to deposit sound welds by qualifying their welding procedures. It is of utmost importance to possess adequate procedures and qualification tests by witnessing the welding of test plates, recording the essential variables and collecting mechanical specimens for testing. Especially for a complex project, quality assurance, compliance and risk management are fundamental – especially quality assurance programs as they are the vehicles for fabrication processes control. This is one of the major advantages of local fabrication when compared to welded fabrication done overseas.

Workmanship

Fracture-critical steel fabrication requires a higher degree of care than standard bridge fabrication. For instance, tack welds shall not be used on fracture-critical or primary tension members unless they are incorporated into the final weld. Also, temporary welds shall not be used on fracture-critical or primary tension members, unless approved by the Engineer.

Special attention to joint preparation, welding preheating, inter-pass temperature and monitoring the heat input alignment with the qualified welding procedures are fundamental thermal control efforts to achieve the desired welded joints' toughness.

Inspection

Fracture-critical steel bridge projects could easily turn into a headache when production takes over at the expense of a proactive quality program and the advantages of hands-on monitoring with local fabrication. Unfortunately, it is common to encounter projects where QC or QA activities are postponed until the welded fabrication is completed. In these cases, problems are most likely detected during the final inspection, therefore the likelihood to pin their root cause and propose a solid corrective action is undermined due to the lack of proper QC or QA records.

QC and QA inspectors should monitor most fabrication activities to assess the fabricator's understanding of the project requirements from the start. It is also important that defects and repairs are closely followed to assess whether their remediation aligns with the engineers' expectations. When local access is available, the risks of defects, repairs and change orders are mitigated.

Critical and noncritical repairs

CSA S6 fracture control makes a clear distinction between critical and noncritical repairs and the requirements to address them. Noncritical repairs include expected deficiencies such as surface defects (i.e., undercut, porosity, arc strikes, etc.) and rejectable non-linear volumetric indications. Steel fabricators must prepare noncritical repair procedures based on CSA S6 minimum steps for repair and submit them to the engineer for his approval, ideally before the start of fabrication. Once approved, the noncritical repair procedure must be followed throughout the whole fabrication. Attention should be given to defects that may undermine the steel's toughness such as arc strikes or undesired tack welds, and how to assess the likelihood of hardness excursions. In addition, there are post-heating and minimum elapse time requirements for accepting repairs of defects detected by magnetic particle or ultrasonic examination.

Critical repairs require the engineer's individual approval of each case prior to repairing them. Critical repairs include lamellar tears, laminations, cracks, surface or internal defects in rolled products, dimensional corrections requiring weld removal and rewelding, and any correction by welding to compensate for a fabrication error. Steel fabricators must open NCRs fully characterizing the defect dimensions, type and location. In addition, the NCRs should include a repair plan including sketches, drawings and case-specific procedures detailing the repair methodology, tools, variables to monitor (i.e., jacks load and heating temperatures) and reinspection plans aligned with the severity of the deficiency.

The use of mock-ups as proof of concept is a reasonable approach to validate a critical repair plan. There may be situations where the root cause of gross nonconformance is unknown. In such cases, it is recommended that a thorough failure analysis including destructive testing is undertaken to comprehend what caused the defect in the first place and validate the adequacy of the repair plan.

Conclusion

There are numerous factors to take into consideration when fabricating fracture-critical steel bridges. For this reason, it is very important for the project team to have a thorough understanding of what it takes to fabricate and erect these bridges.

As a first step, the CISC Steel Bridge Certification provides the specifier with the knowledge that the company has a conforming quality management system with competence for the type of structure covered by the Standard, with an available quality management plan to ensure that deficiencies are timely captured and addressed to the satisfaction of the Engineer. This certification facilitates better compliance to step two, which is the preparation of project specifications reflecting CSA S6 fracture control requirements for materials, workmanship, inspection, testing and nonconformances to prevent serious fabrication issues.

