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NO. 59 FALL 2017

INNOVATION ISSUE

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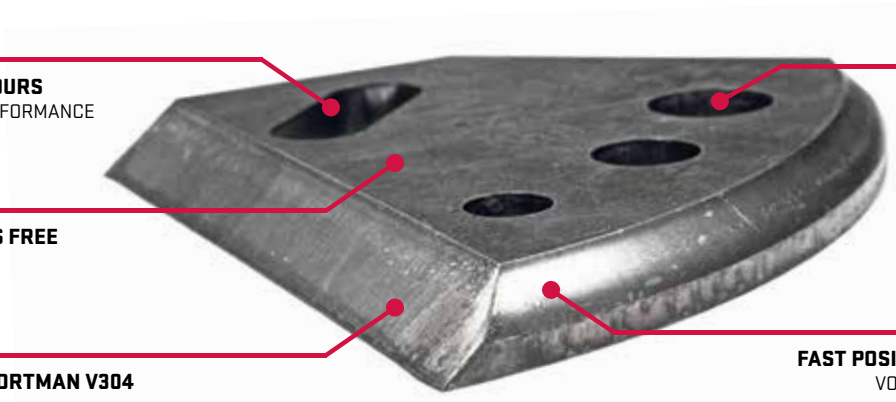

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ADVANTAGE STEEL

NO. 59 FALL 2017

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: Rehabilitating Parliament

Ed Whalen, P.Eng.
ewhalen@cisc-icca.ca

/cisc_icca

Could Unit Pricing Be the Silver Bullet for Commercial Construction Woes?

UNIT PRICING HAS BEEN used in the steel industrial sector in Canada for what seems to be forever but not so in the commercial sector. The reasons for unit prices in the industrial sector are many, but one of the key drivers is that accelerated schedules require design and construction to happen in parallel. Sounds a bit like commercial construction these days now doesn't it? Some would argue the merits of design-on-the-fly are here to stay until something speedier comes along. This methodology seems to be pervasive in the commercial sector with unintended detrimental consequences for all parties involved with lump sum prices. It may be time for owners and their design consultants to consider this mature pricing model for all their future projects to mitigate project conflict, high costs for changes and extras, litigation and to improve resource efficiency. At the end of the day, the owner should pay for exactly what they get, no more … no less.

Realities for commercial construction today:

1. Owners want their buildings yesterday
2. Design consultants are engaged too late in the process
3. Design consultants are pushed to get the drawings out for tender before they are completed
4. Design drawings at time of bidding are not complete and are targets for high priced extras
5. Design drawings have incomplete or sub-standard sections to properly communicate design details
6. Design and re-design are ongoing throughout the construction phase
7. Changes on a project are a given
8. Consultants spend a considerable amount of resources evaluating extras for accuracy and fairness for the benefit of the owner. This work is not always reimbursable.
9. Subcontractors spend a considerable amount of resources pricing, submitting and trying to get paid for extras
10. Fabricators know exactly how many pieces of steel are required, the weight of each piece and location on the 3D model.
11. Design consultants have a pretty good idea of the total weight of the final project before the design is completed.
12. There are fewer pricing disagreements, less administration costs and less litigation on unit priced projects compared to lump sum projects.
13. Evaluating extras and getting paid for extras is one of the top three biggest issues facing the construction industry today

So taking a lesson from the industrial market, and realizing that the world of incomplete design is here to stay at the time of bidding, the move to unit pricing may be the solution that has been staring us in the face all along.

So here is how a commercial project may look in the future:

1. Consultant engineers would provide tender documents, total estimated weight and an estimate of weight per each unit price weight class.
2. Consultant engineers would request pricing based on the following suggested two pricing methods (or variants, refer to the CISC Code of Standard Practice for possible formats):
   a. Separate unit prices for steel fabrication and steel erection
   b. Combined unit price for fabrication and erection
3. Consultant engineers would include provisions for an allowed percentage change in the unit prices due to a certain % change in overall project weight scope up, and a separate one for a weight scope down.
4. Fabricators would base their pricing on the tender documents, providing unit prices to be used throughout the entire project. The fabricator would

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identify their nesting provisions in their bid that can then be used in conjunction with their unit prices (refer to the CISC Code of Standard Practice).

5. Monthly or milestone invoice draws would be based on weight only.
6. All steel fabricated and installed would be billable based on the final as-built drawing.

What are some potential benefits?

1. The owner doesn't pay for things they didn't get (other than scrapped material) nor do they pay high prices for changes on the go.
2. The fabricator, having all the software tools necessary, can easily show every piece supplied and installed, and price using the tendered unit prices.
3. The engineer can easily corroborate the piece, location, weight and cost of the extra - reducing administration time and conflict, and freeing them up to do other things they get paid to do.
4. The fabricator can complete an estimate for tender in a fraction of the time using unit prices compared to the current model of taking off each piece - lowering estimating takeoff, overhead costs and increasing the number of quotes per week.
5. And best of all: reduced conflict, reduced arguments and less litigation!

The move to unit pricing may be the solution that has been staring us in the face all along.

Now what can be easier than that?

Now before I get flooded with emails that the system mentioned above didn't consider this or should have added that, I will agree there may be a few items one can add or tweak upon. That said, if all sides look at this old and true method of pricing with a fresh set of eyes, I bet we will see a change in the pricing of commercial projects that benefits everyone, and the stress and complaints of incomplete drawings and getting paid for extras will be a thing of the past.
I would love to hear your thoughts. AS

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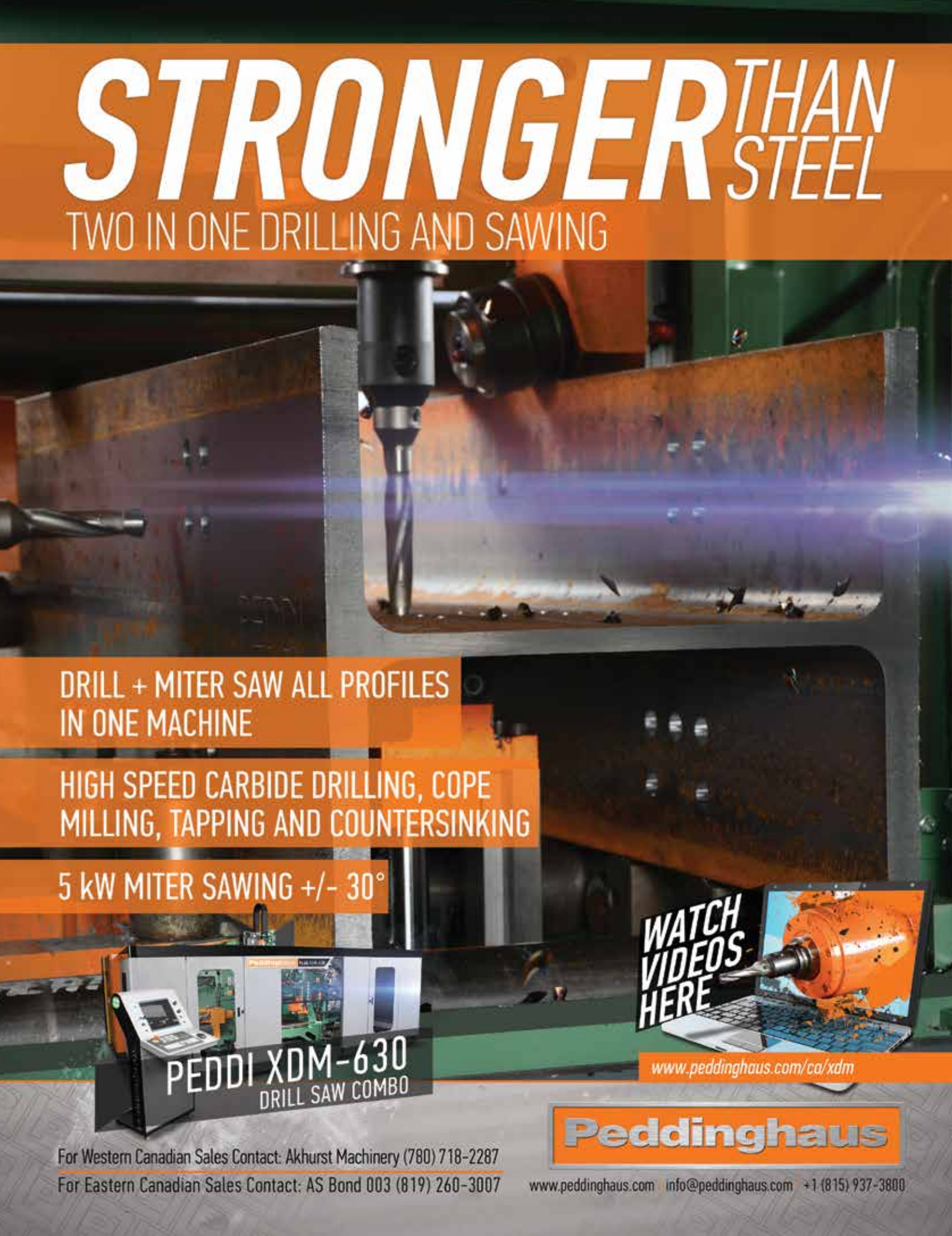

