ADVANTAGE STEEL

NO. 62 FALL 2018

NEW INNOVATIONS IN STEEL

UNIQUE GIRDERS ESSENTIAL TO WINNIPEG'S KENASTON FLYOVER PROJECT

VANCOUVER'S ICONIC TELUS GARDENS

WESTJET GOES GLOBAL

CISC STEEL BRIDGE CERTIFICATION STANDARD

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SUCCESS STORY: Stehl Corporation

PythonX Streamlines Company's Move into Structural Fabrication

Started in 1999, it began as a miscellaneous and metal company and expanded to become premier supplier of structural steel that is based in Phoenix, AZ, USA.

CHALLENGE

AUTOMATE PRODUCTION TO INCREASE VOLUME AND DECREASE BACK LOG

To resolve these challenges, Stehl needed to replace the old beam line with new technology. Stehl knew that a robotic cutting solution could be implemented to process steel in a fraction of the time, thereby increasing efficiency and throughput, while reducing production time, all of which would help the company achieve their goal of expanding into structural steel fabrication.

SOLUTION

RESEARCH

Stehl began an in-depth investigation for new technology that turned out to be a two year process which included a lot of online research. He also spoke and visited others who were using the PythonX and competitive systems. In the end, the advice Stehl received from others in the industry played a pivotal role in his selection of the PythonX.

INSTALLATION AND TRAINING

Although excellent long-term performance was a major criterion, the speed of installation and return to production were also key factors. After the typical 5 day PythonX installation, several employees were trained on how to efficiently operate the PythonX in only 3 days.

THE INVESTMENT

For a growing company such as Stehl Corporation, the PythonX proved to be the answer to numerous challenges. Stehl Corporation's PythonX is outfitted with both infeed and outfeed cross-transfers, as well as an infeed conveyor, for maximum productivity. But beyond productivity, the system also offers capabilities the company previously did not have.

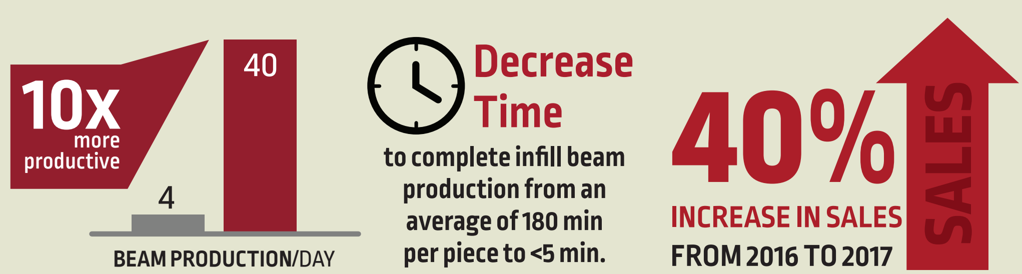
PAUL DAVID STEHL

President and Founder,
Stehl Corporation

THE PRODUCT

The PythonX, a versatile and complete solution that automates processing operations in a fabrication shop while providing increased productivity, unmatched cut quality, predictable and consistent throughput as well simplicity of operation.

RESULTS



For more information on this revolutionary technology: Call +1-833-PYTHONX

Watch our Customer Success Videos: www.pythonx.com/customer-success

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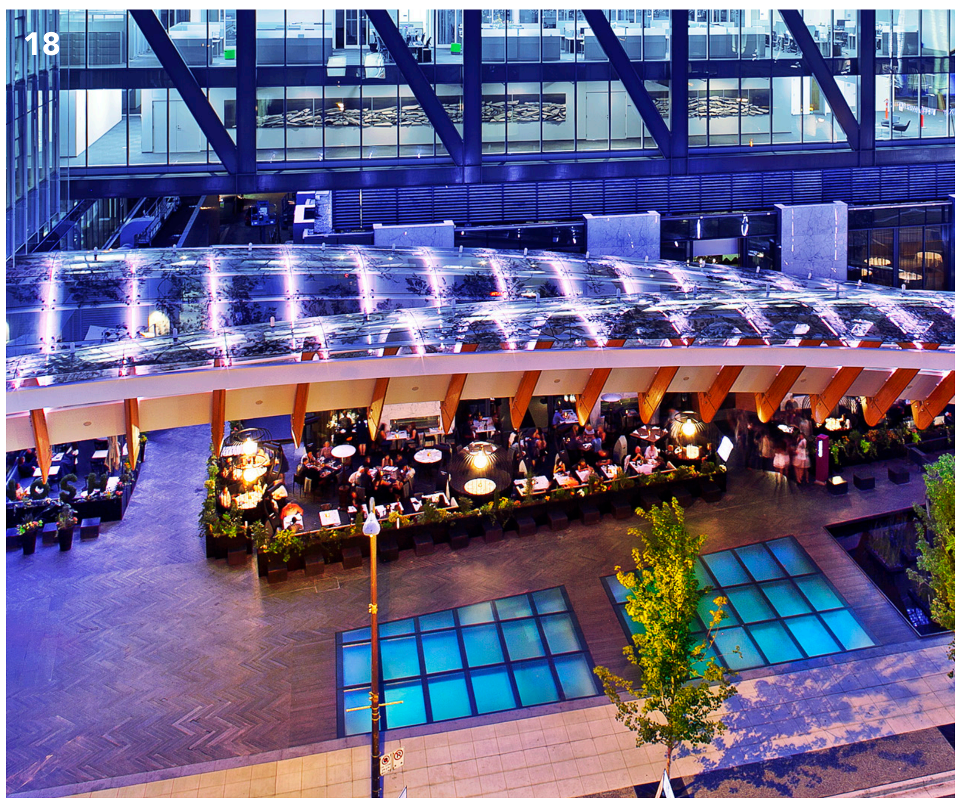
FEATURES



IN EVERY ISSUE

COLUMNS

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.

On the Cover:
Telus Gardens Office tower, Vancouver, B.C.

Photo courtesy of Robert Stefanowicz Photography.

Structural Steel Buildings Escape Canadian Tariffs

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

IN THE MARKETING WORLD, sometimes negative press is good press. It creates awareness and curiosity which is sometimes better than the best laid marketing campaign. It can drive sales and even votes.

The steel tariffs imposed by the U.S. and countered by Canada had little to do with security and all to do with votes. How Canada fairs in this tariff tiff will sooner or later be determined. But how does all this affect structural steel building construction in Canada in the meantime?

What may come as a surprise to some is the fact that Canada does not roll wide flange beams. Algoma long since stopped rolling wide flange beams capitulating this product to the cheaper and more efficient electronic arc furnace (EAF) mini-mills in the U.S.

What may also come as a surprise is that the Canadian retaliatory tariffs do not include steel beams, angles, channels and tee sections larger than 80 mm. Since this comprises the majority of the steel used in steel building construction and the fact that Canada has several HSS mills with enough capacity to supply the Canadian demand, structural steel buildings come out pretty much unscathed compared to other building types, such as concrete.

Canadian rebar mills produce approximately 50 per cent of Canadian rebar consumption needs with the balance being supplied by the U.S. and other offshore countries. With the U.S. tariffs on the rest of the world providing price protection within the U.S., the majority of U.S. rebar is now consumed within the country. Add the 25 per cent Canadian tariff to the U.S. supply and the Canadian government announcement is looking at provisional Rest of World (ROW) Safeguards (a.k.a tariffs) on offshore dumped and subsidized rebar, the supply and price of rebar will be challenging to predict.

For all the squawking the U.S. makes about leakage of Chinese steel through Canada, Q1 2018 stats show that the U.S. mills have 70 per cent of the Canadian market share of wide flange steel beams, with Luxemburg at 12 per cent, Korea at 9 per cent, Spain at 4 per cent and China at 2 per cent. Can you say "fake news," boys and girls?!