It's all about mitigating risk, it's all about ensuring safety, and it's all about effectively controlling final cost! AS

Visit the CISC Steel Bridge Certified Directory: www.cisc-icca.ca/cisc-steel-bridges-certified-directory

STEEL: THE HEART AND SOUL

Winner of the 2022 CISC Quebec Awards for Excellence in Steel Construction - Institutional & 2022 Favourite Project categories

BY :: SDK & ASSOCIES, INC.
(EDITED SUBMISSION FROM CISC QUEBEC AWARDS FOR EXCELLENCE IN STEEL CONSTRUCTION - 2022)

The CHUM – Phase II is one of the largest hospital centres in North America. Located in Montréal, on the quadrilateral formed by Viger, Sanguinet, René-Lévesque and St-Denis streets, a parking lot on five levels is co-imposed through a plaza, as well as two connected towers, one 16 storeys and the other 17 storeys.

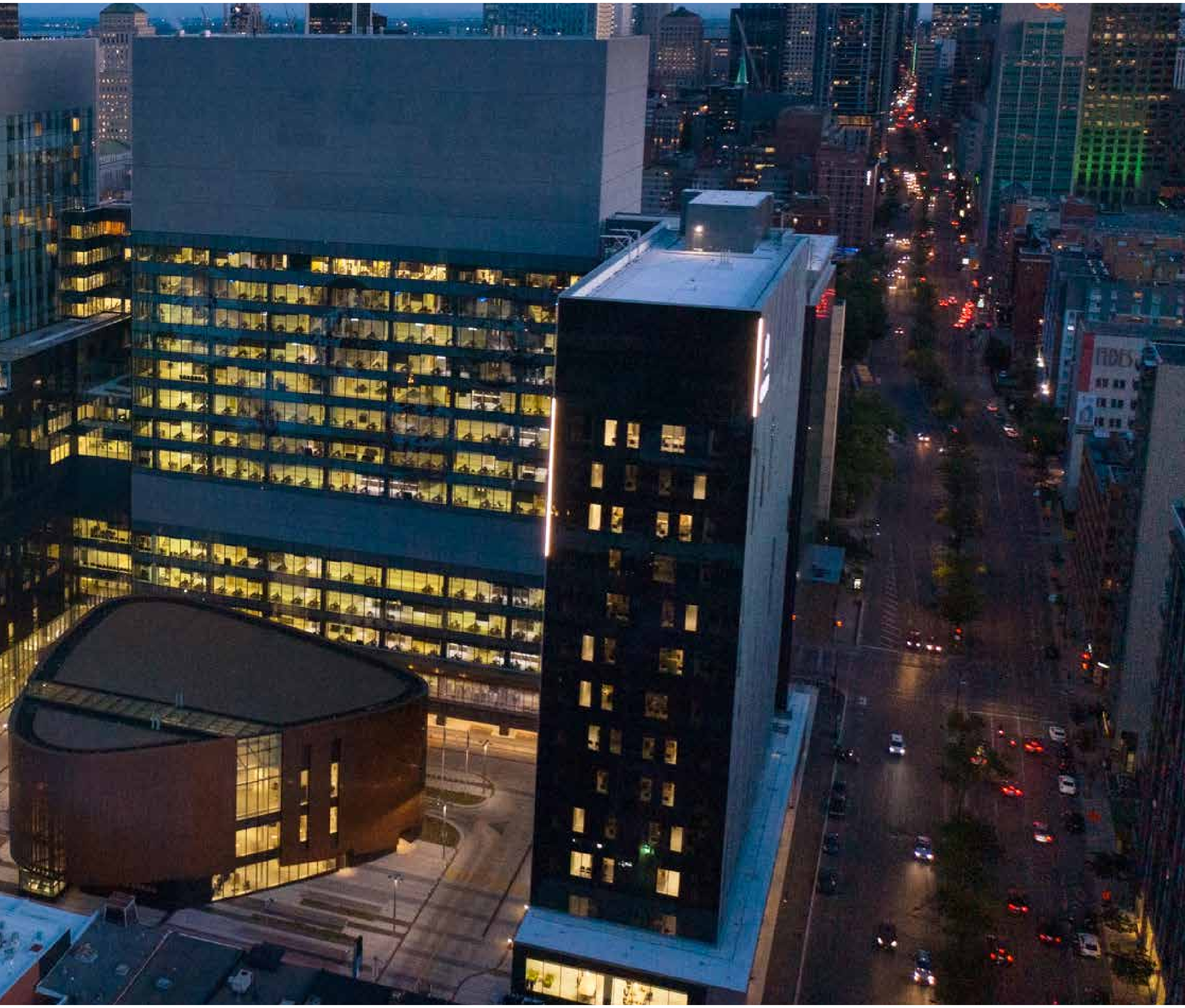
Photos courtesy of Adrien Williams

At the heart of this complex is a dazzling jewel, the Pierre-Péladeau Amphitheatre. This imposing amphitheatre can accommodate up to 365 people and is equipped with the latest technological equipment. It is now ready to receive the greatest influential researchers in modern medicine on a global scale.

Steel as the material of choice

The refined architecture of the amphitheatre – a true work of art – completes the incredible public art program of the new CHUM. This architectural vision is defined by the desire to design a building that contrasts with the rectilinear towers of the quadrilateral and that projects new forms for this area now known as the new Health District (Quartier de la Santé) in Montréal.

