ADVANTAGE STEEL

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CANADIAN INSTITUTE OF STEEL CONSTRUCTION

NO. 71 SUMMER EDITION 2022

STEEL DRIVES NOVELTY

Where creativity and value converge

Photo credit: Newton Group - Humber College Parking Garage

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Westbrook Pedestrian Bridge Structural Steel Parking Structures

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ADVANTAGE STEEL

NO. 71 SUMMER 2022

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STEEL DRIVES NOVELTY
Where creativity and value converge

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

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

Confused, Misused and Abused

We receive several calls by general contractors, engineers, architects and non-member fabricators for copies of CISC's EPDs. The reasons as to why they need them range the whole spectrum. What is evident is that some understandings of the basics are needed by the construction industry.

First and foremost, the EPDs were the creation of LEED. The concept became a recipe of the environmental impacts for a given product. They were not intended to be used outside of that program, but they are. This unintended problem is that EPDs do not reflect the true and full environmental impacts of a given product. They stop at the manufacturer's door, with so many of the impacts not considered. So, if you think you are getting the best product environmentally based on EPDs, you are not. Confused? Don't worry – everyone is. At this point, take the EPD data with a grain of salt.

The CISC does not publish its EPDs. It seems odd, but these are for the exclusive use of the participating CISC fabricators who provided their data, as per LEED regulations. Only those participating in our industry average EPDs can use the CISC EPDs. Those who are not participating, yet require EPDs, need to have their own company-specific LEED EPDs generated. A listing of the qualified CISC fabricators can be found on our website.

When trying to compare materials using EPDs, one needs to understand that any building structure is a combination of materials, not just one. By selecting materials for construction, any design will affect carbon, cost and speed. For structural steel, it is often the complimentary materials that have a negative impact on carbon, not steel itself. For that reason, choose your entire structural system wisely; there are lots of options.

So, to assist in the EPD understanding, I have provided a breakdown of the various types of inquiries we receive and typical CISC responses:

CASE 1 Non-member non-participating fabricator requesting CISC EPDs

As per LEED regulations, if an industry develops an EPD, only those companies that participated in the development with their environmental data qualify for CISC EPDs. Non-participating fabricators are not qualified for the use of CISC EPDs. It is recommended that you develop your own company specific EPDs for your products. Always ensure the project specifications are reviewed prior to bidding to ensure you meet the LEED requirements as applicable.

CASE 2 A general contractor requesting CISC EPDs

Refer to Case 1: The general contractor should verify prior to contracting with the steel fabricator that they are qualified CISC members and EPD holders. The CISC does not issue EPDs to GCs. EPDs are available from the qualified CISC fabricator. Refer to the CISC website for qualified EPD fabricators in your area.

CASE 3 A design consultant requesting CISC EPDs

In most cases, the consultant is looking for a specific value in the EPD and most often that would be the global warming potential (aka carbon). The CISC will be happy to provide

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MANAGING EDITOR
Hellen Christodoulou, CISC-ICCA
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"EPDS DO NOT REFLECT THE TRUE AND FULL ENVIRONMENTAL IMPACTS OF A GIVEN PRODUCT."

the specific data for their design needs. The full EPD will not be provided.

CASE 4 Governments requesting CISC EPDs

Believe it or not, the Canadian government is looking to procure based on carbon. The CISC is working with all levels of government in their quest to design environmentally, which means more than just carbon.

CASE 5 Others requesting CISC EPDs

From research to other material groups, we have received many requests for EPDs. The CISC will deal with each on a case-by-case basis. For those trying to take a very poor steel design and compare with another building material, we take that challenge and say, "you give us your building design and we will show you a steel design that will match or beat on carbon, price and speed."

Remember, the current LEED EPDs do not reflect the full environmental story of a building material. Often, we see that EPDs are generated by the mill and not by the manufacturer of the product. This is not the true product EPD, as defined by LEED. Also, the current EPDs only consider the environmental impact of the material before it gets to site! Shipping, constructing, demolition, disposal and decomposition environmental impacts, to name a few, are all ignored. That's a big problem. If we truly cared about doing the right thing environmentally, then the full story needs to be told. Currently, we are being told it's too complicated. Not so – the steel industry is ready with our cradle-to-cradle story… Are the others? AS

The Canadian National Steel Bridge Competition

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

One of the reasons our industry continues to thrive is the passion for steel construction. At some point in our lives, we were introduced to the endless potential of steel construction, its elegance and efficiency, and its ability to make anything our creative minds can dream up a reality. I'm convinced that, to continue to see our industry thrive, we need to ensure a continuous influx of young steel professionals who share and spread a passion for steel construction.

To support the efforts of the industry to attract new and passionate promotors of steel, the Education and Research Council supports the Canadian National Steel Bridge Competition, one of the most innovative programs for future engineers. CISC is a proud partner with the Canadian Society for Civil Engineering (CSCE) in this annual event which is hosted by a different Canadian university each year. Since 2016, this event has brought together undergraduate civil engineering students from across Canada and from international institutions to learn and work together, experiencing – in a very real way – the power and performance of steel as a construction material.