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Alfred F. Wong, P.Eng., F.CSCE
Director of Engineering

Question 1: Must the ends of compression members at a bolted splice be finished to bear?

Answer: While gravity column segments are usually finished to bear at splices, compression members generally need not be finished to bear provided the bolted splice is proportioned to resist the factored forces and effects without end bearing contribution. An example is shown in the Figure.

Question 2: Are the factored resistances of Welded Unstiffened Angle Seats provided in Table 3-43 of the CISC Handbook applicable to beams with and without bearing stiffeners? How is the beam flange thickness, t_b , determined?

Answer: The Table was developed for beams without bearing stiffeners. The beam flange thickness, t_b , is approximated using the expression $t_b = 1.6w - 3$, which has been derived from regression analysis and gives a very good estimate for rolled wide-flange beam sections. This eliminates the need to look up the value t_b.

Question 3: Are UL listed fire-rated steel-framed floor designs as well as cUL listings applicable in Canada? What is the difference?

Answer: The National Building Code of Canada, in Division B "Acceptable Solutions," requires that fire-resistance ratings be determined in accordance with CAN/ULC Standard S101, "Fire Endurance Tests of Building Construction and Materials." According to UL LLC, cUL listed designs comply with CAN/ULC S101 whereas UL listings were not tested to S101.

Question 4: Should I always specify the spray-applied fire-rated floor assembly design on design documents? May I simply specify the code required fire separation rating to permit multiple bids?

Answer: The regulatory authorities typically ask that the fire-rated listing(s) be specified on the design documents. Moreover, the listed design selection process serves to ensure that the prescriptive design rating is achievable. For example: do the open-web steel joists meet the minimum mass required for the common listings; is the slab thickness and concrete density combination compatible with common listed designs if an unsprayed deck design is desired?

In order to allow multiple bids and competitions among multiple fire-resistive material producers, one may specify several suitable listed design options. Alternatively, specify one design but allow equivalent listed designs in compliance with CAN/ULC S101. Part 1 of *CISC Steel Design Series* "ULC and cUL Sprayed-Applied Fire Rated Designs" includes a summary of popular rated designs for applications in Canada. https://cisc-icca.ca/cisc-steel-design-series/ AS

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.

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.

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Orthogonally Intersecting Moment-Resisting Frames

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

BOTH BRACED FRAMES AND moment-resisting frames have served as effective lateral-load-resisting systems in the construction of steel framed buildings. Steel braced frames are far more common, primarily due to economic reasons. However, moment-resisting frames may be required in certain situations where they are used either exclusively or in combination with braced frames, shear walls or both. When moment-resisting frames serve to resist forces in two orthogonal directions, some of the planar frames may intersect depending on the building geometry, framing layout, etc. Figure 1A shows a floor plan layout that can accommodate two double bay moment-resisting planar frames in each orthogonal direction without intersection, whereas the layout shown in Figure 1B cannot. The selection and seismic design of the columns at these intersections can be quite challenging. This article briefly examines the available options.

SEISMIC APPLICATIONS

Steel moment-resisting frames may be designed and built to comply with one of the four types of *seismic force-resisting systems* explicitly described in National Building Code 2015 and CSA S16-14. In an ascending ductility order, they are: *conventional construction (CC), moment-resisting frames with limited ductility (Type LD),* moderately ductile moment-resisting frames (Type MD) and ductile moment-resisting frames (Type D). Where two planar frames intersect, the column is subjected to bending about both axes as well as axial loads. With the exception of conventional construction used for low seismicity applications ($I_E F_s S_a(0.2) \leq 0.45$), the selection of beam-to-column connection types requires special considerations. These considerations, coupled with the strong-column-weak-beam, design requirements render wide-flange sections unsuitable for the use as columns at these intersections.

TYPE D AND TYPE MD FRAMES

Generally, I-shape columns are unsuitable for use in *Types D* and *MD* frames for two main reasons:

a) Beam-to-column connections for weak-axis column bending lack physical performance test evidence

b) Strong-column-weak-beam design requirement renders weak-axis bending applications of I-shape columns inefficient or even inadequate.

Four column shapes have been incorporated in the CISC publication 'Moment Connections for Seismic Applications – 2nd Edition,' as shown in Figure 2 (reproduced from Figure 2.1 in the publication).

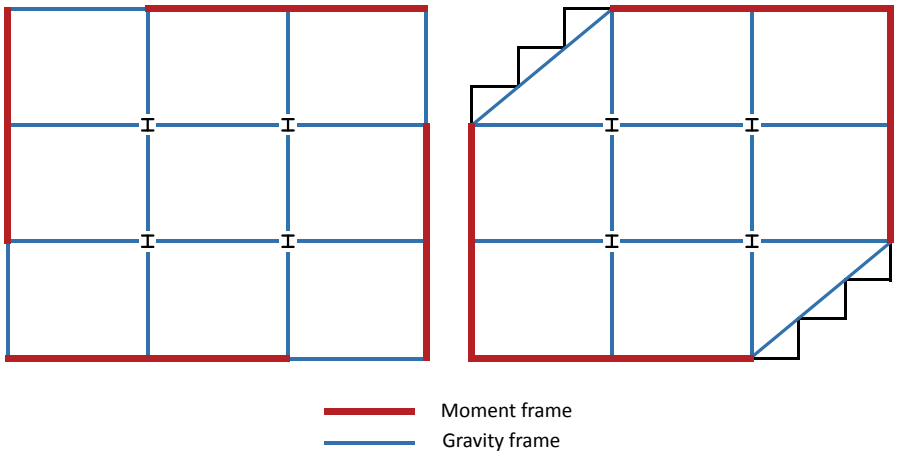


FIGURE 1A

FIGURE 1B

FIGURE 2

Three of them may be used for columns at the intersections: flanged cruciform section, box section and boxed W-shape section. However, the flanged cruciform section may be more practical versus the closed sections, which involve onerous fabrication. Figure 3 shows an isometric view of reduced-beam sections framing into a flanged cruciform column. The above-mentioned CISC publication provides detailed requirements for applications of the shapes shown in Figure 2 as columns.