OF ELEGANCE AT THE CHUM



FEATURE

Photo credit: Adrien Williams

SDK & ASSOCIÉS, INC. (EDITED SUBMISSION FROM CISC QUEBEC AWARDS FOR EXCELLENCE IN STEEL CONSTRUCTION - 2022)

Fabricator (CISC Member)
Structures XL
Erector (CISC Associate)
Structures de Beauce inc.
Architects
Jodoin Lamarre Pratte /
Menkes, Shooner, Dagenais, Le Tourneux Architectes
(In consortium)
Structural Engineers (CISC Associate Consultant Company)
SDK et associés inc.
Owner
Centre hospitalier de l'Université de Montréal (CHUM)

To make this vision a reality, a complex steel frame became a logical choice for SDK's engineering team, thus accommodating its large spans, cantilevered hull and majestic steel curves.

Design – Making the right decisions

The cantilevered hull gives the impression that the structure is floating above St-Denis Street. Its projection is more than 11 metres, and this volume is entirely outside the building. A series of arched beams are suspended from the roof trusses, and on these, steel hangers are fixed to thin perforated copper skin filtering the light. Inside this shell, a

"WE ARE VERY PROUD OF THE RESULT OF THIS EXTREMELY DEMANDING PROJECT. REGARDLESS OF COUNTLESS CHALLENGES AND A VERY CONDENSED TIMELINE, THE SUCCESS OF THIS PROJECT WAS ACHIEVED THANKS TO THE COLLABORATION OF ALL THE TEAM."