This program is unique in that it combines multiple elements that are critical to ensuring overall success in a steel bridge project. Factors such as material selection and strength, estimation, fabrication, erection procedures, dimensional constraints and serviceability – as well as aesthetics, cost and safety – all must be considered and are evaluated as part of the competitions' comprehensive approach.

In addition, the critical skills of teamwork, planning, problem-solving, respect and dealing with timeline pressures are weaved throughout each part of the overall competition. While the structure itself is important, the students also learn how project success can only be achieved with a team that is aligned around a common goal and share a common passion for excellence.

This year's event was held in May at the Université de Sherbrooke and attracted several teams from across the nation. While the main event happens over two days, the actual competition involves months of work by the students involved. First, the teams must consider the theme or problem statement of the competition. The 2022 competition challenges the teams to design a wildlife bridge and prove their solution by constructing a 1:10 scale model. Prior to the actual construction event, the teams must also prepare and present their design through both a project poster and oral presentation.

The construction event is where the models prove their mettle. Several factors are considered by the judges including lightness, stiffness, structural efficiency, load testing, and construction speed and economy.

The scores are then tallied and the winners are announced. The CISC is proud to present a special award to the top Canadian team, showing the support of our industry for the passion and strive for excellence demonstrated by the students. In addition, the CISC also recognizes the Canadian team with the best overall scores in the construction speed and economy categories.

As I write this, the event is still two weeks away and I'm looking forward to seeing the teams at work. On behalf of the ERC and all CISC members, congratulations to this year's winners! We look forward to welcoming many of the participants into our industry in the future.

On behalf of the ERC, I would like to express our gratitude for the continued support for the CISC and our funding partners. We continue to have pride in the accomplishments of the council as we strive to support education and research in the steel construction industry. As always, if you have a passion for supporting the next generation of steel professionals and for the future of the Canadian steel construction industry, I encourage you to consider becoming an ERC financial supporter. AS

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CHARLES ALBERT, P.Eng.
Manager of Technical Publications & Services
CISC-ICCA

CISC Engineers' Corner

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

QUESTION 1: The tables of Factored Axial Compressive Resistances in Part 4 of the Handbook of Steel Construction – 12th Edition provide the factored strong-axis moment resistance (M_{rx}) for rectangular hollow structural sections. Does the value of M_{rx} depend on the unbraced length?

ANSWER: As explained on page 4-13 of the handbook, the values of M_{rx} listed in the bottom portion of the tables were calculated assuming laterally braced members, i.e., with an unsupported length, $L \leq L_u$, where L_u is the maximum unsupported length for which no reduction in M_{rx} is required.

In the case of square and round HSS (Figure 1a), M_r does not depend on the unbraced length and is therefore determined in accordance with CSA S16:19 Clause 13.5. For rectangular HSS (Figure 1b), however, M_{rx} is a function of the unsupported length and is calculated using Clause 13.6. Except for rectangular sections with a high depth-to-width ratio, deflections will usually govern before lateral-torsional buckling becomes a design consideration.

QUESTION 2: What is required for the inspection of pretensioned high-strength bolts installed by the turn-of-nut method? Is it necessary to match-mark the bolts?

ANSWER: The requirement for inspection of pretensioned bolts is given in S16:19 Clause 23.8.1(b): *"For bolts pretensioned by the turn-of-nut method, the turned element of all bolts shall be visually examined for evidence that they have been pretensioned."*

The S16 standard does not specify how the visual examination is to be conducted, although the CISC Commentary on CSA S16:19 in Part 2 of the handbook provides some guidance: *"When pretensioning is specified, the tightening is deemed satisfactory when all of the elements are in full contact, and observation of the sides of the turned elements shows that they have been slightly galled by the wrench. This is all that is required.*

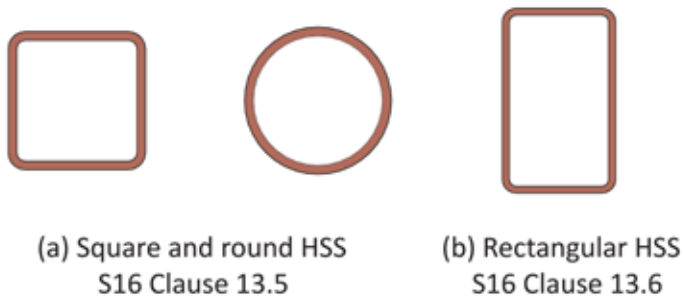


FIGURE 1
Moment Resistance of HSS Members

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.

"IN THE CASE OF TURN-OF-NUT PRETENSIONING, ROUTINE OBSERVATION THAT THE BOLTING CREW APPLIES THE PROPER ROTATION IS SUFFICIENT INSPECTION."

When bolts are tightened by the turn-of-nut method and when there is rotation of the part not turned by the wrench, the outer face of the nut may be match-marked with the bolt point before final tightening, thus affording the inspector visual means of noting nut rotation. Such marks may be made with crayon or paint by the wrench operator after the bolts have been snugged."