TYPE LD FRAMES

Although S16-14 permits a prescriptive option for the design of beam-to-column connections in *Type LD* frames, this option applies to beam-to-column-flange connections only. Therefore, flanged cruciform columns may also be the most viable choice.

HSS COLUMNS

In general, moment connections to HSS columns lack performance test evidence. However, ANSI/AISC Standard 358-16, "Prequalified Connections for Special and Intermediate Steel Moment Frames for Seismic Applications," has incorporated a proprietary connection type which features a concrete-filled HSS 406X406 column and specialty steel fittings. Since CSA S16 does not explicitly reference this connection type, the engineer responsible for the design must assess its suitability in accordance with Annex J of S16-14.

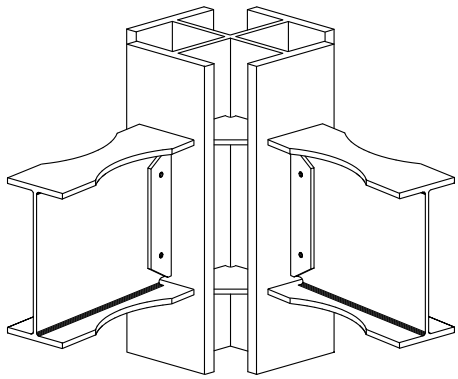


FIGURE 3

All in all, intersecting moment frame layouts complicate design and fabrication. AS

Tareq Ali, RPM
Director of Marketing and Communications

Debunking Wood Industry Sustainability Claims

According to certain "studies," wood claims a smaller environmental footprint than any other major building material. However, a closer look at the myths and facts reveals some significant inconsistencies with that claim.

MYTH: STUDIES DEMONSTRATE THAT WOOD IS A MORE SUSTAINABLE MATERIAL THAN STEEL.

REALITY: The most-cited study contained numerous incorrect assumptions about steel, and it omitted wood impacts. In fact, a study cited often by the wood industry was published by the Consortium for Research on Renewable Industrial Materials (CORRIM) and is based on outdated information. For example, it made incorrect assumptions about the quantity of steel needed for its comparisons.

In reality, wood is typically a single-use material. At the end of its life, a building's wood frame is typically landfilled or incinerated. This returns any stored carbon dioxide back into the atmosphere as either carbon dioxide or methane, shifting greenhouse gas burdens to future generations.

By comparison, steel is the world's most recycled material. Steel construction products have a recycling rate of more than 90%, meaning that at the end of a steel building's life, more than 90% of its steel is recycled into another steel product, using significantly less energy than was necessary to create the original product. A material that can be recycled continually over centuries with no loss in quality and that lowers the burden on future generations is the very definition of sustainability!

MYTH: WOOD IS MORE SUSTAINABLE THAN STEEL BECAUSE IT IS A RENEWABLE BUILDING RESOURCE.

REALITY: Being renewable is not the same as being sustainable. The wood industry claims that for every tree cut down, one or more new trees are planted. However, the claim does not take into account that it will take decades before those saplings mature. In the meantime, the forest is depleted of the oxygen, water storage and filtration, wildlife habitat, global cooling, and other benefits provided by the mature tree. Trees are often harvested by clear-cutting, leaving large gaps in the forestland that also impact the plants and animal species left behind.

MYTH: WOOD IS MORE SUSTAINABLE THAN STEEL BECAUSE WOOD CONSTRUCTION PRODUCTS STORE CARBON.

REALITY: Carbon storage for construction products is temporary, only shifting impacts to future generations. Carbon is sequestered in the fibre of trees, but that does not mean that wood buildings become large reservoirs of carbon that is stored indefinitely. Upon harvesting, the unused root and leaf systems immediately return their CO^2 to the atmosphere by decay. For wood products, the reality is that carbon storage is also temporary and it is released back into the atmosphere at the end of the wood building's life either by the demolition and subsequent decay of the wood or by incineration.

As a result of wood waste and decomposition, the carbon stored long-term in harvested wood products may be a small proportion of that originally stored in the standing trees across North America, approximately 1% may remain in products in use, and 13% in landfills at 100 years post-harvest.

MYTH: ALL WOOD CONSTRUCTION PRODUCTS ARE CERTIFIED AS BEING SUSTAINABLY HARVESTED.

REALITY: The majority of forests in the U.S. do not meet the wood industry's own sustainable harvesting standards. In total, 81% of forests in the U.S. are not certified, 11% are Sustainable Forestry Initiative (SFI®)-certified, and 7% are Forest Stewardship Council (FSC®)-certified.

The sustainable harvest certification provided by the Sustainable Forestry Initiative has often been challenged as to whether it reaches the required threshold of sustainable forestry. In actuality, only 7% of the forestland in the U.S. reaches the threshold of being considered sustainably managed.

The benefits of steel vs. wood for mid-rise building construction

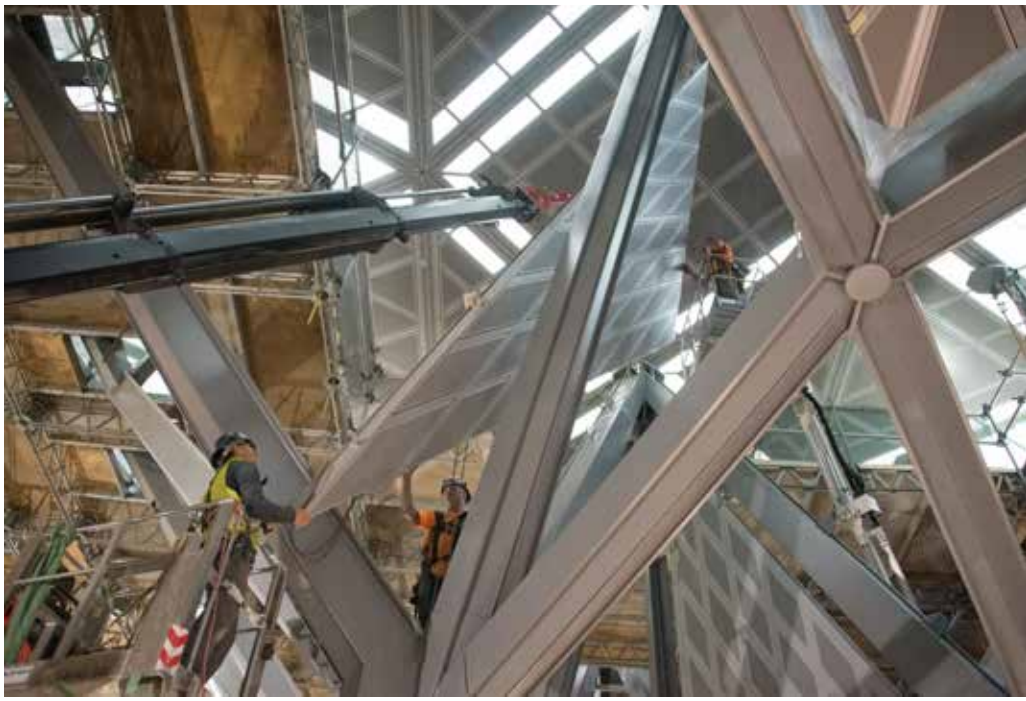
Now that we've discussed the myths, let's look at the facts. Sustainability, durability, fire resistance, structural performance, and cost-effectiveness are some of the strongest reasons for using structural steel framing in mid-rise building construction. As a dependable, non-combustible material, steel-framed structures provide a wise investment for builders and the occupants who live and work in them. AS

OH CANADA

Rehabilitating the West Block of Parliament

By Mark Koppelaar, Vice President Projects, Walters Group

Photography by Richard Seck, courtesy of Ojdrovic Engineering, structural engineers for the West Block Project.