– DAVID GIROUX, ENG. ESTIMATION MANAGER, STRUCTURE XL

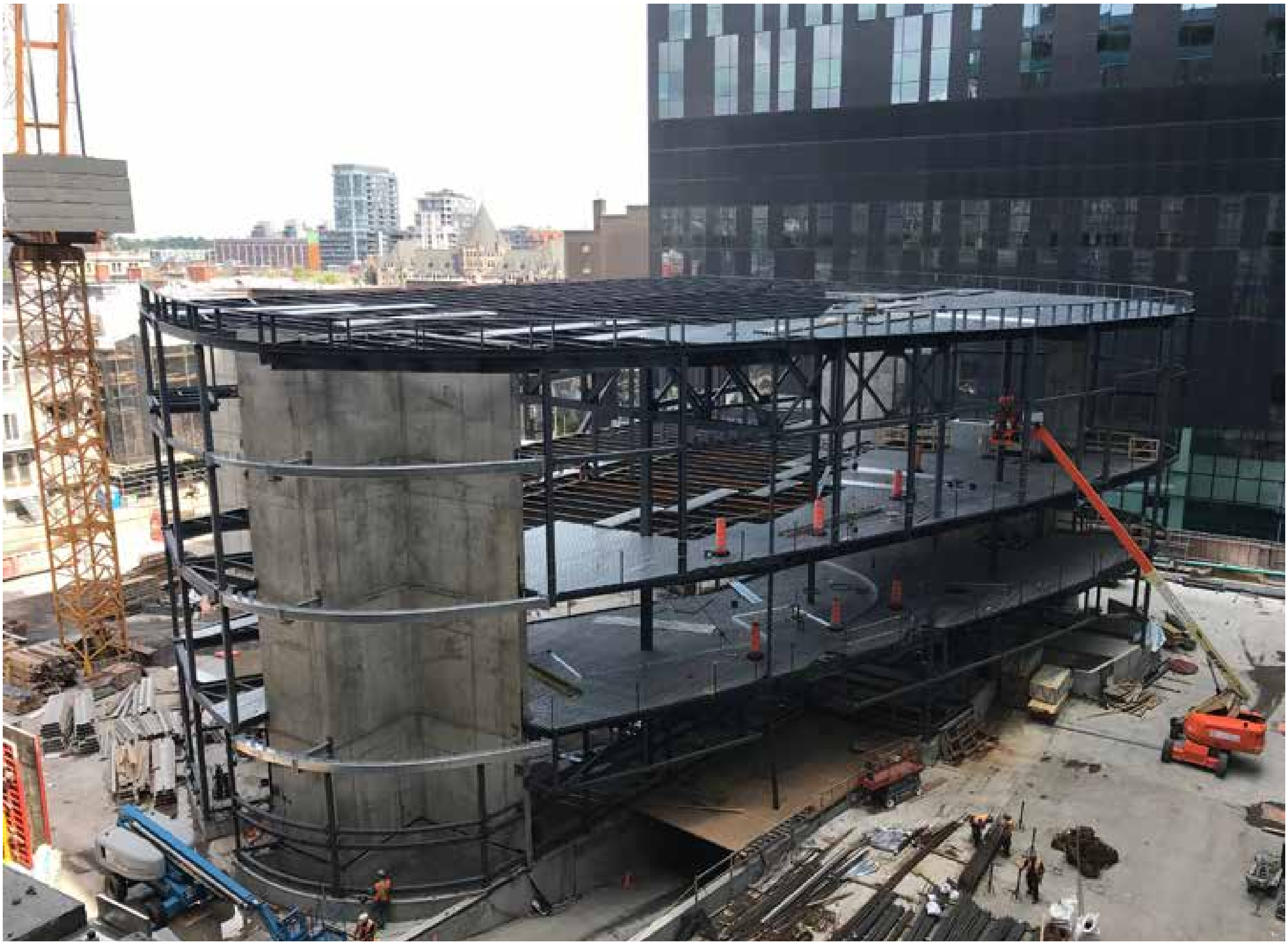


Photo credit: Adrien Williams

monumental staircase – entirely glazed – allows the observation of this unusual space.

This hull has also brought other challenges, particularly in terms of the structural continuity of the steel elements that had to cross from the heated interior space to an outdoor space and be exposed to climatic variations. The use of thermal breakage and highly coordinated efforts to locate their position in the building envelope remained an important factor throughout the project design.

Another notable aspect was the consideration of the corrosive potential of different materials such as copper and steel galvanized by zinc layers. The principles of assemblies have been well illustrated in the construction documents to clearly indicate the required dielectric separators.

The amphitheatre is column-free! It is located on the ground floor and is of a height corresponding to two floors. On the second level is the foyer, a gathering place for the public, while the third level is

Photo credit: Adrien Williams

occupied by various meeting rooms and a mechanical room. It should be noted that the floor structure of the mechanical room was designed to limit the transmission of sound and vibration to the underlying amphitheatre and to support a retention basin weighing more than 90,000 kg.

The steel frame on the roof forms an extremely rigid belt, formed by imposing trusses three metres high that intersected and limited the points of support. Tensile columns (lines) attached to the roof support the underlying floors with optimal spans.

This concept permitted the base of the copper hull and the amphitheatre to be free of columns.