Another useful reference is *High-Strength Bolting for Canadian Engineers,* which states on page 20: *"In the case of turn-of-nut pretensioning, routine observation that the bolting crew applies the proper rotation is sufficient inspection. Alternatively, match-marking can be used to monitor the rotation. However, it will be readily apparent that an air-operated impact wrench has been applied because the faces of the nut become peened during the installation operation."*

QUESTION 3: When purchasing galvanized high-strength bolts and nuts, must they both come from the same supplier?

ANSWER: For building applications, CSA S16:19 Clause 22.2.5.2 refers to ASTM F3125 for galvanized bolt assemblies, which in turn refers to the *RCSC Specification for Structural Joints Using High-Strength Bolts.* The latter states in the Commentary to Clause 2.8 on Galvanized and Coated Bolting Components and Assemblies: *"The purchase of galvanized high-strength bolts and nuts from separate Suppliers is not in accordance with the intent of ASTM F3125 because the Supplier responsibility for the performance of the bolting assembly clearly could not have been provided as required."* AS

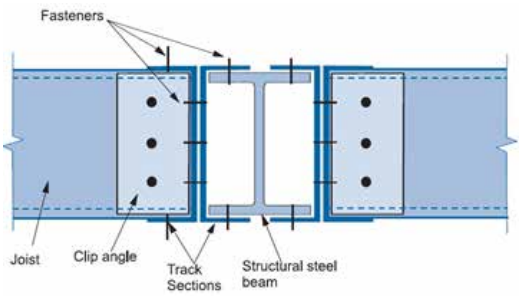
CSSBI Engineers' Corner

BY :: BRETT PERRAS, P.Eng.
Steel Market & Industry Development Engineer at Canadian Institute of Steel Construction (CISC-ICCA)

QUESTION 1: In Appendix B of CSSBI 59-05: Lightweight Steel Framing House Construction Handbook, what does "the number of strap braces per wall" refer to? Secondly, how is a flush joist-beam connection completed?

ANSWER: Within the CSSBI 59-05, the "strap braces per wall" (Table X-1) refers to the flat-strap X-braces fastened to the wall-framing vertical chord studs, which provide lateral resistance to prevent racking from wind and seismic loading on the residential assembly.

For a flush steel beam joist connection, referring to Figure 3.8 located on page 43, "Flush-in-Floor Joists with Steel Beam" shows each joist complete with a back-to-back track capping the joists. The track with legs facing the beam should have a matching depth, and the legs of the track must be track-fastened to the top and bottom flanges of the structural beam. The joists are also complete with clip-angles (acting as web-stiffeners to prevent buckling) which are fastened to the web of the joist and the web of the track. These connections can be completed by welding, or most commonly, with self-drilling fasteners or power-actuated fasteners to the beam.



QUESTION 2: What is galvanized wet storage/white-staining, and how is it repaired?

ANSWER: Wet storage stain of cold-formed steel, also referred to as white-staining, appears as a white or off-white rough, chalky, rust-like deposit that can occur on newly galvanized members and results from zinc oxide/hydroxide forming on the galvanized surface.

Wet storage stain is typically found on stacked galvanized products where moisture penetrates between the members, resulting in reduced airflow to the galvanized zinc surfaces, promoting an oxidizing environment. Other conditions shown to create wet-storage stain are rain, dew or high humidity.

To prevent wet storage stain when shipping galvanized products to site, follow the proper shipping instructions or use strapping to enforce proper airflow, reducing the environment promoting staining.

When considering removing wet storage stain, initially, the remaining coating thickness should be verified. In some instances, the galvanized coating can be intact and not require remediation, while other instances, when measured, can be completely oxidized, therefore requiring remediation. If sufficient coating remains, a wire brush can typically be used to remove the wet storage stain.

QUESTION 3: What is the difference in performance between G90 and higher levels such as G210?

ANSWER: The thickness of the galvanization coating on cold-formed steel products is measured as a coating weight or coating mass. Depending on the project's conditions, a higher coating thickness may be specified. Thicker coatings are usually specified in corrosive or wet environments where extended lifespan is required, and dependent on the application of the product (indoor/outdoor). Even in the most corrosive industrial environments, a G210 coating should withstand a 30+ year period for five per cent red rust to appear on the sheet. The other 95 per cent of the sheet will have the protective galvanized coating present.

Consideration must be made to the point at which red rust being visible is considered acceptable. Once the estimated product life and environment are determined, the appropriate zinc coating weight should be selected in accordance with ASTM A653/A653M.

The minimum zinc coating weight in imperial units is G30 (0.30 oz/ft^2) and a maximum of G235 (2.35 oz/ft^2) with a wide range of weights in between. In metric units, the minimum is Z90 (90g/m^2) and a maximum of Z700 (700g/m^2). It's important to note that the measured weights include the total weight on the sheet steel; therefore, it's assumed that half of the weight is on each side.