Canada has long preferred U.S. milled steel over offshore products due to product conformance and global competitive pricing. The U.S. market share of steel beams in Canada bears this out. What Canada does have, to its benefit in 2018, are procurement options. With an established offshore supply chain, Canada can easily increase procurement from these regions of the world to moderate pricing and meet demand.

But sometimes cost perception is worse than reality. Even in this time of fluctuating steel prices, the price of structural steel has a very small effect on the overall cost of a construction project. The entire installed cost of a steel framed building ranges from 9-13 per cent of the entire building cost. For your typical commercial structure the raw steel material costs represent approximately 30 per cent of that. Fluctuations in steel prices up and down by 25 per cent would only represent a 0.6 to 1.5 per cent effect on the total overall project cost.

This is all very good news for Canadian building owners considering building in structural steel. No steel tariffs, an established supply chain from the U.S. and from the rest of world, and an under utilization of fabricator capacity positions steel framed buildings in a very competitive place. AS

> "With an established offshore supply chain, Canada can easily increase procurement from these regions of the world to moderate pricing and meet demand."

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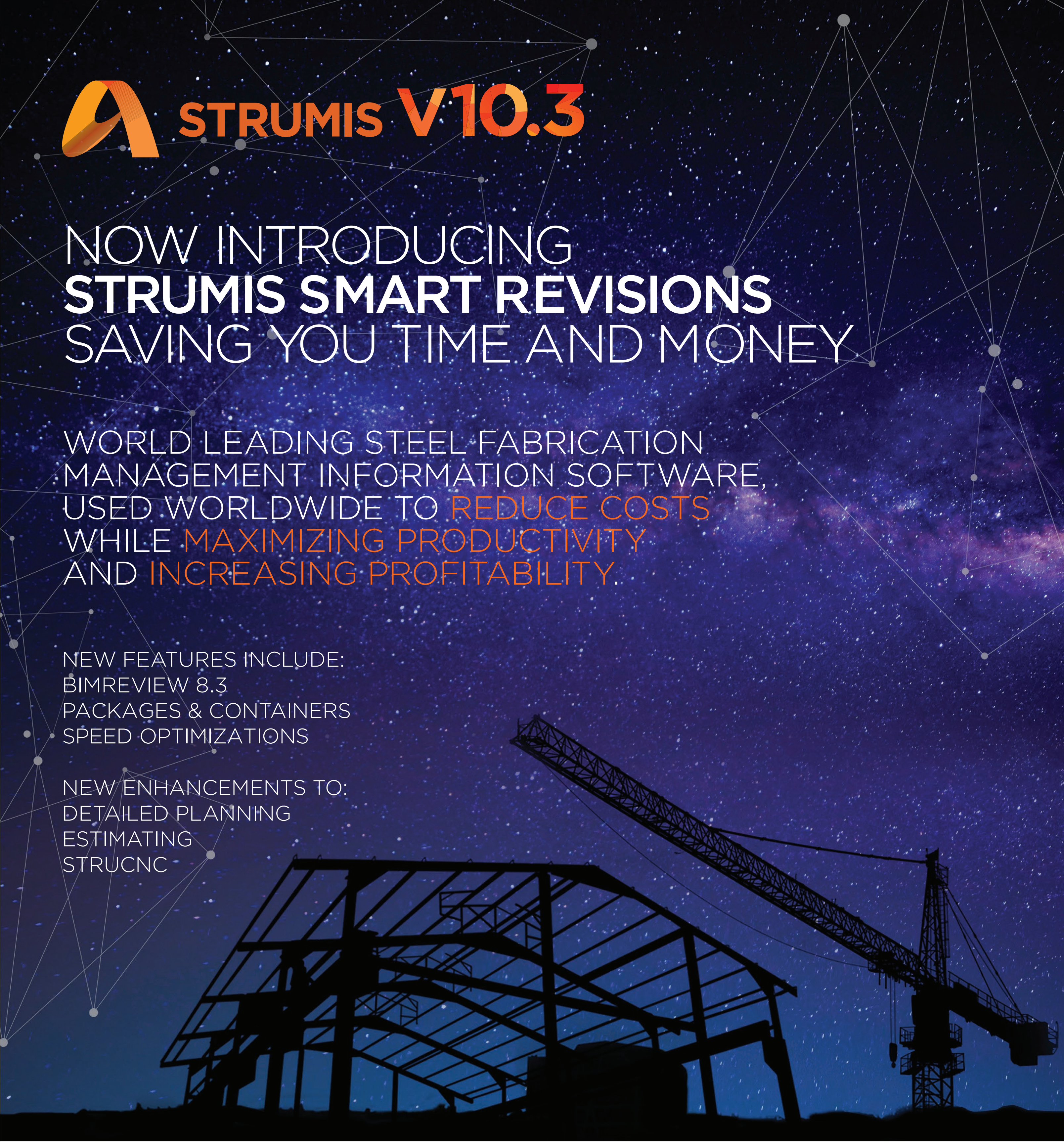
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Alfred F. Wong, P.Eng., F.CSCE
Director of Engineering

Question 1: What is the difference between "snug tightness" and "snug-tightened condition"?

Answer: The term "snug tightness" is defined in CSA S16-14, whereas the term "snug-tightened condition" is used in the reference below. They share the same definition: the tightness that is attained with a few impacts of an impact wrench or the full effort of an ironworker using an ordinary spud wrench to bring the plies into *firm contact*.

Question 2: Firm contact is defined in CSA S6-14 as the condition that exists on a *faying surface* when the plies are solidly seated against each other, but not necessarily in continuous contact. Does the lack of continuous contact adversely affect the clamping force in the joint and the joint's slip resistance?

Answer: Continuous contact throughout the *faying surface* area between thick plies may not be possible. Snug tightness is attained if the plies are solidly seated against each other. As explained in the reference below, "if the specified pretension is present in all bolts of the completed joint, the clamping force, which is equal to the total of the pretensions in all bolts, will be transferred at the locations that are in contact and the joint will be fully effective in resisting slip through friction."

Question 3: CSA S6-14 permits burrs that are 2 mm in height or less to be left in contact surfaces of bolted joints. Do these burrs affect the clamping force in the joints and their slip resistance?

Answer: Research studies conducted in the 1980s and 1990s demonstrated that the presence of small burrs did not adversely affect the slip resistance. However, greater effort may be required to bring the contact surfaces into "firm contact" in order to attain the "snug tightness," which is particularly important when the turn-of-nut method is used to pretension the bolts. If the small burrs are not flattened prior to the nut turn count, a small reduction in bolt tension for the specified nut turn is expected.

Question 4: Should ASTM F959 direct tension indicators be used as tension calibrators for pre-tensioned bolts installed using the turn-of-nut method?