During construction

The structure was erected at a phenomenal rate; from August 2019 to August 2020, up to 760 metric tons of structural steel were delivered and installed at the site for the erection of the amphitheatre. To keep up with this pace, professionals had to produce construction documents and complete the review of shop drawings in an accelerated mode.

The amphitheatre, in the heart of the plaza, is located above the parking spaces as part of the hospital complex, rubbing shoulders as it overlaps through the plaza with the underground parking lot and the two towers. All the lifting equipment required for the erection of the framework had

“THE BIGGEST CHALLENGE FACED REMAINS, IN MY OPINION, TO HAVE SUCCEEDED IN DESIGNING AND DELIVERING AN EXCEPTIONAL ARCHITECTURAL PROJECT AND THIS, IN AN ACCELERATED CONSTRUCTION MODE.”

– PIERRE MALENFANT, ENG, M.SC.A., ASSOCIATE, SDK ET ASSOCIÉS

to circulate and be positioned on a structural slab of the appropriate capacity yet limited to receive excessively high point loads.

The professionals had to carry out a very tight control of the weight of the lifting equipment allowed to circulate on the plaza. For the heaviest loads to lift, the largest cranes had to be positioned on the street, requiring good planning and coordination to minimize traffic obstructions on St-Denis Street.

Durability

In the process for a Silver LEED NC accreditation, the CHUM integrates many sustainable development measures such as exemplary management of construction waste, the integration of recycled materials, energy efficiency and building envelope performance, and the reduction of water consumption.

The SDK team is proud of this sustainable achievement, in line with its sustainable development policy. This project incorporates the most advanced technologies and the efforts invested have resulted in one of the most modern amphitheatres.

Architectural aspects

Nestled between the towers, the amphitheatre impresses with its sparkling copper envelope, a noble and durable material reminiscent of the roofs of several emblematic buildings in Montréal. The partially perforated copper cladding like lace deftly reflects sunlight during the day and reflects a warm glow at night through the surface. In this way, the envelope preserves the intimacy of the place while maintaining a link with the outside.

The strategic position of the amphitheatre also attracts attention. With its calibrated height, the building forms the core of the new University Hospital Center of Montréal (Montréal Centre Hospitalier Universitaire de Montréal). This complex geometry represents a human heart, hence its very particular shape with its curved and inclined walls.

Collaborative and innovative approach

The nature of this project is characterized by two distinct aspects: the mode of construction and the complexity of the building. It was unusual yet possible to see a project with so many remarkable shapes and unique details being realized in an accelerated mode. An accelerated mode of construction may bring its share of constraints, yet these did not hinder the creativity of the architects.

The result is that the best architecture could be created, and the team was able to realize any challenge. Steel made it all possible!

THE ROBARTS COMMON PROJECT

Winner of the 2022 CISC Ontario Awards for Excellence in Steel Construction – Institutional & Renovation (Retrofit) Project categories

BY :: MICHAEL FEINDEL, M. ENG. P. ENG PRINCIPAL, BLACKWELL STRUCTURAL ENGINEERS
(EDITED SUBMISSION FROM CISC ONTARIO AWARDS FOR EXCELLENCE IN STEEL CONSTRUCTION - 2022)

The Robarts Common project responds to the new modern function of an academic library and the University of Toronto's growing need for more study space by introducing a 50,000-square-foot building dedicated entirely to solo and group work environments. The new design adds 1,200 study spaces over four floors in a variety of configurations, all enclosed in a five-storey glass envelope that brings a new spirit of transparency and openness to Canada's preeminent academic research library. Completed in October of 2021, the facility was designed by Diamond Schmitt Architects.

Photo credits: Tom Arban, courtesy of Diamond Schmitt Architects

Photo Credits: Tom Arban, courtesy of Diamond Schmitt Architects

"We were always sort of thinking of ways that we could have a counterpoint or a variation on a theme of the base structure," says Gary McCluskie, a principal at Diamond Schmitt. "It's taking the original Robarts and abstracting it."