Credit Roberta Gal, Public Services and Procurement Canada

LOCATED IN OUR NATION'S capital of Ottawa, Ontario, the West Block Rehabilitation Project consists of the West Block building being rehabilitated to meet the current and future needs of Parliamentarians, while respecting its heritage character.

Walters has helped to create a new roof over a previously open courtyard to build a new, naturally lit interior space. In accordance with the Government of Canada's plans, the permanent courtyard infill will serve as the House of Commons Chamber during the rehabilitation of the Centre Block. Rehabilitation work began in 2011, and building occupancy is planned for the opening session of Parliament in Fall 2018.

One of the keys that distinguishes Walters in the marketplace is our ability to provide complete services "in-house" across areas

Credit Roberta Gal, Public Services and Procurement Canada

including construction engineering, project management, fabrication, finishing, delivery and on-site construction.

Walters' role in the rehabilitation project included supplying, fabricating, and installing steel "tree columns" and "branches" and the cloud roof structure. This project consisted of over 5,000 assemblies which if placed end to end would stretch over seven kilometres. These assemblies are held together with over 30,000 bolts. All fabrication and painting of this more than 1,000-ton structure occurred at both of Walters' Hamilton and Princeton, Ontario facilities. Evolving engineering requirements necessitated additional strength and safety testing, and adjustment to weld requirements. The precision in fabrication and installation ensured that the glazing fit to the steel with no issues.

The tapered architecturally exposed structural steel (AESS) and encased steel branches needed to be held together with hidden bolted connections. These branches had a two-coat high-end coating system, including a polyurethane finish. The shapes, which are both geometric and organic, created challenging tolerance issues that needed to be resolved before installation began. The geometry of this project is quite unique, in that the cloud structure is completely independent of the existing structure and fully supported by the trees and branches. Using steel and the flexibility it provides was the best material to utilize for such an exceptional structure.

The cloud structure consisted of a complex array of vertical bracing and beams supported from the branch tips creating a type of three-dimensional space framing, where the load paths are not apparent. This is far different and more complex than the typical simply supported truss system seen in most buildings.

Using 3D software, Walters was able to identify and resolve potential interferences – places where glass fittings, mechanical elements or other features conflicted with one another.

Our modeling also revealed paths where conduits could run up through the tree columns and branches, adding additional function beyond

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Photography by Richard Seck, courtesy of Ojdrovic Engineering, structural engineers for the West Block Project.

structural strength. The overall height from floor of courtyard to top of roof is 23 metres.

For any project, understanding the architect's intent and creating a plan for constructing it is always our focus. Our goal is to help make a vision a reality. For this project, the architect's design of a gothic revival architectural style was consistent with the original building, which allowed Walters to continue the connection design and detailing to incorporate the constructability needs without compromising the style.

The tree columns and branches were fully connected in a 3D digital model and sent to the Architect for review to ensure the creative objective was met, prior to fabrication. After fabrication and painting, prior to shipping, Walters Group again engaged the Architect to review the product, to confirm that we were fulfilling the Architect's intent.

"We always have enormous satisfaction when we see an architectural vision and a brave design successfully materialize. The steel plates and members allowed for the airy large span glazed

"We are proud to have participated in such an important project for Canada."

Jane Krisanova, P.Eng.,
Senior Structural Engineer, Ojdrovic Engineering

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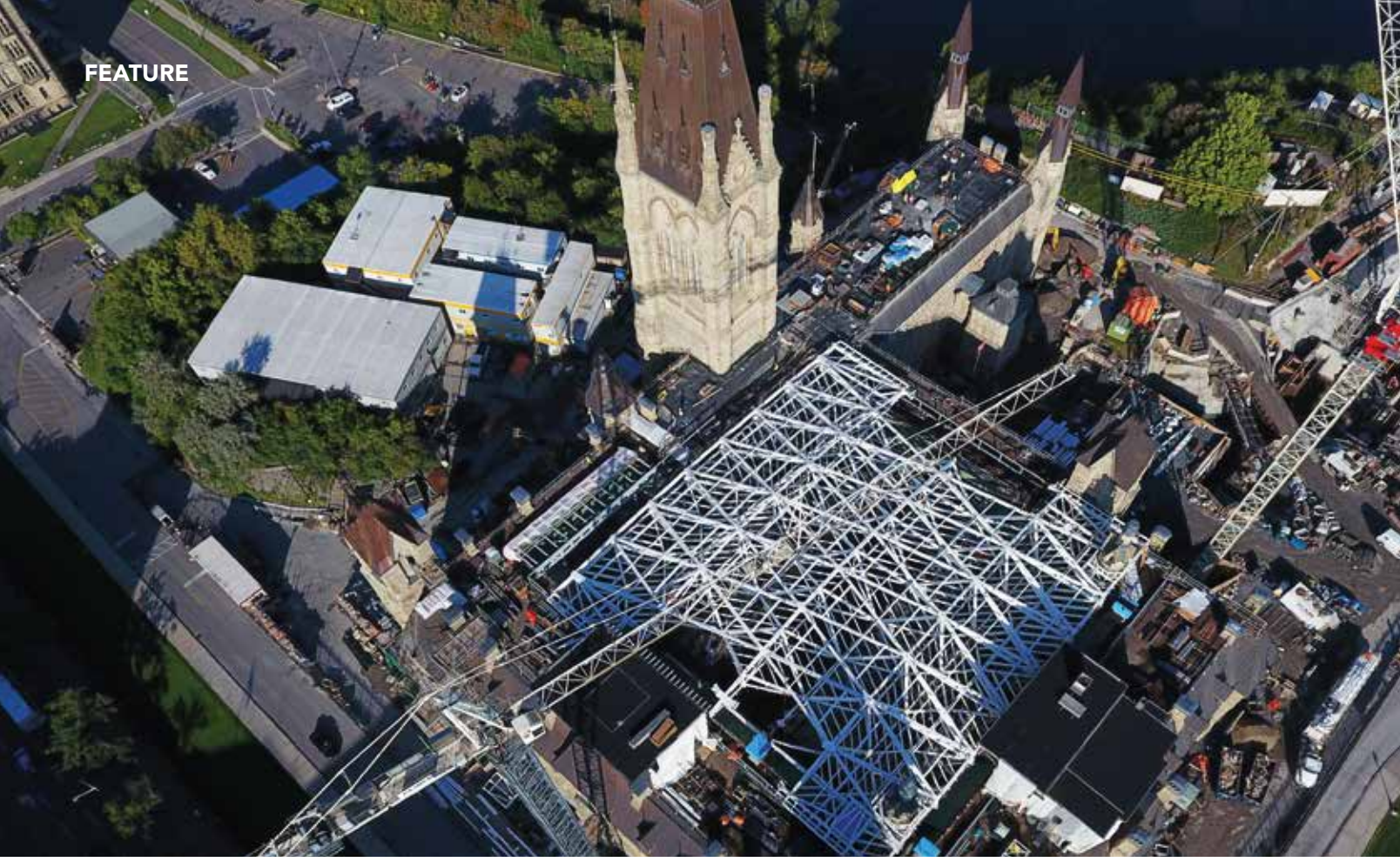

roof structure over the House of Commons chamber," says Jane Krisanova, P.Eng., Senior Structural Engineer of Ojdrovic Engineering and Chief Structural Engineer for the West Block Project. "It was a great professional challenge to analyze this non-standard, complex, ornamental steel structure. Hundreds of hours of modelling, and linear and non-linear analysis, allowed us to completely understand the behaviour of the steel frame subjected to a large number of load combinations. We are proud to have participated in such an important project for Canada."