The standard for indoor application of cold-formed members is G40/G60 (Z120/Z180) coating weight while in most unpainted outdoor applications, G90 (Z275) is used. When using the product for a high corrosion environment such as water drainage, heavier coatings such as G210 (Z610) are utilized. Also note that the weight of the coating is a direct correlation to protection; therefore, a G60 will have twice the lifespan of a G30 product.

Note that the above figure should only be used for galvanized coatings, and not applicable to other alloys in the sheet steel market. AS

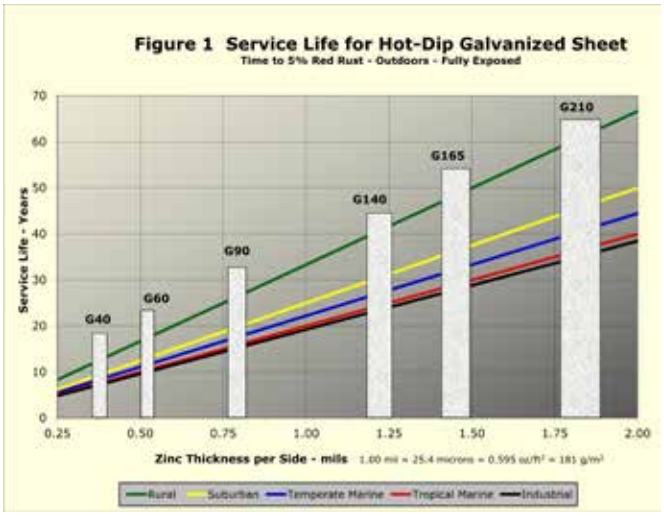


FIGURE 1 Service Life for Hot-Dip Galvanized Sheet. Time to five per cent Red Rust – Outdoors – Fully Exposed

To the CISC, Safety is of the Utmost Importance

Promoting better safety practices and policies is of high value

BY :: JIM KANERVA, M.Eng., P.Eng.
Chair, National Safety Committee

All stakeholders must ensure a safe working environment for employees and lead in the prevention and elimination of accidents. In the last year, the CISC National Safety Committee has been active, setting both short-term and medium-term goals.

In the short term, the committee aims to engage the CISC in a national safety conversation based on best practices and procedures. CISC/CSSBI members and associates will be an integral part of this effort by providing data on safety trends, safety alerts and lessons learned.

The "Safety First" section in the CISC Steel Links portal is the national steel-focused safety "conversation" exchange between members and associates. The www.steellinks.ca portal is exclusive to CISC/CSSBI members and associates.

"Safety Alerts" may include, but may not be limited to, sharing a significant near miss, medical aid or a lost time incident – incidents where something went wrong

"Lessons Learned" may include, but may not be limited to, those incidents where your team believed they were doing things correctly (and for the most part, they may have been) and something unexpected happened that lead to an incident. "Lessons Learned" might normally lead to a management system corrective action.

"Safety Alerts" and/or "Lessons Learned" can be sent to safety@cisc-icca.ca

As a medium-term goal, the committee will be developing the CISC National Safety Program that will focus primarily on steel fabrication, expanding over time to include more industry sectors. The program will be designed specifically for the steel construction industry, benefitting the novice to the seasoned. It will include a management system standard with minimum set requirements for certification, auditing and KPI reporting.

The CISC National Safety Program will add measurable value and promote better safety practices and policies to keep rigorously improving our industry, eliminating or limiting safety incidents more effectively. In 2023 the CISC will be celebrating exceptional safety performance by introducing a "Safety First" prize at the CISC National Steel Conference. AS

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→ The Conference offers the unique and valuable opportunity to all participants to meet, exchange, collaborate and network with industry leaders and stakeholders.

→ This CISC Conference also offers a rich and comprehensive program of multiple business development, educational, and networking activities.

Technical Sessions & Trade Show

Wednesday - September 28, 2022	
8:00 am – 6:30 pm	Trade Show Runs
7:00 am – 8:00 am	Breakfast
8:00 am – 9:30 am	Steel Conference Kick-off
9:30 am – 10:00 am	Break
10:00 am – 12:15 pm	Multi-track Technical Sessions
12:15 pm – 1:30 pm	Lunch Buffet
1:30 pm – 3:00 pm	Multi-track Technical Sessions
3:00 pm – 4:30 pm	Free Time - During this time slot Steel sponsors can organize the "Special" sessions
4:30 pm – 6:30 pm	Steel Sponsors Reception
7:00 pm – 12:00 am	Social Event
Thursday - September 29, 2022	
8:00 am – 4:30 pm	Trade Show Runs
7:00 am – 8:00 am	Breakfast
8:00 am – 9:30 am	CISC Award Presentation
9:30 am – 10:00 am	Break
10:00 am – 12:15 pm	Multi-track Technical Sessions
12:15 pm – 1:30 pm	Lunch Buffet
1:30 pm – 3:00 pm	Multi-track Technical Sessions
3:00 pm – 4:30 pm	Free Time - During this time slot Steel sponsors can organize the "Special" sessions
4:30 pm – 6:30 pm	Closing Reception
6:30 pm – 7:30 pm	Trade Show Exhibitors Move-Out
Friday - September 30, 2022	
Post Tours both Groups 1 & 2 will meet for the luncheon	
Day Tour - Group 1	Capilano Suspension Bridge / Granville Island
Day Tour - Group 2	Bon Chovy Fishing Charter / Granville Island

For details on the program and the committee meetings, visit the CISC website:
www.cisc-icca.ca/canadian-steel-conference

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For Trade Show and Sponsorship opportunities, visit the CISC website for details:
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The CISC Awards for Excellence in Steel Construction are the most prestigious signature events across Canada.