The original design of Robarts Library features a large primary building surrounded by several smaller pavilions. Built in 1973, two of the three pavilions were completed: the Thomas Fisher Rare Books Library at the southeast, and the Claude Bissell Building in the northeast. Almost 50 years later, the project realizes the third and final pavilion with Robarts Common. The scheme is constructed as a steel gambrel truss with diagonal braces that connects to Robarts Library via a narrow bridge on the upper floors.

Because the unrealized third pavilion was intended to be the location of an auditorium, the main building's electrical vault and mechanical room were constructed at the B2 level below the V-shaped loading dock. Above this area is where the new Robarts Common

"IT'S TAKING THE ORIGINAL ROBARTS AND ABSTRACTING IT."

– GARY MCCLUSKIE

was to be built. It was known before beginning the project that these spaces and services had to remain uninterrupted with operations continuing without obstruction. In addition, the loading dock also had to remain in use during and after construction of the Robarts Common as it handles all library materials coming in and out of the building from off-site storage and other university libraries, as well as food services. As a response to these existing site constraints and building conditions, Robarts Common spans from north to south over the loading dock, bearing primarily on only two columns at each end.

Steel frame construction with precast concrete slabs was chosen as the structural system primarily due to the speed of erection and its ability to minimize downtime of the loading dock. However, steel proved to be the paramount solution in many other aspects of this project.

Foundation conditions

The library from which this new addition extends was constructed in 1973. Accurately described by some as a concrete fortress, this brutalist building required an eight-foot-thick floating raft slab foundation system due to the less than adequate support of very poor soil conditions. Understanding this context, it was determined from the outset that steel's lightweight characteristics in comparison to concrete make it ideal for mitigating the implications of the site's poor soil condition and challenging foundation considerations. This approach culminated in a design that directs the load of the new steel structure down to two slabs on grade foundation sections that bear on micropile clusters at both ends of the existing slab over which the new building spans.

The structure is a bridge

The new structure was required to span over the existing loading dock, covering a span of approximately 52m. This unique requirement required the structural system to be essentially designed as a bridge, with the top three floors (levels three, four and five) functioning as a