The construction sequence was one of our main challenges. With many dignitaries and media frequently touring the project (including Prime Minister Justin Trudeau), the site was quite congested, having narrow access roads on the south, west and east side. This job site, being Canada's government, naturally had significant security and access restrictions.

During the erection, the massive excavation for the new Visitors Welcome Centre on the north side of the building kept logistics and communications at the forefront with our project teams. This involved hundreds of trade personnel inside the existing building, which also led our scope of work to include coordination of conduits for electrical and lighting.

The construction planning on this project required us to detail everything piece-by-piece. Accordingly, a plan was developed in the 3D model. Each stage

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required engineering review and supply of custom temporary supports or bracing when necessary, to ensure continuous stability of the structure during erection. This attention to planning allowed Walters to construct this project in a timely, efficient and safe manner.

"The prestige of constructing the roof of our future Canadian parliament was very exciting to us," shared Mark Koppelaar, Vice President at Walters Inc. "If the glazing was clear, the extremely complex roof geometry and connections would have been impressive for all to see. Standing in the courtyard viewing the steel, glazing and stonework gives an amazing sense of the grandeur of this space."

This project required Walters Group to bring together an array of experienced individuals to address the many challenges. The broad team consisted of engineers, detailers, welders, fitters and ironworkers to cover all the facets on this project.

However, the teamwork attributing to the success of this project did not only include Walters staff – our gratitude of partnership extends to the owner, Public Services and Procurement Canada, our client, PCL Constructors Canada, the Architects ARCOP/FGM, the Engineer Ojdrovic Engineering, and the glazing contractor seele canada Inc., along with the many others we dealt with during this project's journey.

For those that plan on visiting the parliament in the years to come, make sure you pay attention to the roof as it is a great example of the effectiveness of structural steel for both structural and architectural design. AS

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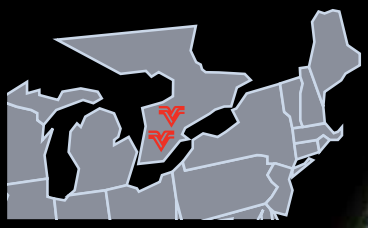

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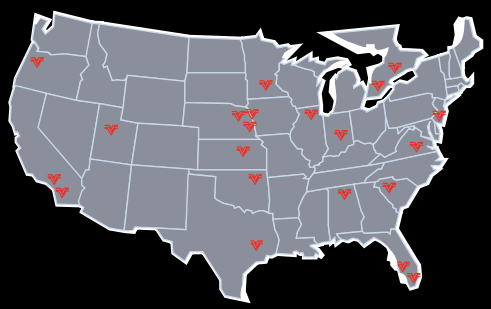

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A NEW HOME FOR KN

As Calgary's Central Library turns the page

Richard Woodbury

OWLEDGE

Image courtesy of CMLC

AT THE SITE WHERE the new Calgary Central Library is being constructed, designers were presented with a challenge that could either be viewed as a blessing or a curse – the presence of a curved light-rail transit (LRT) line that literally goes from underground to street level. Embracing this challenge as an opportunity, the LRT is now one of the defining characteristics of the library.

"When you look at it from the north end, the trains literally come out from underneath the building. Because of the curved nature of the tracks, you can't really see where they're coming from … it's kind of like the library is spitting out trains every so often," says Entuitive's Ian Washbrook, who served as the engineer of record on the project.

This feature not only provides a stunning visual element, but a practical one as well. "By building over top the tracks … we were able to create a site that was much larger," says Washbrook. Before the library was built, the first phase of the construction project was to encapsulate the LRT line, which literally provides the foundation for part of the library and inspires its design.

"This had a significant impact on the design, which adopted a curved grid and plan that accepted the imposition of the LRT into the design. Almost 40% of the building structure is coincident with the structural enclosure of the LRT," says Janice Liebe, Dialog Design's architect of record on the project.

Image courtesy of Calgary Municipal Land Corporation

"Concrete really wasn't an option to frame these trusses... the advantage of structural steel is that it's an excellent material for both compression and tension."

Ian Washbrook, Entuitive.

The finished product will be a four-storey library with 240,000 square feet of functional and flexible space, and is expected to cost $245 million. It will be a place for Calgarians to "explore, relax, reflect and connect," says Susan Veres, the senior vice president of strategy and business development with the Calgary Municipal Land Corporation, the project owner.

The library will replace the city's existing central library, which was built in 1960 but had an addition done in 1974. Many of the library's existing systems – such as fire and washrooms – no longer meet code and a retrofit would have been prohibitively expensive.

Exterior construction has mostly finished on the project and the work is now shifting to finishing the interior. It's anticipated the building will be handed over to the Calgary Municipal Land Corporation in May 2018. It will then take a number of months to transfer the library books and allow staff to learn the new systems. The expected opening date is in the fall of 2018.

Certain elements of the building, namely trusses, required structural steel. "Concrete really wasn't an option to frame these trusses," says Washbrook. "It's doable, but the members would be a lot larger and it wouldn't satisfy the architectural intent of trying to keep these members as compact as possible. And the advantage of structural steel is that it's an excellent material for both compression and tension."

One of the things that makes building a library different from structures like condos or office buildings is the heavy loads that must be accounted for because of the countless books libraries hold. The new library is expected to house around 600,000 books.

Shaune Turpin served as the project manager for Supermetal, the company that fabricated and erected the structural steel used on the project, of which approximately 1,711 tonnes was used. A good portion of the steel was standard-type fabrication, with the exception of five large truss components that form the building's structural framework.

The majority of the five trusses were fabricated using steel plate sections up to four inches thick and came directly from a steel mill in Pennsylvania. "The plates were shipped to a plate-cutting specialist in Pennsylvania where they were cut in strips to be used in the final assembly," explains Turpin. The need for cutting the steel was there because they would have been too heavy to ship. "Essentially, we had to take a large 6 by 80 foot sheet of plate and cut it into strips, then ship them to the fabrication plant. The strips of plate were then

Image courtesy of CMLC

stacked like a sandwich and welded together, to create a nearly solid block of steel," says Turpin.

The heaviest single member, a component of truss No. 4, weighed about 50 tonnes and had a length of almost 75 feet. (The longest member was about 83 feet long, but only weighed around 42 tonnes.)

Given the huge size of the trusses, a specific installation sequence was required using a temporary bracing member to hold the truss components in place until all members were erected. "Using a 500-tonne hydraulic crane, we hoisted the truss components into place and held them until the bracing members were installed using the site tower crane," says Turpin.