Teams are rewarded for excellence for the realization of their exceptional projects in steel. Projects showcase complexity, innovation, beauty, uniqueness, and originality, amongst many other noteworthy attributes. Hundreds of nominations are received yearly; Engineers, Architects, Fabricators, Contractors and developers, as key stakeholders of the steel construction industry submit their projects individually or in teams. The best finalists are picked by a distinguished jury of renown Architects, Engineers and Steel Industry connoisseurs, and the winners in the various categories are selected and announced at the Awards Ceremony and dinner. These ceremonies offer an opportunity for the teams to shine and for all industry to appreciate, admire and applaud the immensely talented Canadian Steel Industry.

CISC Quebec 22nd Awards for Excellence in Steel Construction

October 27, 2022
Palace Convention Centre

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Steel Drives Novelty – Where Creativity and Value Converge!

Creation and innovation results in new, underestimated benefits

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

This edition of *Advantage Steel* illustrates four different projects that highlight how steel drives novelty and how creativity in design choices can effectively lead to a better value – how the two successfully converge.

Creativity and value converge when default thinking ceases to persist. When reliance on the "status quo" is the determining factor premising our design choices, we miss out on new, creative and innovative choices that may result in underestimated benefits.

We do, however, see an inspiring trend in our design choices that is based on an increased focus on more conscientious environmental and sustainable solutions, triggering the closer and simultaneous consideration of key factors in the decisions-making process, like speed of construction, overall cost and long-term operational benefit.

The adoption of a steel-framed parking structures is a head-turner, far from normal practice. The article clearly illustrates some of the major advantages that may not have been considered in the past. "Why?" you ask? The honest answer would likely be because it was always done this way!

Steel-framed parking structures amalgamate architectural freedom, structural efficiency and an overall lighter structure and can provide the flexibility to choose the best-suited deck system. Keeping in mind the importance of lower capital/construction costs, these are facilitated given the potential lower maintenance costs – given the durability of the structural members and the proactive ability inherent in the shop fabrication for quality control and quality assurance process, minimizing the difficulties in quality control inherent with labour-intensive on-site work.

WE MUST SWAY FROM CONVENTIONAL THINKING IN ORDER TO PROVIDE THE RIGHT SOLUTIONS TO MAXIMIZE BENEFITS, WHERE THE STATUS QUO IS NO LONGER AN OPTION.

Our carbon-conscious design options should search for sustainable solutions that anticipate the advantages of utilizing structural steel, which contains an average of 93 per cent recycled content; steel can be reused and repurposed.

Vancouver's Riverbend Business Park is Canada's first multi-level logistics facility: What an innovative way to use steel to provide cutting-edge facility space, effectively lowering its carbon footprint. This facility was built with recycling and repurposing decisions made from the outset and the consideration that only steel can offer a secure benefit for the future.

Calgary's Westbrook Pedestrian Bridge is a clear example of default thinking shelved! The innovative design led to an aesthetically unique structure that blurs the line between the span and the support by best integrating structural elements; one flows into the other. This was a novel hybrid approach and quite the engineering challenge, but steel was the driver, for it enabled the streamlining of connections between materials.

Calgary Ring Road is one of Alberta's most ambitious infrastructure initiatives. This is a great example of creativity and value converging. The decisions were driven by equally challenging factors – the spiraling road geometry, the combination of geometrical complexities as skewedness, curvature and the need to be flared were key drivers in determining the required shape of the bridge.

Atmospheric weathering steel offered the answer to the 75-year design life and durability requirements, providing the owner with the greatest service life for this superstructure. The adherence to Alberta Transportation's newly introduced standard and technical specification requiring fabricators to be CISC Bridge Certified, and steel procurement to be from Canadian or U.S. steel mills, also imposed stringent inspection and testing tolerances, which all contributed to an exceptional execution.

The moral of the story is that we must sway from conventional thinking in order to provide the right solutions to maximize benefits, where the status quo is no longer an option. We see projects that are a testament of how steel drives novelty to allow creativity and value to converge, and we can facilitate in making this the new norm! AS

STRUCTURAL STEEL

A viable alternative for open deck parking structures

BY :: MICHAEL SAMUELS, MASC, P.ENG., MANAGER OF ENGINEERING, CISC-ICCA
BRETT PERRAS, P.ENG., STEEL MARKET & INDUSTRY DEVELOPMENT ENGINEER, CISC-ICCA

Photo credit: Newton Group

Increasing scarcity and availability of urban and suburban sites for grade-level parking lots, together with the phenomenal growth of large suburban malls, offices and recreational parks have brought into prominence the need for structured parking.