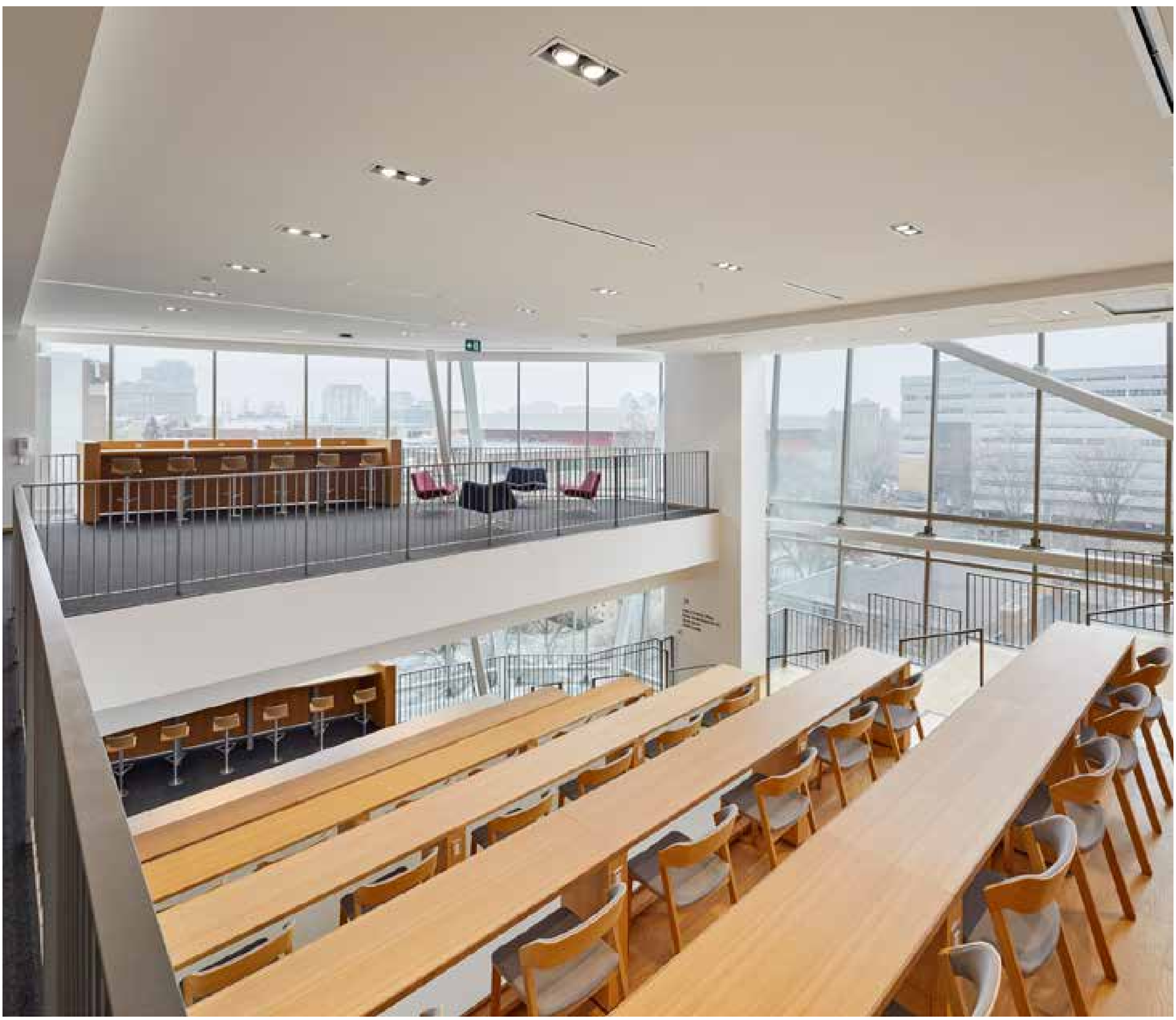


Photo credits: Tom Arban, courtesy of Diamond Schmitt Architects

Fabricator (CISC Member)
C_ORE Metal Inc.
Architects
Diamond Schmitt Architects
Structural Engineers (CISC Associate Consultant Company)
Blackwell Structural Engineers
Owner
University of Toronto

multi-storey truss with the second floor suspended from above. In fact, there are two trusses: one along the west elevation that uses flat plate diagonals exposed to view and wide flange verticals; and one along the east elevation using a similar strategy except with an opening at mid-span that allows for a link between this new building and the existing concrete library. This link is also suspended from the truss and does not bear on the library whatsoever.

With its lightweight and high volumetric strength density, steel was the ideal choice for the design of this structural truss bridge system. The trusses required a material that would be easy to erect quickly without the need for shoring during construction – the steel moment connections of this system allowed for this. The steel components were fabricated in shippable-sized elements, assembled into trusses on the site.

Steel overall

From an architectural and functional standpoint, steel was the ideal material. The requirement for a non-combustible structure was easily met by employing exposed steel with an intumescent coating.

Since the project required a short construction schedule to minimize obstructions to operations, a steel scheme could take advantage of a focused design time for meticulous planning and detail fabrication. This would allow very fast erection once the project was underway. The limited permissible building envelope on a restricted downtown site also meant that every available millimetre on the site had to accommodate a program. As such, steel seemed like the obvious choice because its high strength permits the implementation of a significantly smaller structure, which was critical to the feasibility of the project.

A tremendous amount of program was woven through these trusses as they spanned the length of the building. As a result, very clever web arrangements were required. Due to the requirement for a link to pass through the east truss, solid steel plate webs were implemented at one end in places that necessitated kinked webs.

AESS was used extensively for this project as an essential part of the architectural expression. The large three-storey-deep truss is the defining feature of the east façade, left exposed using intumescent paint on the HSS webs.

Establishing a Counterpoint

Set against the austere west façade of the library, Robarts Common establishes a transparent counterpoint to the Brutalist expression of the original architecture – a monolithic concrete volume. This counterpoint is derived from the use of steel and glass rather than concrete, allowing for an open feeling, making use of steel's visually small proportions and its suitability to detail well with glass façades.