One particular connection took seven days of welding on two to 10 hour shifts, and approximately 140 hours of work to complete. During the entire process, the connecting members needed to be heated to about 190 C, with some post-heating afterwards. Each welded area like this required some protection from the elements in case of snow or rain.

Calgary's current central library hosts more than one million customer visits per year and offers hundreds of community programs. With an increasingly dense downtown core, more

PROJECT TEAM

ENGINEER: ENTUITIVE **GENERAL CONTRACTOR:** STUART OLSON **OWNER:** CALGARY MUNICIPAL LAND CORPORATION **CLIENT:** CALGARY MUNICIPAL LAND CORPORATION **FABRICATOR, ERECTOR:** SUPERMETAL **PROJECT MANAGER:** COLLIERS PROJECT MANAGERS

Photos courtesy of Shaune Turpin

Image courtesy of Calgary Municipal Land Corporation

Image courtesy of CMLC

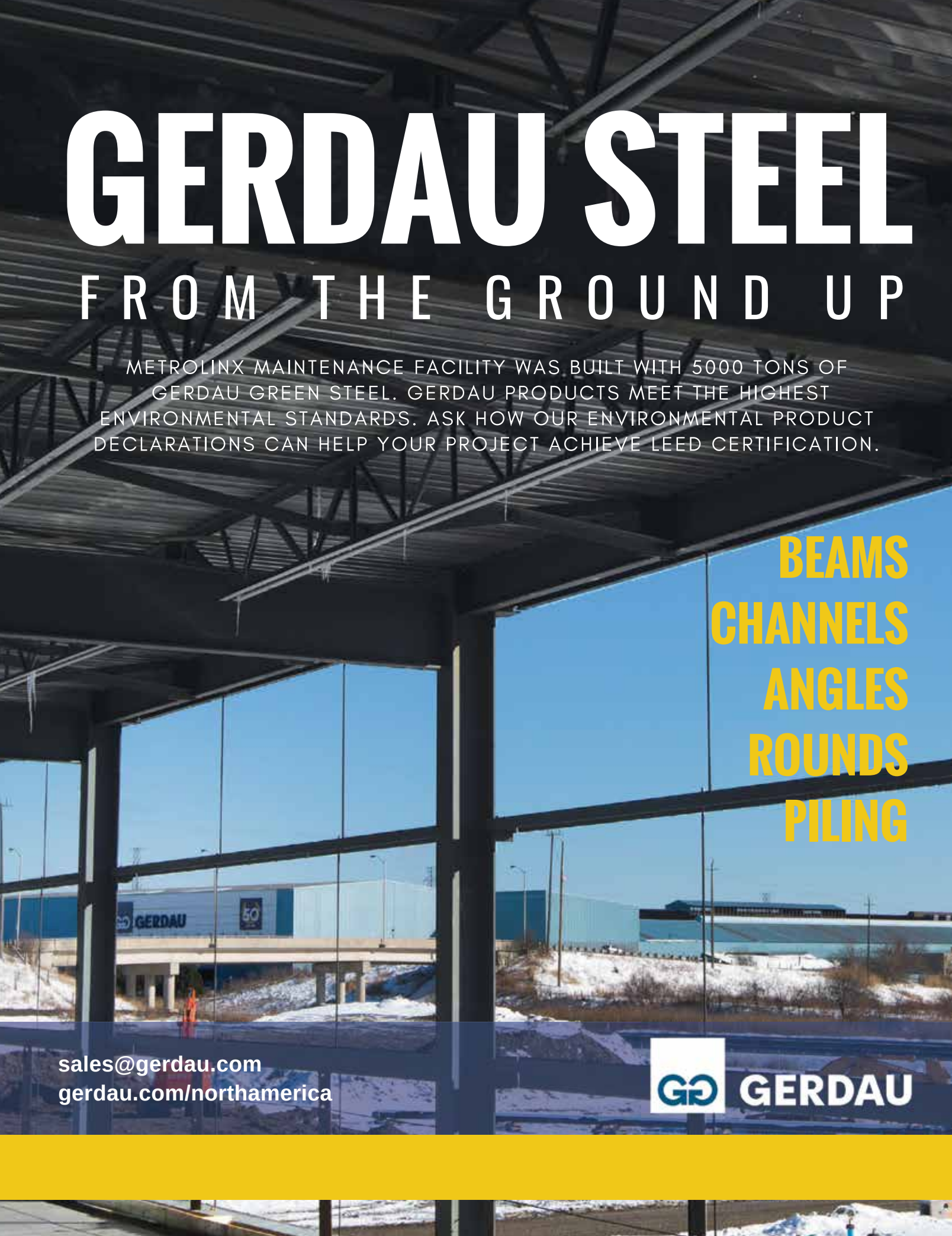
Image courtesy of CMLC

pressure is being placed on the library system to provide relevant and current programming. "The vision for the new central library is to foster an educational destination and an intellectual journey for all Calgarians, while providing more programs and services which cater to Calgary's changing demographic and psychographic profile," says Veres.

Adding to the experience is the LRT. "What's unique is the user experience that's created as a result of the train: if you are sitting in the north area of the library you will see the train come and go from underneath. The exterior and street life surrounding the library is just as much a part of the building as the interior," says Veres.

Washbrook says this has been a great project to work on, in part because he's done many presentations about it to classes at his children's school. "All the kids can relate to it," he says.

Once it's ready, the library will become a permanent fixture of life in Calgary meant for the entire population to enjoy. "Not many buildings have I worked on where you can go in and walk through at any time," says Washbrook. AS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RAISE THE ROOF

Rubic becomes the prototype for innovation

Tareq Ali/Marie Riopel

Photo credit: Saul Rosales

AS YET ANOTHER powerful example of innovation in the steel construction industry, Montreal-based engineering firm 3L Innogenie recently debuted their Upbrella System, a revolutionary patented construction system for buildings that uses a series of synchronized telescopic lifting actuators and a protective roof enclosure to fully construct one floor at a time behind weatherproof barriers, providing a safer and more protected working environment and virtually eliminating bad-weather delays on jobsites.

The Upbrella system, which recently made its debut in the "Rubic," a 10-storey mixed use building in downtown Montreal, has captured the attention and imagination of the construction industry and is drawing rave reviews.

In addition to providing a protected, factory environment for construction, the Upbrella system significantly reduces the costs and risks associated with multi-storey building construction, while improving safety and overall build quality.

PROJECT OVERVIEW

The excavation and foundation began with traditional methods for vertical construction; however, a mini revolution soon unfolded when the Upbrella system was introduced on site. "Upbrella starts with the roof and uses a two-storey high protective enclosure that surrounds and closes the construction zone atop the building," explains Upbrella president Joey Larouche. "The additional floors are constructed under the roof to be lifted in place as the roof goes up. When the work is ready, only the roof and the last floor are raised. The 10


Photo credit: Saul Rosales


Photo credit: Saul Rosales

storeys of Rubic were erected at an average pace of two storeys per month."

This innovative building strategy does not require the traditional use of a crane or complicated scaffolding. It ensures that the construction is protected and supported by using gateways attached to the building as they are sheltered by the roof and a temporary perimeter of reinforced canvas. A synchronized system of lifting actuators replaced conventional lift methods, allowing workers to be protected from severe weather in a closed and controlled area.