Over the last 40+ years, open, above-ground, multi-level parking structures have been used extensively in North America and various parts of the world, specifically fabricated structural steel-framed parking structures (SFPS).

In the current market, precast concrete continues to be the default material of choice for parking developments, which accounts for approximately 45 per cent of garages being built, while cast-in-place concrete accounts for 36 per cent. In recent years, structural steel or some hybrid form has come to represent approximately 19 per cent of the market. There are major advantages to be demonstrated and gained from the adoption of steel-framed parking structures; thus, skewing away from normal practice.

Why should you choose steel?

Steel-framed parking structures provide the flexibility to use any of the three concrete deck systems (precast, cast-in-place slabs, cast-in-place post tensioned slabs). Surface-mounted conduits can be run through prefabricated openings in the steel beams or, alternatively, using castellated/cellular beams. Structural steel simplifies future expansion, which can be completed vertically through the splicing of existing columns and the placement of steel members with readily available cranes, all while keeping the existing structure in use.

A steel-framed parking structure provides extreme architectural freedom. The exterior envelope can be customized and is not limited. There are unlimited choices in the type of façade and flexible layout options, easily attaching the structural framing members. This is in contrast to concrete structures, often requiring solid interior shear walls as part of the Lateral Force Resisting System (LFRS), which create a "closed-in" feeling. SFPSs utilize braces and/or moment frames, resulting in a more open and safe feeling space. Additionally, steel columns require 80 per cent less floor space than equivalent concrete columns and provide the owner with flexibility in layout, capacity and efficiency and additional parking stalls for the same building footprint of competitor materials.

Cost is the driving factor in most construction projects in today's industry, so why would a developer choose to overpay for an equivalent if not superior product? SFPSs are typically constructed with lower capital/construction costs, with a cost saving of 10 per cent to 20 per cent over an alternative framing option. A comparative study by the American Galvanizers Association determined the unit costs of stalls, premising the evaluation on the choice of structural system as follows:

- Steel-Framed: Range 20k-25k per stall
- Concrete: Range 30k-40k per stall

Photo credit: Newton Group

The cost savings associated with an SFPS occur from a variety of factors. A steel-framed parking structure can be erected significantly quicker compared to other types, hence limiting construction costs and making early occupancy possible, noting that delays due to weather (winter months) for the construction/erection are minimal. The process of erecting the steel framing for a parking structure consists of bolting steel segments together in a prescribed sequence. Compared to competitors, SFPSs utilize smaller member sizes, which simplifies erection in locations with limited delivery or construction access. Savings can be achieved by utilising Welded-Wide-Flange beams resulting in a 15-30 per cent material saving on beam tonnage. Lastly, a smaller transportation price tag comes with the reduced weight of a steel structure; during construction, lightweight building materials reduce onsite crane requirements.

The structural design of an SFPS is also optimized. A steel frame is lighter than a traditional concrete structure. This results in reduced weight, which is an important factor in reducing the seismic design, lateral force resisting system and foundations. These reductions ultimately contribute to lower construction and material costs since these steel structures can be fabricated and erected by local companies.

One other major factor in parking structure costs is the maintenance cost associated with the project over its lifespan. SFPSs are typically constructed with hot-dip galvanized steel, which provides excellent corrosion protection resulting in minimal maintenance. An SFPS typically only requires protection at the joints (approx. seven per cent of the total area). This in turn reduces the maintenance and replacement costs by 93 per cent compared to alternatives. Life cycle cost analysis (LCA) have indicated that over a 50-year life, the cost to maintain a precast concrete deck and frame system is between five and eight cents per square foot, while the cost to maintain a post-tensioned deck on a steel frame is between three and five cents per square foot – a

PROJECT EXAMPLES IN SIMILAR CLIMATES:

Canadian Projects: Centennial GO Station, Humber College

U.S. Projects: National Renewable Energy Laboratory Parking Garage, JetBlue Airways Yellow Garage, Portland International Jetport Parking Garage, Harrisburg International Airport Parking Garage

Photo credit: Newton Group

savings of 40 per cent. Additionally, long-term repair costs for an SFPS are approximately 25-30$/stall per year compared to repair for a precast, double-t system which is approximately 200-250$/stall per year. Exposed beams, girders and columns facilitate accessible direct inspection, evaluation of the frame and ease of maintenance for exposed steel surfaces.

The key factor to keeping maintenance costs low is the durability of the structural members in the system. As mentioned above, the galvanizing process protects steel from the inside out. Utilizing a tough barrier protection and intrinsic cathodic protection, a standard 4 mm coating can easily achieve 40 to 50-year maintenance-free expectancy. If required, an additional paint can be applied on top of the zinc layer. This resultant "duplex" system minimises maintenance costs and substantially increases the duration of protection against corrosion. The "sacrificial" aspect of most concrete decks placed on the steel beams means that major deck repair and rehabilitation can be accomplished with minimum disruption and cost, typically not requiring additional work to the steel structure itself.