"There's a sustainable design strategy there as well, in terms of passive ventilation," says McCluskie. In the afternoon, roller blinds drop down to reduce heat gain.

The exposed steel structure reveals the student activity within and invites the university community inside through a new accessible south entrance and plaza that improve circulation throughout, while also establishing an alternate entry point to the long-standing St. George Street entrance. Expectations of architectural and functional perspectives were met by using steel, the ideal material for such a project.

New CISC Members and Associates since June 2022

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Altar-construction, Granby, QC

Associate Individual:

Charlotte Bond, Etobicoke, ON

Noel Gascon, Ottawa, ON

Maksym Ivan Kadziela, Edmonton, AB

Mahmoudreza Mivehchi, Port Moody, BC

Piotr Kazimierz Ostrowski, Port Hope, ON

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GROUPE CANAM INC.
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GROUPE CANAM INC.
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GROUPE CANAM INC.
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JP METAL MASTERS 2000 INC.
Maple Ridge, BC

KUBES STEEL INC.
Stoney Creek, ON

LAINCO INC.
Terrebonne, QC

LAMBTON METAL SERVICE
Sarnia, ON

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Oakville, ON

M.I.G. STRUCTURAL STEEL (DIV. OF 2480367 CANADA INC.)
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Publisher
Michael Bell
michaelb@mediaedge.ca

Editor
Emily Weidenbacher
emilyw@mediaedgepublishing.com

National Sales Executives
April Hawkes, Derek de Weerdt, Kristine Dudar, David Tetlock, Dawn Stokes

Senior Graphic Designer
Annette Carlucci

Junior Design Specialist
Bethany Giesbrecht

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531 Marion Street
Winnipeg, MB Canada R2J 0J9
Toll Free: 1-866-201-3096
Fax: 204-480-4420
www.mediaedgepublishing.com

President
Kevin Brown
kevinb@mediaedge.ca

Senior Vice President
Robert Thompson
robertt@mediaedge.ca

Director, Business Development
Michael Bell
michaelb@mediaedge.ca

Branch Manager
Nancie Privé
nanciep@mediaedgepublishing.com

PLEASE RETURN UNDELIVERABLE COPIES TO: CISC-ICCA
445 Apple Creek Blvd, Suite #102
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Telephone: 905-604-3231

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IRON WORKERS INTERNATIONAL SETS THE STANDARD HIGH WITH **ACCREDITED RIGGER & SIGNAL PERSON CERTIFICATION**

The National Commission for Certifying Agencies (NCCA), the accrediting body of the Institute for Credentialing Excellence, has granted accreditation to the Iron Workers International Certification Board's (I.I.C.B.) Rigging & Signalperson Certification Program.

WHY IS IT IMPORTANT?

MEET REQUIREMENTS

OSHA's Subpart CC requires signal person qualification by a third-party qualifier.

MEET DEMAND

While an OSHA letter of interpretation recognizes apprenticeship programs that train and assess riggers and signal persons as third-party qualified evaluators, many contractors, states and municipalities require a Qualified Rigger and Signal Person Certification.

REDUCE COST

Third party certification comes with a hefty price tag without input on testing from subject matter experts, ironworkers and their contractors. The Iron Workers' certification eliminates the recertification cost of $500 per person.

IMPROVE SAFETY

Ensuring that only trained, skilled and competent ironworkers complete rigging and signaling tasks elevates workplace safety standards and reduces risk.

WHAT IS IT?

Iron Workers International Certification Board's (I.I.C.B.) Rigging & Signalperson Certification Program is accredited by the National Commission for Certifying Agencies (NCCA), the accrediting body of the Institute for Credentialing Excellence. The I.I.C.B. joins an elite group of more than 130 organizations representing over 315 programs that have obtained NCCA accreditation.

HOW IS IT DONE?

- 6,000 HOURS OF HANDS-ON EXPERIENCE
- 3-PART EXAM
- TESTING & RECERTIFICATION EVERY 5 YEARS
- IRON WORKERS RIGGING & CRANE COURSE