The structure, composed of Comslab® deep steel decking and concrete cover slab, displays many unique features. Factory prepared materials were assembled on site, and though solid, are lightweight enough that two workers can transport the pieces without special equipment. The Upbrella technique attracted so much attention in the field that a hundred specialists visited their construction site during an open house in the fall of 2015. Since then, news reporters from around the world – including France, Ukraine, Norway, the U.S. and Vietnam – have been paying attention.

This ingenious system was created and developed by Joey Larouche, a mechanical engineer who taught Product Design at Montreal's École Polytechnique. One of 3L Innogénie's co-founders, of which Upbrella is a subsidiary, Larouche's work experience in the manufacturing sphere inspired him to think outside the box, and he further perfected the Upbrella system with his cousin Justin Larouche and father Gilles Larouche, through their firm.

For the first three years, Upbrella Construction invested in developing software, 3D models and prototypes while consulting professionals such as general contractors, specialists and government authorities to ensure their project was on track. Happy with the positive response, Joey felt encouraged to persevere. The 3L co-founders wanted to be "construction ready" before proposing their model to the very conservative construction field. Their motto is based on quality, security and efficiency.

Finally it was Luc Poirier, a well-known Montreal real estate promoter, who became the first to try Upbrella's technology for his Rubic building, understanding its many advantages. Upbrella's roof is made of metal for a temporary reinforcement, in order to use it as an anchor for all the materials. The roof can remain permanently if it has the required design or it can be adapted to the architectural needs of the building at the end of the project. At the outer-covering steps, a peripheral

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Photo credit: Joey Larouche

protective wall also protects the workers and the construction field.

Upbrella Construction aims to use the highest-grade materials on all their projects. "We propose composite structures to reduce the carbon footprint associated with conventional caste-in-place concrete and to reduce the weight of the structure. Composite structures benefit from better use of the high resistance properties of steel to reduce both steel and concrete and provide greener structures with less materials to transport to the job site," explains Joey. Composite structures also provide better immediate support for the Upbrella roof and allow for a quick installation.

Inspired by elevators and cylinders, the hydraulic screw jack system is used for periodical lifting and remains on the site during the full construction operation. In the Upbrella system, a 10-ton capacity cylinder equipped with synchronized double action is fixed to each column. One cylinder by column is usually sufficient to lift the roof and the new floor.

The floor is typically raised in two phases. First, the floor is installed to its permanent level. This is followed by phase two, which involves raising the roof to insert the new columns, linking

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Celebrating 15 Years Supporting North American Steel Fabrication

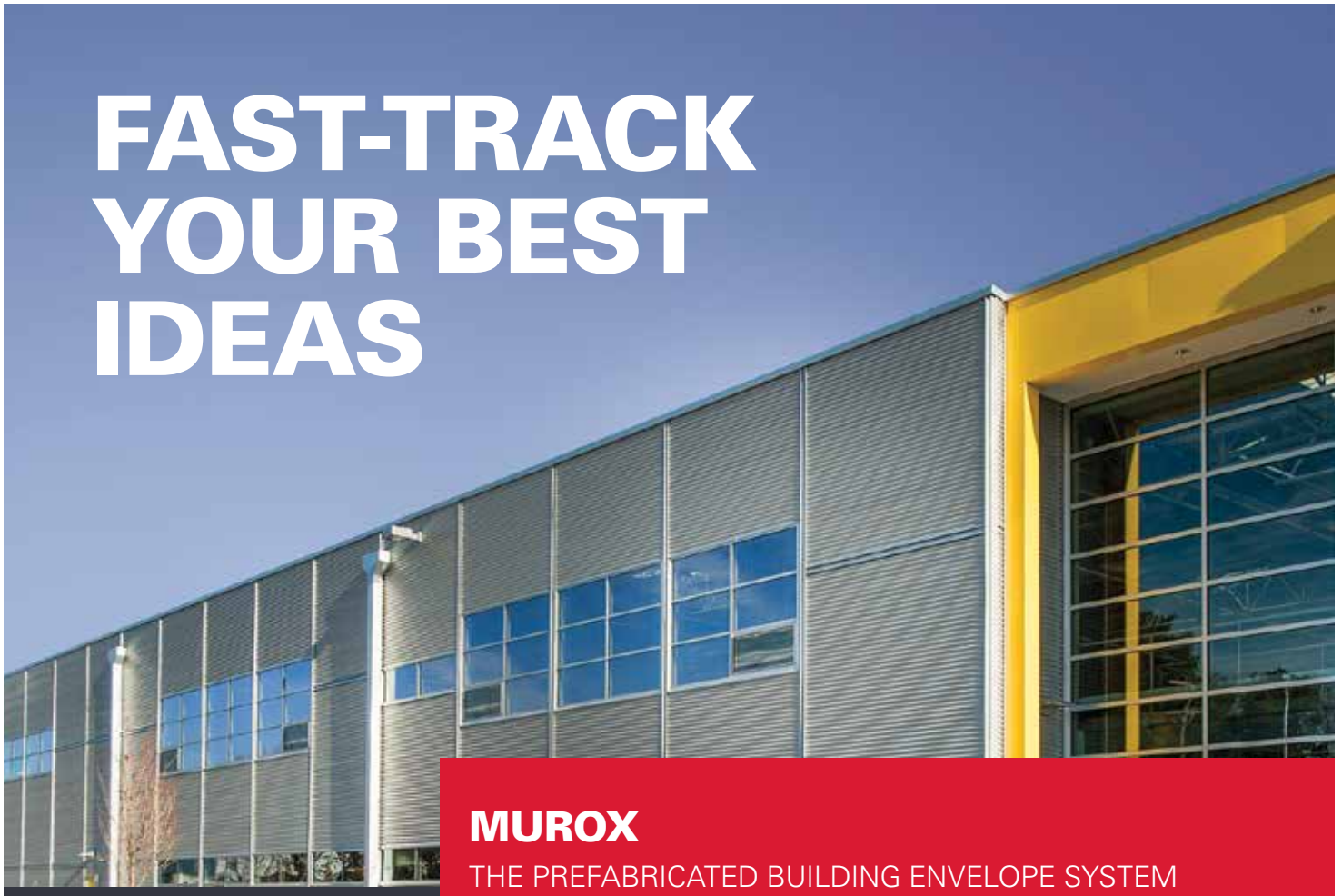
Photo credit: Joey Larouche

The Upbrella system significantly reduces the costs and risks associated with multi-storey building construction, while improving safety and overall build quality.

the new floor. Workers assemble the next floor structure from the ground level and so on as the project progresses. One of the great advantages of the Upbrella concept is that it conveniently requires minimal space to work in a dense urban environment. The Rubic 10-storey tower was built on just 3,700 square feet.

Home insurance brokers applaud the minimal risk of weather damage and other incidents. This approach also maximizes the economical value of a project by reducing business risks and costs. "Once the roof is raised and the new floor reaches its permanent height, the exterior wall below is completed. Therefore, a complete structure and shell is erected within the protective enclosure (the Upbrella), to maximize safety (and) quality, and accelerate deliveries," says Joey. As Luc Poirier illustrated during the open house: "While part of the construction crew works on the 9th and 10th floors structures, their colleagues can install the outer covering on the 7th and 8th floors, while other members of the crew divide the section and do the finishing touch on the 5th and 6th floors. During this time the model suites are already ready and levels 1 to 4 could be potentially rented." Joey adds, "Model apartments were ready to show and facilitated rentals three months after the first roof lift." This can have a significant impact on the funds being invested on a building project.