As the world moves to create more conscientious environmental and sustainable decisions, the key is to utilize recycled materials and decrease our carbon footprint. All structural steel contains an average of 93 per cent recycled content, meaning a lower initial environmental impact. By specifying a hot-dip galvanized zinc coating for corrosion protection, you are choosing to utilize yet another abundant, recyclable, natural metal to further the cause of sustainability. For 50+ years, the galvanized steel members will remain maintenance free, resulting in no further raw material or energy expended, including no further carbon footprint beyond the production phase. At the end of its lifespan, the steel-framing system can be recycled into new steel for an infinite number of other applications, including new steel members!

Inherent in the fabrication of structural steel is a first-class quality control and quality assurance

Photo credit: Newton Group

"INHERENT IN THE FABRICATION OF STRUCTURAL STEEL IS A FIRST-CLASS QUALITY CONTROL AND QUALITY ASSURANCE PROCESS."

process. Shop fabrication of steel framing eliminates weather as a factor. Utilizing structural steel minimizes the difficulties in quality control inherent with labour-intensive, on-site placement of reinforcing steel, forming and casting of concrete columns and beams. The developer has the option of selecting its preferred steel fabricator, concrete deck subcontractor and/or precast/prestressed deck fabricator, based on experience and quality of work. Also, the ease of inspection of SFPSs allows for inspectors to observe localized breakdown of a coating system on a steel beam to identify a developing problem with the concrete deck above, such as water or chlorides (road salts) leaking through a crack or a joint. Early detection of deck leakage permits timely corrective measures to be implemented.

So, what is holding this viable and cost-effective solution back from taking over the parking structure market? The answer is a lack of information and common misconceptions as the need to further educate the industry on the best construction practices for an SFPS is necessary. First off, rust/corrosion occur with all systems: steel, precast and cast-in-place concrete. With respect to structural steel, although rust does occur, with a proper maintenance plan and schedule and exposed steel being easy to inspect, it can be easily identified and repaired. Next up, reducing early staining of steel will make potential owners more receptive. The natural sheen of a galvanized member proves to be a great aesthetic architectural finish, and touch-ups will keep the member protected for its lifespan. The main areas of concern are the reinforcing steel within the floor system, which is covered and difficult to inspect (concrete surface looks sound, however under the surface the real issues occur). Rust and corrosion due to seepage of chlorides create long-term effects that may not manifest for years (spalling, cracks, delamination, etc.). When these occur, the remediation measures are significant and costly, also putting the structure out of service. In reducing the chance of water

Concrete Cost[2] ($/sq. ft.)	HDG Cost Range[3] ($/sq. ft.)
37.77	28.65 - 32.33
42.04	31.70 - 35.66
48.84	38.05 - 42.80
47.19	36.25 - 40.78
35.66	27.74 - 31.20
40.48	31.45 - 35.38

Sample Cost Data from various US Cities
Source: American Galvanizers Association

Photo credit: Newton Group

ponding and damage due to seepage, we need to consider the importance of drainage and the positioning of drains within the system. Drains are located generally near columns and at the bottom of ramps throughout the structure. If lateral runs are required, they must not fall within the critical bearing area of structural member.

Fire protection is often a significant factor in the cost of a project. Based on the NBC 2015, Clause 3.2.2.90 requirements, the structure must be less than 22m high, less than 10,000m^2 area and that all floor area must be within 60m of an exterior opening. An SFPS meeting the NBC requirements is considered an open-air structure and does not require fireproofing, resulting in a major savings.

An owner's/developer's decision is often made based on preferences premised on default thinking, past projects and experience, and design team choices. However, when we consider key drivers like speed of construction, overall cost and long-term operational benefit, these should be the determining factors in the decision-making process that should be the basis of new and improved choices for the future. AS

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1. American Galvanizers Association, "Hot-Dip Galvanized Parking Structures," A sustainable, economic solution for a transportation necessity.

MAKING MILESTONES

Vancouver's Riverbend Project – A Canadian first

BY :: MATTHEW BRADFORD

Vancouver's Riverbend Business Park is now the site of Canada's first multi-level logistics facility. Dubbed the "Riverbend Project," the 707,000-sq.-ft. building marks a significant addition to the newly developed business campus and a milestone for steel construction.

Photos courtesy of Oxford and Supermétal.

The project was the vision of Oxford Properties Group and the final component of the 1.35-million-sq.-ft. master-planned business campus. It was built to provide cutting-edge facility space that would make the best use of its footprint.

"Vancouver is one of the tightest and most land-constrained industrial markets in the world, so we knew bold solutions were required to deliver the type of footprint demanded by the growing digital economy," said Jeff Miller, Head of Industrial at Oxford Properties. "Backed by the strength of our conviction and a world-class team, we delivered not only Canada's first multi-level industrial property, but the largest speculative building ever constructed in Greater Vancouver."

Ledcor Construction Services was tasked with making Oxford's ambitions a reality. Its team consisted of Glotman Simpson Consulting Engineers, which recognized the advantage of utilizing steel components early in its design.