Answer: CSA S16-14 recognizes both the turn-of-nut method and the use of ASTM F959 DTIs as two independent methods for installation of pre-tensioned bolts. In any case, if for whatever reason the bolt tension installed using the turn-of-nut method needs calibration, DTIs give unreliable results for two reasons:

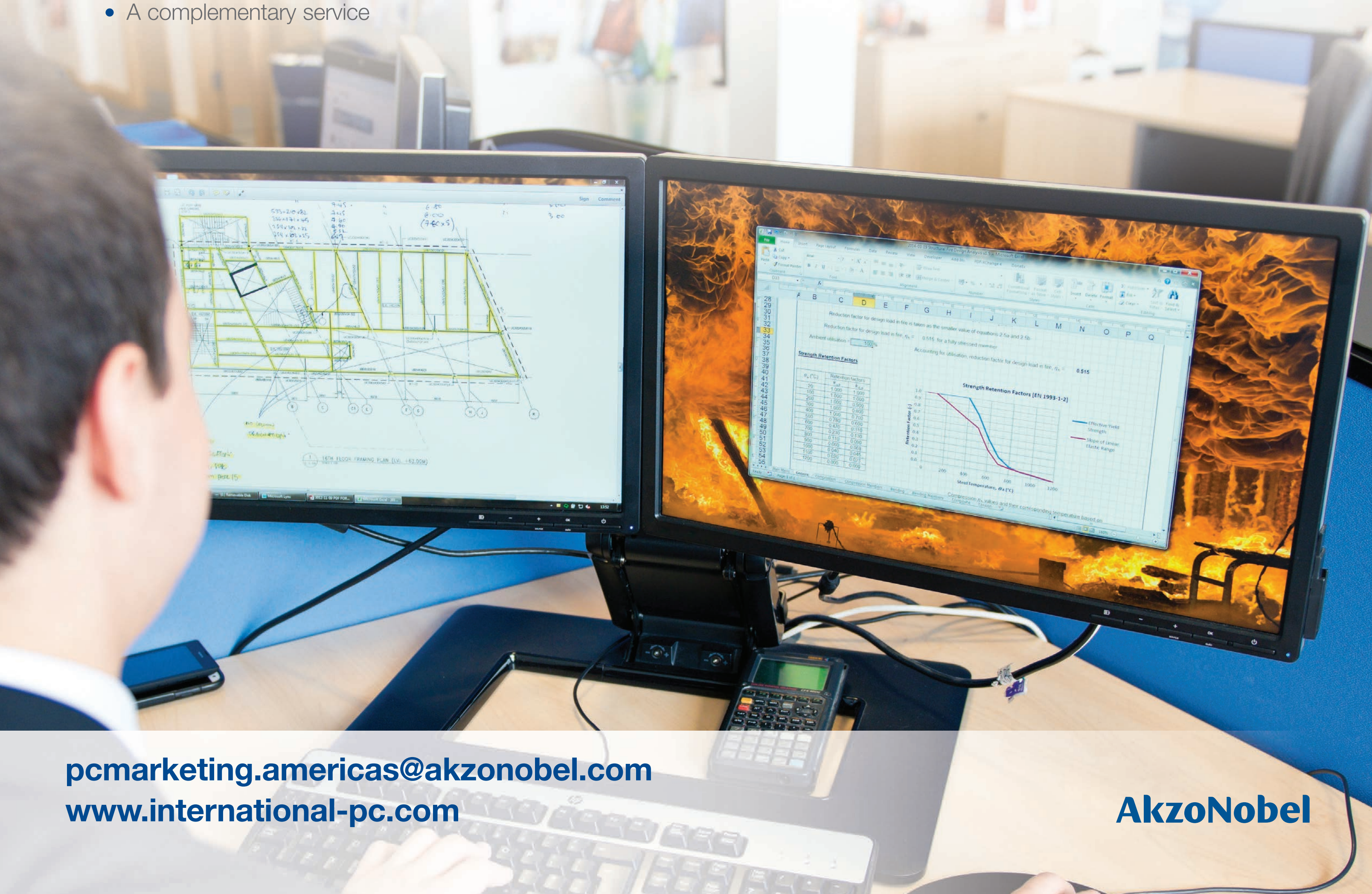
a) the deformation of the DTI consumes part of the turn provided, and
b) the turn-of-nut method is expected to achieve significantly larger pretension than the DTI method, and the larger pretension and slip coefficients are recognized in the design in accordance with S16-14, but these larger pretension values are not explicitly defined in S16.

Question 5: CSA S16 does not specify the oversize hole diameter for 1-inch bolts. Where may I get such information?

Answer: *CISC Handbook of Steel Construction – 11th Edition,* in Table 3-47, includes oversize hole dimensions for the Imperial series of bolts. The hole diameter values for bolts not covered in S16-14 were converted from the values provided in the reference below and rounded to the nearest millimetre.

Reference: RCSC. 2014 Specification for Structural Joints Using High-Strength Bolts. Research Council on Structural Connections. AS

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.



Michael Holleran, P.Eng.
Canam Buildings and Structures

Encouraging the Growth of the Steel Industry Through Education and Research

ON BEHALF OF THE Education and Research Council (ERC), it is my pleasure to take this opportunity to inform the membership of our latest activities and developments. A lot has happened since my last quarterly update, and I am optimistic and excited to share our recent developments. Over the last quarter, the ERC has completed a number of initiatives that I believe will allow us to promote steel through education and research in order to ensure long-term and profitable growth in the steel industry.

The ERC hosted the CISC Educators Forum in Ottawa, ON, from March 2-3, 2018. This biennial event brought together 38 academic and research professionals who focus on teaching steel design to undergraduates and graduates in facilities across Canada. This two-day event involved discussions on current and emerging steel design and products, codes and standards, and innovative seismic design philosophy and developing systems. The educators were invited to share new technologies and concepts in making steel the material of choice for educators, students and industry. The CISC Educators Forum also had the opportunity to attend a site tour of the rehabilitation of the Parliament Hill West Block. This was a unique chance for the educators to walk and learn about the steel and glass roof design.

The ERC Research Committee has completed their research grant cycle for the 2018-2019 academic year. The committee reviewed 18 applications from 11 universities throughout Canada. The committee met together to review the evaluation of each research proposal. The total amount requested was over $420k, and we are pleased to be in a position to fund $96,600 for four research projects. The 2018 H.A. Krentz Research Award winner for the highest ranked proposal was Jeffrey A. Packer. Committee Chair, Mr. Terry Wilk will present the award to Jeff Packer at the CISC Canadian Steel Conference in Halifax, N.S.

The 2018 Jackson Fellowship is a prestigious award valued at $25,000. It is presented annually to an engineering student who will be registered in graduate studies in structural engineering, with major emphasis on the study of steel structures. The Jackson Fellowship Committee received seven high quality submissions. The committee reviewed all applications and met to discuss the evaluations. Xiao Lin (Dimple) Ji from the University of Alberta was selected as the 2018 Jackson recipient. Xiao Lin had a very strong application, and the committee felt as though she was an excellent choice to receive one of the steel industry's highest academic honours. Her research project, under the supervision of Professor Robert Driver, examines the lateral-torsional buckling capacity of welded wide flange girders and includes large-scale tests. She has received numerous awards and has maintained a GPA of 4.0 through her master's program. We wish Xiao Lin success in her future research endeavors.

The ERC has a long history of supporting several educational institutions and educational programs that align with our mandate and vision. I would like to highlight a new program offered by Conestoga College in Kitchener, ON, called Structural Steel Management and Detailing. This is a two-year graduate certificate specializing in the detailing, supply, fabrication and installation of steel structures and the management and coordination of such projects. The training is directly related to industry standards and working conditions within Canada and will enable students to develop detailed analytical and communication skills necessary for working in the structural steel industry.

Once again, please consider supporting the ERC to ensure these initiatives and the growth of structural steel. Please contact the CISC for more information on how your funding can directly support education and research in the steel industry. AS

"The ERC has a long history of supporting several educational institutions and educational programs that align with our mandate and vision."

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

When Other Loads Govern

FOR PRACTICALITY AND ECONOMIC reasons, codes are reluctant to enforce design for full elastic forces, especially where seismic forces are large. Inelastic design complicates the design substantially and has led to the concept of capacity-based design, a major departure from traditional design philosophy. The design becomes very challenging when seismic forces are significant, but wind or gravity load dictates some of the member sizes. This article briefly examines several common situations.