FAST-TRACK YOUR BEST IDEAS



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The Upbrella system is also geared to minimize waste and help contractors save time and money. Today Joey can measure gains that include the saving of 500,000 BTUs of heat that normally dissipates when working on open structures. His construction system for high-rises proved a great and viable alternative to small lots where traditionally there would be no place to build. Furthermore, a continuous ongoing team working in harsh temperatures can save the investors as much as 20%. Needless to say, Upbrella handed over the Rubic building on its scheduled date. "The just-in-time deliveries and the lowered amount of materials reduced the public occupancy charges and the overall disturbances caused by the project in a very tight and busy urban area," he says.

In a construction industry concerned with safety, Upbrella also offers a safer ergonomic option for its workers: working at an eye-level position, on a solid floor, at all times. As Joey puts it, "No need for harnesses – we recreate a factory environment on the construction site." This has in turn enhanced staff productivity onsite; the staff are more motivated and productive at work.

Multiple awards have been given to 3L Innogénie and its subsidiary Upbrella. Last December, Upbrella was recognized as the Most Innovative Product of the Year by the Toronto Construction Association. In March, they received the 2017 Regional Recognition award for an innovative project by l'Ordre des ingénieurs du Québec. In June, at PwC Canada's Vision to Reality Awards, Upbrella won in the under $25-million Disruptors category. AS

PROJECT TEAM

ARCHITECT: RAYSIDE LABOSSIÈRE **GENERAL CONTRACTOR:** UPBRELLA CONSTRUCTION **STRUCTURAL ENGINEER:** CPF GROUPE CONSEIL **ELECTRICAL/ MECHANICAL ENGINEER:** CPF GROUPE CONSEIL **CIVIL ENGINEER:** GENEXCO **ENVIRONMENT AND GEOTECHNICS:** SCP ENVIRONNEMENT **CODE CONSULTANT:** GLT+ GROUPE CONSEIL **CLIENT:** LUC POIRIER, INVESTISSEMENT POIRIER **OWNER:** LUC POIRIER, INVESTISSEMENT POIRIER **FABRICATOR, ERECTOR:** ACIER MÉTAUX SPEC, BAILEY METAL PRODUCTS (COMSLAB) **(ALUMINIUM OUTER COVER):** MULTI-PLIS

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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 2015 Str. Comm.	NBC 2020 Str. Comm.	2021
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] 3rd Printing[2]	TBA	
CISC Moment Connections for Seismic Applications	2nd Edition[3]	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	
Crane-Supporting Steel Structures: Design Guide (Informative)	3rd Edition	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]3rd Printing of Handbook has been updated to reflect changes introduced in CSA S16-14 Update No. 1 released in Dec. 2016

[3]Adopted in S16-14 by reference

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Distributed nationally to 5,000 subscribers (including developers, architects, engineers, fabricators, detailers, erectors and suppliers), it's published three times annually and reaches key industry personnel and decision-makers in construction.

Advantage Steel is produced in separate English and French issues – with 5,000 English copies and 1,500 French copies – and is the definitive source for readers to increase their expertise in steel in construction. In addition, it presents an excellent means of communication to the industry; detailing trends and providing a forum for thought leadership in architecture, engineering, technology and construction.

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

This 6-hour (9-module) course covers the changes in CSA S16-14 and the design of steel members and elements using the recently published 11th Edition of the Handbook of Steel Construction. Course participants will be able to purchase a copy of the new Steel Handbook at a discount.

The first 3 modules cover an overview of the 11th Edition of the Handbook and the major changes and new provisions introduced in CSA Standard S16-14, "Design of Steel Structures" and the CISC Commentary on CSA S16. Changes in Clause 27 Seismic design are included in this session.

The remaining 6 modules provide the background and use of design aids contained in the new Handbook while drawing the participants' attention to changes, new additions and hidden gems. However, overall building behaviour and seismic design are outside the scope of the Handbook of Steel Construction and this portion of the course.

Modules 4 through 7 present 22 design examples to illustrate design aids for bolts, welds, simple beam connections (single angle, double angle, end plate, seated and shear tab), tension members, compression members and flexural members (composite and non-composite).

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.

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This 16-hour course (19 modules) covers the design, fabrication and construction of steel bridges based on CAN/CSA-S6-14, Canadian Highway Bridge Design Code. In addition to 4 reworked design examples, updated topics include code overview, brittle fracture, fatigue, methods of analysis, wind and seismic load effects, and aesthetics including pedestrian bridges.

The presentation and 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, sustainability, design process and economics, highway bridge loads and methods of analysis, wind and seismic effects, fabrication and economical details, construction and erection methods.

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

INDUSTRIAL BUILDING DESIGN

This 8-hour course (4 modules) focuses on practical and economical solutions for framing a typical industrial building to the requirements of the 2015 National Building Code of Canada and the pertinent provisions of CSA Standard S16-14. Whenever possible, relevant provisions in NBCC 2015 are discussed. The course material references the new third edition of the Crane-Supporting Steel Structures: Design Guide and feature a completely reworked design example. Each student will receive a copy.

This course covers loading conditions for industrial buildings, design of crane-supporting girders, stepped columns, purlins and girts, lateral force resisting systems, roof trusses and efficient connections, serviceability considerations and limitations, fatigue, standing seam roofs, rehabilitation, tolerances and coatings.

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

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.

SINGLE STOREY BUILDING DESIGN

This 8-hour course (4 modules) provides the design theory and the rationale behind code provisions as well as the application of specific Code formulae and requirements. It focuses on practical and economical solutions for framing a single storey warehouse building with attached office area to the requirements of the 2010 National Building Code of Canada and the pertinent provisions of CSA Standard S16-09. Practical steel framing concepts and integration with architectural and mechanical features are discussed. Major changes in NBCC 2010 and CSA S16-09 are highlighted.

This course covers gravity loads, including ponding and snow drifting, companion load combinations, wind and seismic loads, selection of deck and joist systems, design of Gerber girders, interior and exterior columns, girts, base plate and anchor rods, selection and design of braced frames and roof diaphragm, notional loads and P-delta effects. Each student will receive the Single Storey Building Design Aid which contains an example set of calculations for the single storey building presented in the course.

ARCHITECTURALLY EXPOSED STRUCTURAL STEEL (AESS) SERIES

This series of five 1.5-hour presentations introduces the CISC suite of AESS documents on the design and specification of Architecturally Exposed Structural Steel, with specific focus on the CISC matrix, categories of AESS and the visual guide to assist architects and engineers in specifying AESS. The idea behind the matrix and guide are to provide the means to differentiate the expectations for finish and detailing of the final product, and assist in clearing the communication paths between the architect, engineer and fabricator.

The presentations focus on walking the participants through the documents, with emphasis on the matrix and illustrated guide. The different characteristics of design and fabrication that are associated with the AESS categories are described in detail. As the categories were developed in response to form, fit and finish, the associated issues of welded versus bolted detailing, the importance of distance to view and the impact of finish selection on the appropriate detailing of the project are addressed. The content addresses other issues associated with finishes (paint, intumescent coatings, galvanizing) and handling, as well as the incorporation of curved members and other specialty products. The webinar will be highly visual and include many examples from recent projects in Canada and around the world.

Each student will receive a complimentary copy of "CISC Guide for Specifying Architecturally Exposed Structural Steel, 2nd Edition."

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