CAPACITY DESIGN

Traditionally, building structures have been designed to resist seismic load in combination with gravity loads in accordance with the applicable load combinations in the building code. Since the introduction of capacity design requirements in CSA Standard S16, capacity-protected elements in *seismic force-resisting systems (SFRS)* other than *conventional construction (CC)* are generally designed to resist forces corresponding to the capacity of the yielding elements instead. Capacity design works well except when loads, other than seismic load, govern the design of the "yielding members" in the SFRS. In this case, the yielding members that are stronger than what are required to meet the seismic load combinations inflate the required resistance for the capacity protected elements, including the resistance of columns, connections, foundations and floor and roof diaphragms. Capacity design requirements do not apply to CC. For some applications, however, CC is either not permitted or unsuitable.

WHEN WIND EFFECTS GOVERN

Wind forces or effects, such as deformation and accelerations of taller buildings, may govern the member sizes of the *SFRS*, including the yielding elements. These situations include tall and mid-rise buildings subjected to moderate seismic hazard as well as tall buildings subjected to high seismic hazard. Moment resisting frames are generally more flexible as compared to braced frame and shear wall systems, hence they are more sensitive to wind related serviceability requirements.

WHEN GRAVITY EFFECTS GOVERN

Live load deflection or floor vibration control may govern the design of beams in moment resisting frames with long spans. Since the beams are the yielding members, use of beams stronger than what are required to resist seismic load inflates the columns, connection, panel zone, foundation and diaphragm forces.

SOLUTIONS AND OPTIONS

S16 sets the upper bound for capacity design forces at forces corresponding to R_dR_o = 1.3 for members, horizontal diaphragms, foundations and ductile connections. Forces at this bound, however, are usually several times larger than the factored seismic forces in the yielding elements in a ductile system such as *ductile moment-resisting frame* (R_dR_o = 7.5). The upper bound forces may also be established using non-linear time-history analyses. Although the rules for non-linear time-history analyses are not well defined in S16-14, guidance is on the way.

Use of special systems, such as those incorporating seismic isolation or energy-dissipating devices, is also permitted. The burden to demonstrate that their performance meets or exceeds the safety level required in S16 and NBC rests with the structural engineer. S16 also permits the use of truss moment frames with ductile truss segments although S16-14 lacks specific requirement for the system. The trusses yield in shear near the mid span instead of flexural yielding near the columns, thereby separating the yielding mode from the flexural stiffness required for control of deformation due to wind or live load. Special truss moment frames have been used in the U.S., including prominent projects, such as the Terminal B Building and Concourse in Minetta (San Jose) International Airport (See Figures). Design provisions for special truss moment frames were introduced in AISC Specifications (now known as ANSI/AISC 341-16) in 1997 and research studies continued. Incorporation of the Canadian version is a logical development. AS

FIGURE 1: Minetta (San Jose) International Airport Terminal B Building

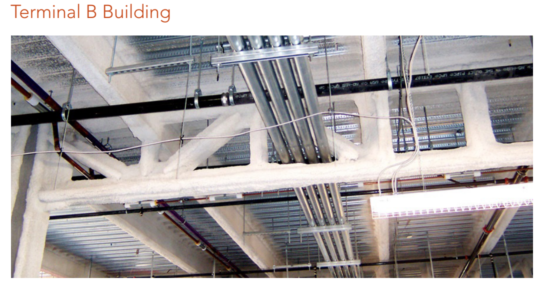


FIGURE 2: Special Truss Moment Frame - Minetta (San Jose) International Airport

Courtesy: Magnusson Klemencic Assoc. Inc.

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UNIQUE GIRDERS ESSENTIAL FLYOVER PROJECT

By James Peters

IN A CITY NOT OFTEN lauded for its traffic planning decisions, the Kenaston Flyover in Winnipeg is clearly an exception to the rule. Situated around a curve joining two well-established 80 km per hour thoroughfares in the city—the bridge has been widely recognized, and awarded, for its innovative design and construction features. The project received the 2017 Canadian Institute of Steel Construction Manitoba/Northwestern Ontario steel design award for bridges. The flyover is situated around the merging curve of Bishop Grandin and Kenaston boulevards, and a part of Winnipeg's Waverley West arterial roads system.

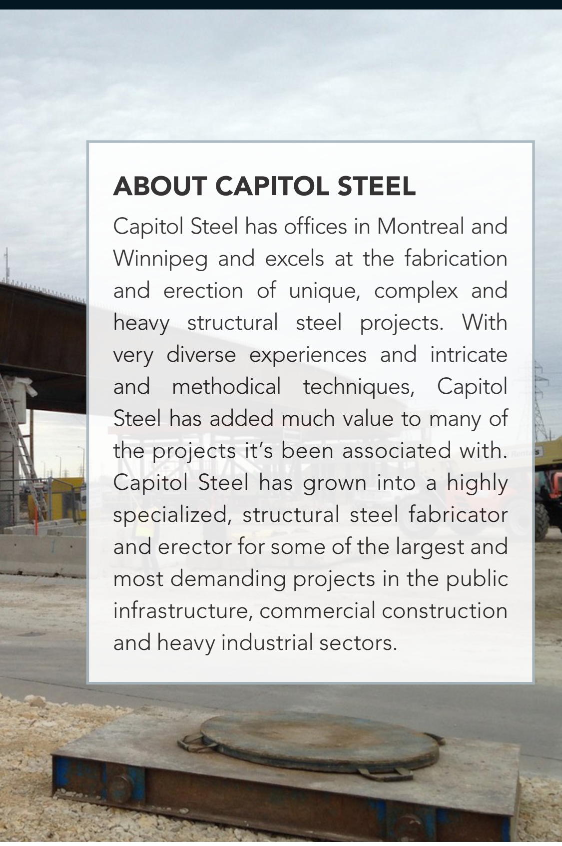
TRAPEZOIDAL BOX GIRDERS

Undoubtedly a key component in the project's success, Capitol Steel (Winnipeg) fabricated and erected the six trapezoidal box girders in two lines of three—each measuring seven feet in depth, 11 feet in width and 115 feet in length. Kris Overwater, Capitol's chief operating officer, describes the challenge, "A flyover isn't unique

PROJECT TEAM

CLIENT: CITY OF WINNIPEG **GENERAL CONTRACTOR:** M.D. STEELE CONSTRUCTION LTD. **DESIGN AND CONTRACT ADMINISTRATION:** DILLON CONSULTING **FABRICATOR/ERECTOR:** CAPITOL STEEL

TO WINNIPEG'S KENASTON



ABOUT CAPITOL STEEL

Capitol Steel has offices in Montreal and Winnipeg and excels at the fabrication and erection of unique, complex and heavy structural steel projects. With very diverse experiences and intricate and methodical techniques, Capitol Steel has added much value to many of the projects it's been associated with. Capitol Steel has grown into a highly specialized, structural steel fabricator and erector for some of the largest and most demanding projects in the public infrastructure, commercial construction and heavy industrial sectors.

ABOUT DILLON CONSULTING

One of Canada's Best Managed Companies, Dillon Consulting has evolved into a major engineering consulting organization. From its humble beginnings in London, Ontario over 70 years ago, Dillon offices can be found in most of Canada's major cities. The Winnipeg office was responsible for the Kenaston Flyover design.

but it hadn't been used in Winnipeg before. It's simply a traffic bridge that allows a thoroughfare to continue flowing uninhibited underneath the structure. What made this project a little more complex was the bridge being constructed on the curve where Bishop Grandin and Kenaston boulevards meet. But traffic essentially stayed open with only a few closures and lane drops."

Steel was clearly the ideal choice for the flyover for all of its usual advantages, such as strength and durability. The horizontal curves and super-elevated deck on the bridge earmarked the project for steel construction at the outset. And although the structure didn't present any insurmountable problems—it had some challenges.

Overwater says, "The geometries on this bridge were extremely complex and required high tolerances and quality metrics throughout. The curved design called for a trapezoidal tub girder system—as opposed to a standard three-plate girder solution—making for a unique construction task. With a standard three-plate girder system you typically have a top and bottom flange joined together with the middle web, so your profile looks like an I. And when you connect I-girders you have three access points—top, bottom and centre. But a tub girder is essentially two I's on a cant with a longer bottom flange, looking like a tub in profile. While there's more surface area to connect tub girders, you have to be much more accurate with your connecting points as a result."

Complicating matters was the magnitude of the steel and the length of the girders, which were all over 100 feet in length. Overwater says, "With those lengths, the girders can move, depending on air temperature and direct sunlight. And complicating things is the way construction cranes normally handle girders to tilt and fit the pieces together. But those connections were made much easier for the flyover project by using a computerized hydraulic cylinder system—meaning we could alter the craning with very refined calculations and degree points to make the fit closer. It worked beautifully."

The tub girders used for the Kenaston Flyover were a first for Capitol Steel. Overwater adds, "We're currently using

STEEL TUB GIRDER APPLICATION ISSUES*

Steel tub girder use is becoming more commonplace in modern infrastructure design. The system offers several advantages over other superstructure types in terms of span range, stiffness and durability — particularly in curved bridges. In addition, the structures have an aesthetic advantage because of their clean, simple appearance. But the girders are not a panacea—there is an inherent complexity to their use—especially when it comes to construction loading stages. Designers need to carefully consider each bridge on a case-by-case basis to determine if steel tub girders are an appropriate superstructure choice.

Much of the criteria depends on:

>Span ranges: Steel tub girders are generally more economical in mid-span ranges, from about 150 to 500 feet.

>Curvature: The torsional strength and rigidity of tub girders make them excellent choices for curved structures with tight radii of curvature.

>Aesthetics: Their smooth uncluttered form and the reduced number of girders give steel tub girder bridges a clean, simple appearance.

>Durability and maintenance: Since many elements of tub girders are located inside the box section and protected from the elements they exhibit greater durability.

>Economy: Tub girders are not inexpensive but do offer economically competitive solutions in difficult design situations.

*From *Practical Steel Tub Girder Design*, 2005, Coletti, Fan, Holt, Vogel.

"The geometries on this bridge were extremely complex and required high tolerances and quality metrics throughout. The curved design called for a trapezoidal tub girder system—as opposed to a standard three-plate girder solution—making for a unique construction task."

- Kris Overwater, Chief Operating Officer, Capitol Steel

tub girders for the Neptune Bulk Terminals project in the Vancouver port. The bridge in the port is actually very similar to the Kenaston project scenario."

DILLON CONSULTING

Canada's Dillon Consulting firm acted as the primary consultant on the project and was responsible for the flyover's design and contract administration. Paraphrasing some of the details outlined in the firm's presentation from the 2016 Transportation Association of Canada conference, "Designed with sustainability and economic viability top of mind, the Kenaston Flyover clearly demonstrates Winnipeg's efforts to reduce infrastructure life-cycle costs and meet the increasing demands on infrastructure in a limited space. The project illustrated the benefits of using the technologies and techniques available to efficiently use resources—including land and available funds."

And the true measure of the Kenaston Flyover's success? A grudging acceptance from Winnipeg drivers; no minor accomplishment itself. AS

VANCOUVER'S ICONIC

A true testament to the versatility of steel

By Rob Third, President, George Third & Son

Photo credit: Robert Stefanowicz Photography

TELUS GARDENS

THE ICONIC Telus Gardens Office tower, located on Georgia St. in Vancouver, B.C., presented special challenges to the innovative team at George Third & Son.

The project featured an "office bar," which is virtually a building laid on its side that creates a horizontal office structure. The steel trusses were 60'-0" high and all exposed, as well as external of the Curtain Wall Window System. They cantilevered over the traffic of both Seymour St. and Richards St., something only a steel design could do.

"Assembling and erecting this 800 ton structural box truss in such a busy area of the city, with shoring towers on the streets, required a lot of planning and careful execution by everyone on our engineering and installation team," said Jeff Mullins of KWH Constructors Ltd.

The tower stops pedestrian traffic as passers-by wonder how the steel can cantilever like a bridge over the street. There is an exciting view to the north and south of those main streets in the downtown core of Vancouver.

This structure was also designed to support a garden of trees on its roof, again adding to the originality of the structure.

The main iconic feature is the Pavilion Entrance Canopy, which arches above the sidewalk along 500 West Georgia Street. Spanning at 250', this built up steel plate spine carries the load of 54 curved and shaped glulam timber arches that fan out in either direction. It imitates the rib cage of a huge body, supporting the curved glazing cover over this elegant piece of Vancouver art; the welcoming entrance to the Telus Tower.

"This is the work George Third & Son are known for. This is why my guys in the shop love

working with us! It's challenging, it's risk, you have to stay on top of it all the time; but the rewards of making the architect's dream become a reality, and seeing another timeless landmark that we built standing blocks from where George Third started the business 108 years ago, makes it worthwhile," said Rob Third, president of George Third & Son.

GTS revised the steel plate to 60,000 yield material and reduced thickness from 2" to 1 1/4" – therefore reducing plate costs, weight for fabrication and erection, and welding. Erected in eight arch pieces, they were all trial fit in the fabrication shop to ensure a seamless fit on site.

GTS also offered to custom manufacture welded sprinkler lines to retain the sleek lines of the structure, rather than segmented straight sections joined with heavy "victaulic fittings."

As the project proceeded, George Third & Son was later called upon to erect the Pavilion Canopy "under" the Existing Tower. The formwork contractor could not accommodate the section of the pavilion canopy that was in the lobby of the office tower, so ICON Pacific

Photo credit: Robert Stefanowicz Photography

PROJECT TEAM

STEEL FABRICATOR: GEORGE THIRD & SON **STEEL ERECTOR:** KWH CONSTRUCTORS LTD.

PROJECT ARCHITECT: HENRIQUE & PARTNERS **ERECTION & CONNECTION ENGINEERS:** SOMERSET ENGINEERING **STEEL ERECTION ENGINEERING:** SOMERSET ENGINEERING LTD.

TIMBER: STRUCTURLAM PRODUCTS LP

Const. approached GTS to come up with an installation solution to slide one third of the canopy under the concrete office tower structure. The innovative solution was to bring the steel arch parts to site and lift the 22 ton segments onto a custom built buggy and roll the parts under the existing structure and then jack down the buttress to the previously installed anchor bolts. After each segment had been trial fit, it was attached to the next segment using the same "buggy and rail" system, where they were welded together in the air. Variable falsework frames supported the arches in their increasing height as they moved out from under the tower.

George Third & Son also included in their contract the supply and installation of 54 glulam timber wing beams CNC machined to a custom profile, from a douglas fir billet 365mm wide and 762mm high. They also needed to be pushed up from below without overhead lifting. The previously installed ceiling, which was made of glass (just to make it more difficult), and the timber arches only had 16" of space between them and the glass ceiling.

Continuous weekly meetings with the design consultant's team explored opportunities to enhance the build-ability of the structure. To ensure the architectural accuracy and workability of the Pavilion Canopy elements GTS built a full scale mock-up of the canopy in their plant for architectural and trade review and harmonization. This enabled the trades to experience the installation and compatibility of each element to each other, as well as let the architect make modifications and improve the final design.

George Third & Son have been in business since 1910 (108 years), are a family business, and do what they say they will do. GTS excels at complex, one-of-a-kind structures, and are experts at working with the timber industry. With very inventive people on their team and a historic reputation for innovative steel design and execution, GTS leaves no stone unturned to bring the costs in line.

George Third & Son have fabricated and erected many landmark steel and timber structures, like: Brentwood Station, Commercial Street Station, Di Long Lake Pavilion (China), Husky Union Building (Seattle), Missouri Baptist Medical (Missouri), and the Richmond Skating Oval.

GTS was delighted to work shoulder to shoulder with our partners Somerset Engineering (Erection and Connection Engineers) and KWH Constructors (Steel Erectors) to bring this landmark structure to its successful completion.

"Westbank," asked GTS to install a plaque on the structure, upon completion, to commemorate George Third & Son's craftsmanship and attention to detail on this iconic Vancouver structure. AS

PRAISE FOR THE TELUS GARDEN TEAM

"We were very delighted to have George Third & Son on the team for this project, their reputation for innovative steel structures and dedication to detail drew us to their team."

HPA Architect - Gregory Henrique

"The TELUS Gardens building is a fantastic structure and I am pleased a Vancouver Architect (Gregory Henrique) is stepping up with something special. The cookie cutter structures of this city need some landmarks to break up the uniformity, and here we have one. That beautiful steel timber and glass 'pavilion canopy' is a work of art and the contactors that fabricated this icon should be very proud."

Ben Rowe (Project Architect) Henrique & Partners

"I wanted to take this opportunity to let you know how much I enjoyed working with the GTS/KWH crew on TELUS Office and I am proud of the result of our efforts. The Pavilion was an incredibly difficult thing to put together but you and your team seemed to manage it with ease."

Ben Rowe (Project Architect) Henrique & Partners

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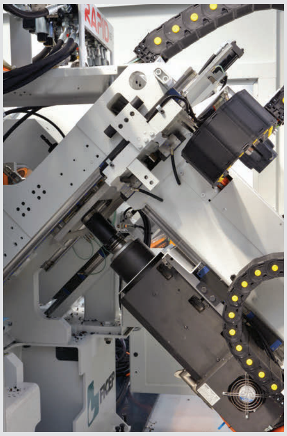

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WESTJET GOES GLOB

With new airplanes and a new hangar

By Dave Crawford, P.Eng. and Brian Breukelman, P.Eng.

AL

WESTJET IS JOINING the ranks of global airlines as it gets ready to deploy 10 new Boeing 787-9 wide body aircraft. The addition of these new "Dreamliner" aircraft to the fleet is the next chapter in the WestJet story.

With the new additions to the fleet, a new home for servicing and maintaining these aircraft at the Calgary International Airport (YYC) was required. Stantec Architecture Ltd. as prime consultant, with Stantec Consulting's structural team, began the design for the new hangar in 2017. A fast-track construction approach was selected to enable servicing of the new aircraft when they arrive in 2019.

Construction of the pile foundation began in 2017 and the steel superstructure for the hangar and associated office and service shops started in 2018. The project will be complete in early 2019, just-in-time for delivery of the first Dreamliner.

CANA construction is the prime contractor with Glenmore Fabricators taking on the fabrication and erection of the steel superstructure.

Steel was the obvious choice for the large 80m spans (75m clear span) of the hangar superstructure. Twelve (12) massive steel moment frame trusses/columns provide lateral stability in east/west direction while conventional cross-bracing provides the stability required for the opposite building direction. Deep steel deck was used to directly span the 8m distance between the moment frames to avoid secondary framing

PROJECT TEAM

OWNER: WESTJET **STRUCTURAL ENGINEER:** STANTEC CONSULTING LTD.

PRIME CONTRACTOR: CANA CONSTRUCTION **FABRICATOR:** GLENMORE FABRICATORS

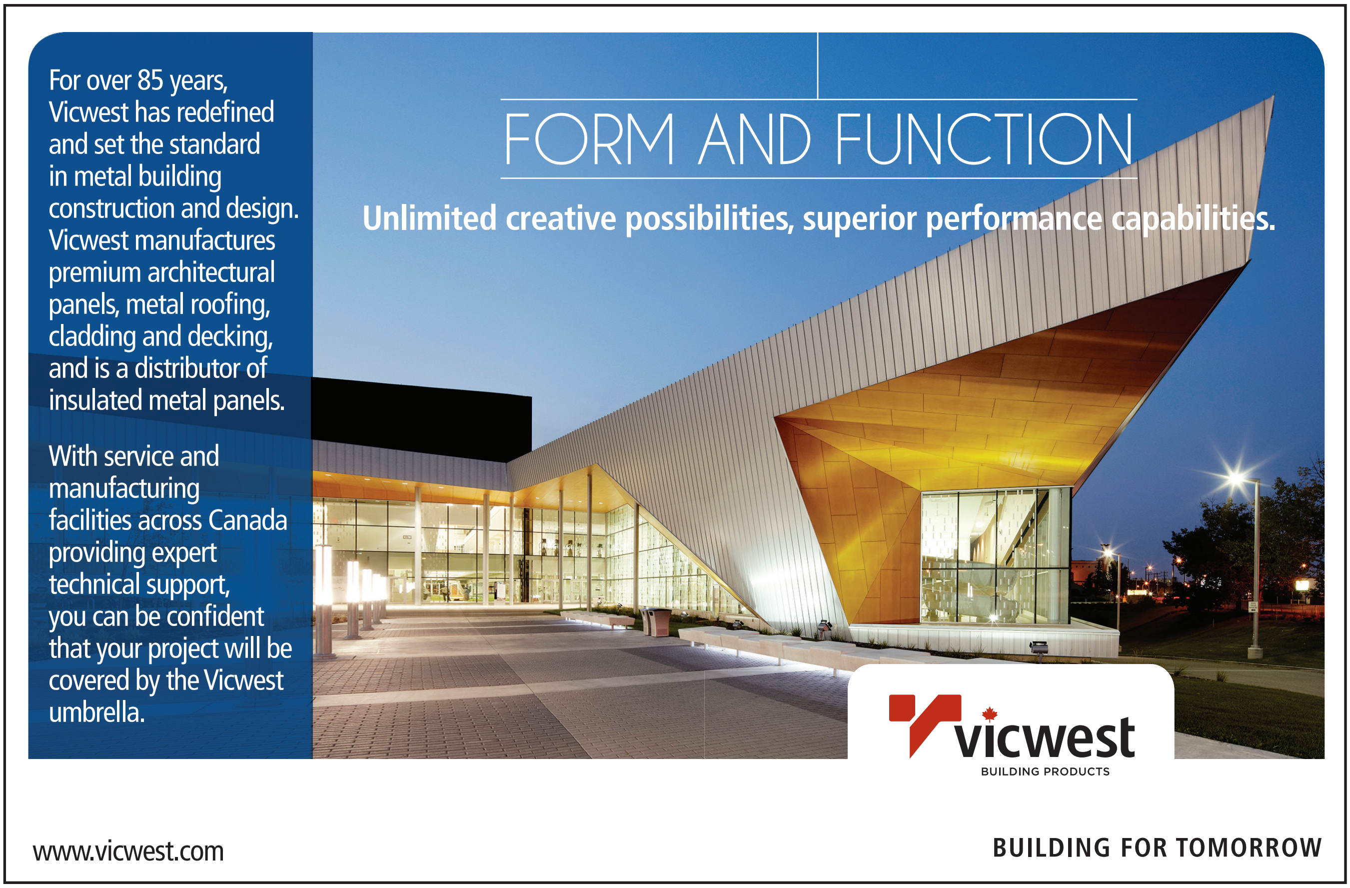
Construction of the pile foundation began in 2017 and the steel superstructure for the hangar and associated office and service shops started in 2018. The project will be complete in early 2019, just-in-time for delivery of the first Dreamliner.

and minimize the steel weight. The total weight of steel Including the frames, purlins and wind girts comes to over 1,800 tonnes.

Foundation to support the steel structure is provided by driven steel H-pile groups (ranging from seven HP360 piles for the more lightly loaded frames to 21 for the two secondlast bay and end bay supporting the large hangar doors). 1800dp reinforced concrete pile caps tie the H-piles together and provide the necessary surface for mounting the large moment frames to the foundation.

NBCC 2010 wind load requirements became a bit tricky – given that the height of the hangar is 26m, the application of Figure I-7 (low buildings under 20m height) gust pressure coefficients was not possible. The "high-buildings" requirements of Figure I-15 became the design basis wind loads. Stantec Consulting Ltd. engineers believed that wind loads were more likely to be similar to the Figure I-7 wind loads with the small increment in height beyond 20m.

Wind tunnel testing by CPP Wind Consultants of Fort Collins, Colorado, was completed to verify this assumption. While the wind loads contributing to the design of the large moment frame trusses were governed primarily by non-wind load cases, the secondary structural elements (girts, cladding, etc) could be substantially reduced. The wind tunnel testing concluded that the design wind loads were much more similar to the Figure I-7 wind loads with the exception of the corner bays which had wind loads more similar to Figure I-15. This load reduction resulted in eliminating over 35,000 kg of steel from the structure. AS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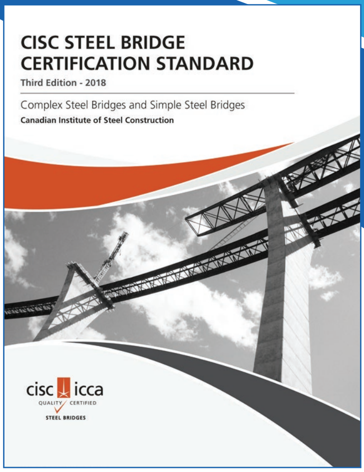
WHY IS CERTIFICATION ESSENTIAL? WHY SHOULD IT BE CONSIDERED MANDATORY?

Hellen Christodoulou, Ph.D.ing., B.C.L., LL.B., M.B.A, CISC &
Paul King, MS, P.Eng., VP Engineering, Rapid-Span Group



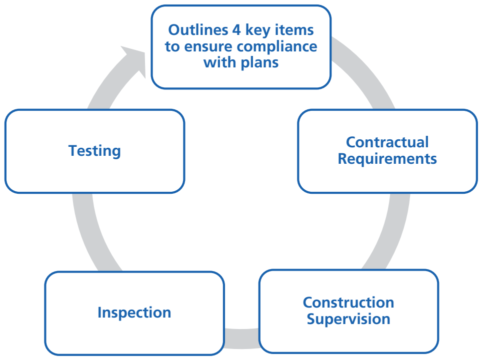
The **CISC-ICCA Steel Bridge Certification Standard, 3rd Edition**, for Complex Steel Bridges and Simple Steel Bridges is designed to assess the Fabricator's Quality System. Additionally, it provides a level of assurance that the company performing the fabrication processes has personnel in place to better abide to the contractual and regulatory requirements. This standard addresses the special processes and specific requirements of steel fabrication for highway and railroad bridge structures.

What are the Quality Requirements in the Bridge Code: CAN/CSA-S6?

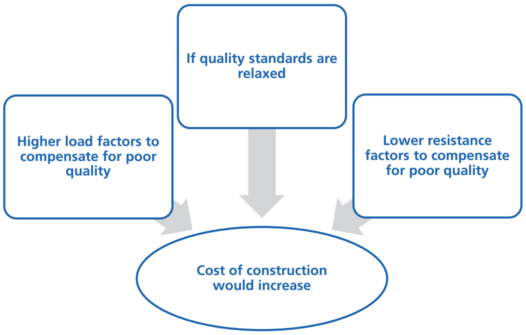
In most jurisdictions in Canada, the Canadian Highway Bridge Design Code (CHBDC) applies for the design and construction of bridges.

The provisions within CHBDC are:
- Intended to provide a uniform level of safety, durability and economy;
- To form an integral part of the approach to ensure construction quality is maintained;
- To ensure a mandatory requirement to provide "inspection and testing to ensure compliance with the plans".

CHBDC: Section 1.4.4.6 On Quality Control and Assurance



CHBDC: The Commentary Section C1.4.4.6 On Quality Control and Assurance



The provisions of the code have been formulated and calibrated on the assumption that high standards of construction will be adhered to. If this were not so, generally larger design loads and lower strengths would have to be used, or lower safety levels accepted.

High standards of construction require:
- That only competent and conscientious constructors be entrusted with the work;
- The plans include clear, comprehensive and practicable specifications;
- Testing and the supervision of construction are such, to guarantee compliance.

Traditional vs. Modern Construction Practice

Traditionally, many jurisdictions ensured compliance with the plans by maintaining a team of highly trained inspectors. Inspectors were employed or retained by the owner to monitor every stage of construction, as well as ensure the specified level of quality was upheld.

More recently, construction practice has shifted to require the constructor to take responsibility for adherence to quality. This means that quality control is no longer in the hands of the owner. As P3 and design-build delivery mechanisms have become more prevalent, all aspects of project delivery, including quality management, have become outside the direct control of the owner.

For pre-fabricated and plant produced products such as structural steel or precast concrete, a system must be in place to ensure only competent and conscientious constructors (including subcontractors) are entrusted with the work. In the absence of full time inspectors employed or retained by the owner, this can only be achieved by requiring plants to maintain a quality management system that is audited and certified by an independent and accredited organization.

Importance of the Quality Management System (QMS)

The certification body must verify that the Quality Management System (QMS) is specific to the product being produced. It must also be comprehensive enough to ensure all aspects of a fully functioning QMS are maintained.

For structural steel fabrication, an auditing and certifying system did not exist in the past. In 2010, the CISC-ICCA (with industry support) addressed this need with the introduction of a comprehensive certification program specific to steel bridge fabrication.

To obtain certification, fabricators must demonstrate they have a documented QMS. Additionally, they must provide evidence they have the knowledge, experience, equipment and personnel capable of fabricating steel bridges to the requirements of CHBDC and referenced standards W47.1 and W59.

In essence, the CISC-ICCA certification program provides assurance that only competent and conscientious constructors are involved in steel bridge fabrication.

Key requirements of the QMS include:

Quality System Requirements
- General Requirements
- Work Procedures
- Control of Documents
- Control of Quality Records

→

Management Responsibility
- Management
- Commitment
- Organization
- Responsibility and Authority

→

Resource Management
- Personnel
- Infrastructure & Equipment
- Reference Material

→

Process Management
- QC Planning
- Contract Review
- Purchasing
- Drafting
- Receiving
- Material Verification
- Control of Workmanship
- Product Verification
- Customer Supplied Products
- Storage, Loading, and Shipping
- Control of Measuring and Inspection Equipment

→

Measurement, Analysis, and Improvement
- Control of Nonconformity
- Corrective Action
- Preventive Action
- Analysis of Data

Annex A10.1

Annex A10.1 is a normative (mandatory) part of CHBDC—the construction requirements are considered essential for structural safety and durability.

In keeping with the general requirements of Clause 1.4.4.6, Clause A10.1.1.2 requires fabricators to have a comprehensive QMS addressing the requirements of Section 10; including fracture control.

A10.1.1.2

Fabricators shall have a comprehensive, documented quality management system (QMS). The quality standard shall be an industry recognized certification program specific to steel bridge fabrication acceptable to the Regulatory Authority. The QMS shall address the requirements of Section 10 and shall include a documented fracture control plan. For single-span girder bridges consisting of un-spliced rolled sections or single span pedestrian bridges, certification requirements may be waived or modified by the Regulatory Authority.

Note: A quality management system certified by the Canadian Institute of Steel Construction, in the category of steel bridges, is compliant with this requirement.

Some important considerations:

- CISC-ICCA Certification in the category of steel bridges is specifically mentioned as being compliant with the requirement;
- While the regulatory authority may accept other compliant certification programs, the CISC-ICCA certification is the only current program that fully addresses the requirements of CHBDC;
- CISC-ICCA certification does not supersede the mandatory requirement for steel fabricators to be certified by the Canadian Welding Bureau (CWB) to CSA 47.1;
- CISC-ICCA certification and certification to W47.1 go hand-in-hand. In fact, it is mandatory for CISC certified fabricators to be certified to W47.1 Division 1 or 2;
- Certification to W47.1 is specific only to welding. The certification requirements for W47.1 do not have mandatory requirements for a quality management program. W47.1 does not assess qualifications that are critical to bridge fabrication, such as fracture control (CHBDC Clause 10.23) and construction requirements (CHBDC Annex A10.1).

Taking just two examples that highlight why a mandatory certification would have mitigated, if not altogether, avoided issue related to project execution.

WATERDALE BRIDGE IN EDMONTON (ALBERTA)	
The Original Cost	155.0 M
Final Cost (excluding legal costs-estimated at 32M)	158.5 M
Expected Completion Cost	**3.5 M**
Expected Completion Date	September 2015
Final Completion Date	September 2017
Delay	**24 months**

Some of the critical issues of this project

- Delivery and fabrication delays of the steel arches;
- Defects and deficiencies upon arrival from abroad;
- Incorrectly sized and painted modules were delivered;
- Inspection confirmed steel did not meet Canadian standards;
- Defects required for local welding corrections and other repairs.

JOHNSON BRIDGE IN VICTORIA (BRITISH COLUMBIA)	
The Original Cost	63.0 M
Final Cost (excluding legal costs- estimated at 32M)	103.0 M
Expected Completion Cost	**40.0 M**
Expected Completion Date	January 2015
Final Completion Date	January 2018
Delay	**36 months**

Some of the critical issues of this project

- Delivery and fabrication delays of the steel;
- Defects and deficiencies upon arrival from abroad;
- Fitting issues and over 75 deficient welds;
- Material was rejected;
- Inspection confirmed steel did not meet Canadian standards;
- Defects required additional bolted plates and connections;
- Required new design for some sections;
- Local fabricators were consulted to offer opinions on remedial measures;
- Remedial measures required for additional bridge closures.

These are just two examples that were taken amongst many others, all of which have a consistent pattern of problems and issues that arise. These issues include:

- ➞ Late deliveries;
- ➞ Cost overruns;
- ➞ Legal pursuits;
- ➞ Defects and deficiencies;
- ➞ Non-conformities to Codes and Standards;
- ➞ Require intense inspection and testing;
- ➞ Local fabricators consulted to solve and remedy issues.

Lessons Learned

In a world of global supply chains, all levels of government are facing new procurement and construction challenges. As with many pre-fabricated products, steel bridge girders could come from anywhere in the world.

At this time, it can no longer be assumed that a fabricator will be familiar with Canadian bridge construction standards or have the facility, personnel and equipment capable of compliance with the contract requirements. Moreover, it can no longer be assumed that a fabricator will be concerned with his long-term reputation. Lastly, the competitive bidding process can put price above all other considerations.

1) To comply with the intent and requirements of CHBDC: Section 1.4.4.6, on Quality Control and Assurance, inspection and testing are facilitated if fabrication is local;
2) Certified fabricators having CISC-ICCA Steel Bridge Certification Standard offer the only current program that fully addresses the requirements of CHBDC;
3) The National Building Code, the Handbook of Steel Construction and the CHBDC are formulated on the assumption of quality and to guarantee compliance. As is intended, certification would offer this guarantee;
4) CHBDC recognizes the interdependence between the design requirements and construction quality in maintaining the targeted reliability and durability. The certification requirements for steel bridge fabricators are considered an essential part of the code requirements. While a regulatory authority is free to waive or modify parts of CHBDC as it sees fit, it does so at its own peril;
5) At the same time, global procurement is becoming more prevalent and project delivery mechanisms are changing. Owners have diminishing control over the enforcement of quality standards. The potential for compromising safety and durability have increased proportionately;
6) Recent contracts require the contractor to take the responsibility of "quality control", as opposed to the owner. The engagement of a certified fabricator would give back some control to the owner as an underlying guarantee of the expected quality of work;
7) Many quality issues can take years or even decades to become evident, which can lead to increased maintenance costs and shortened life cycles. The CISC has recognized the changing situation and has taken the lead in creating a world-class certification program for bridge fabricators specific to the needs of Canada.

To ensure compliancy with the requirements of CHBD

↓

To guarantee the best overall return of $ value for the public infrastructure projects

↓

Adopt the CISC-ICCA Steel Bridge Certification Program

↓

Require mandatory CISC-ICCA Certification for Canadian fabricators

For more info visit

www.cisc-icca.ca/cisc-quality-certification-programs

Contact

Contact **certification@cisc-icca.ca** for details regarding the CISC Certification process.

EVENTS

CANADIAN STEEL CONFERENCE
SEPTEMBER 19-21, 2018
Marriott Harbourfront Hotel, Halifax, N.S.

The Canadian Steel Conference brings our steel industry together every year to learn, build relationships, develop businesses and celebrate steel—while having fun!

Over the course of three days, we'll be hosting multiple business development, technical and social networking events for over 300 attendees from the Canadian steel industry.

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See you in Halifax!

STEELDAY 2018
SEPTEMBER 28, 2018

SteelDay is an annual event held nationwide that showcases the versatility, performance and sustainability of steel, as well as its various innovative applications.

Every year, CISC Members and Associates from across Canada open their doors to welcome industry professionals and the general public for various tours, BBQs, demonstrations and/or special presentations. Each event provides a unique insight on how producers, service centres, fabricators or erectors contribute to our vibrant steel industry.

This is an exciting opportunity to learn from industry experts about the advantages of using structural steel in construction! Register for a free SteelDay event on September 28, 2018, in your community and discover how the steel industry is building Canada. AS

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	Sep. 2019
CISC Commentary on CSA S16 (Part 2 of CISC Handbook of Steel Construction)	CISC Handbook 11th Edition[1] 3rd Printing[2]	CISC Handbook 12th Edition	2020
CISC Moment Connections for Seismic Applications	2nd Edition[3]	3rd Edition	Sep. 2019
CSA S6 Canadian Highway Bridge Design Code	CSA S6-14	CSA S6-19	Sep. 2019
CSA S6.1 Commentary on Canadian Highway Bridge Design Code	CSA S6.1-14	CSA S6.1-19	Sep. 2019
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 W59-18	TBA	
CSA W47.1 Certification of Companies for Fusion Welding of Steel	CSA W47.1-09 (R2014)	CSA W47.1-19	Mid 2019
CSA S136 North American Specification for the Design of Cold-Formed Steel Structural Members	CSA S136-16	TBA	
CSA S136.1 Commentary on CSA S136	CSA S136.1-16	TBA	

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

[2]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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www.aclsteel.ca

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www.akalsteel.ca

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www.algonquinbrige.com

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www.arkbrostructures.com

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www.bensonsteel.com

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Concord, ON 905-761-6155
www.burncomfg.com

C_ore Metal Inc. S
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www.coremetal.com

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www.canam-construction.com

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www.centralwelding.ca

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www.coastalsteel.ca

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www.cooksvillesteel.com

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www.gensteel.ca

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www.lorvinsteel.com

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www.migsteel.com

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www.miragesteel.com

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www.arcweld.ca

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Memramcook, NB 506-758-8181
www.vicwest.com
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Vicwest Building Products
Oakville, ON 800-387-7135
www.vicwest.com

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Vixman Construction Ltd.
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Voortman USA Corporation
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www.voortmancorp.com

Vulcraft Canada, Inc.
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Ironworkers Local Union 728 Winnipeg, MB www.ironworkers728.com/	204-783-7853
Manitoba Infrastructure (Water Management and Structures) Winnipeg, MB www.gov.mb.ca	204-391-5253
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