"From the very beginning of the project, one of the main objectives was to make the structure as light as possible," says Omar AlHarras, Project Engineer with Glotman Simpson Consulting Engineers. "This is due to the challenging soil conditions, B.C.'s seismic activity and the very high storage loading requirements for this structure."

The design team was also intent on making the design as modular as possible to accelerate the development. "We knew having a structural steel solution would make the construction a lot faster since we weren't dealing with formwork or a lot of concrete," notes AlHarras. "Of course, we'd be using some concrete for the decks, but with steel, we knew we could erect the bays very fast."

With designs set, Ledcor went to market for a steel fabricator that could take on this Canadian first. The bid was awarded to steel industry veteran Supermétal Structures Inc.

Aerial view of Vancouver's Riverbend Business Park.

Framing the challenge

Strength is at the core of the Riverbend Project. Specifically, its second-floor structure is designed to accommodate fully loaded semi trucks as they load and unload into the space using a large structural ramp.

"The Level 2 floor steel is much like a bridge consisting of 1.2m- to 2.0m-deep girder beams, with additional infill steel that is all part of a composite floor system requiring a 3-in.-deep floor deck, over 200,000 field-applied shear studs and later topped with 250mm to 300mm of concrete," explains Shaune Turpin, Regional Manager, Western Division with Supermétal.

Over 11,000 metric tons of steel were used to bring the multi-storey facility together. Supermétal fabricated the bulk of the large W columns in one piece at its shop, with the largest measuring 21.8m long and weighing 30 tons. The floor girders were also fabricated off site and consisted of numerous WWF sections ranging from WWF1200 to WWF2000.

"The depth of these beams was dictated by the minimum clearance requirement at the Level 1 warehouse," explains Turpin. "The largest WWF section was a WWF2000 that was 18m long, and the heaviest was a WWF1200 that was about 15 tons."

Once ready, these pieces were shipped to the site for installation. For this phase, Supermétal utilized its patented load-out trailer, a custom platform designed to pull loaded racks out of containers and transport them onto a trailer that was moved further into the jobsite for unloading.

"As large as this jobsite is, the building footprint fills almost the entire area," says Turpin. "Logistics were a huge consideration for this project – to have enough steel shipped to the site and strategically placed inside the footprint to allow a clear travel path for the large 250-ton crane, as well as the other mobile equipment required."

Once each steel column was moved into position, crews anchored them to the ground with 8 x 70mm diameter anchor bolts assembled to a cast-in-place uplift plate. The columns' baseplates were 127mm-thick steel plates, which required the precise placement of anchor bolts to ensure a seamless installation process.

"Ledcor and the forming contractor took extra care in placing the anchor bolts, and I am happy to report that all 2,560 anchor bolts were placed correctly, with no rework required," Turpin adds.

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LIFE AFTER RIVERBEND

Constructing the Riverbend Project with steel will prove beneficial in the future. Long after the facility is no longer in use, AlHarras says there will be opportunities to recycle the material for future projects: "We can utilize this structural steel again for other applications. Since it's a warehouse typology and quite modularized, it's easy to rethink another life for the material."

RIVERBEND BY THE NUMBERS

11,000 MT of steel
145,000 structural bolts
200,000 shear studs
2,560 anchor bolts
880,000-sq.-ft. deck
537 tons OWSJ

Construction of Canada's first multi-level logistics facility.

Going with the flow

The Riverbend Project brings a Canadian first to Vancouver's industrial community. Both Turpin and AlHarras agree that the milestone would not have been possible without unwavering collaboration between the entire team.

"We were always in contact," says AlHarras. "Throughout the design and construction, we were always meeting with Supermétal and discussing ways to make fabrication easier or to deal with changes. It was great to get their feedback, and that's something we always welcome."

"Being involved in a project of this magnitude is special," he adds. "We're very proud of this building, and we hope to see more of it."

"Added up," says Turpin, "all these components equal a major achievement in steel construction and an awesome showpiece in the Vancouver / Burnaby area." AS

"LONG AFTER THE FACILITY IS NO LONGER IN USE, ALHARRAS SAYS THERE WILL BE OPPORTUNITIES TO RECYCLE THE MATERIAL FOR FUTURE PROJECTS."

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THROWING THE CALGARY RING ROAD FOR A CURVE

Steel helps Bridge 36A take shape

BY :: MATTHEW BRADFORD

The Calgary Ring Road infrastructure project is coming full circle thanks to Supreme Steel and KGL Constructors. In 2020, crews completed the southwest portion of the east-west trade corridor, helping to both connect Alberta's economy and showcase the versatility of steel.

KGL Constructors (a consortium of Kiewit Corporation, Graham Construction and Ledcor) served as the design-construction lead for the 31km project, dubbed the Southwest Calgary Ring Road (SWCRR). The route was built between Highway 8 and MacLeod Trail SE and included the development of a six- and eight-lane divided highway, a tunnel and 46 bridges, among other key assets.

Supreme Steel was hired to provide steel elements for six of those bridges. And while each required special consideration, it was Bridge 36A that best put the benefits of steel on display.

"The spiraling road geometry over a new section of highway dictated the required shape of the bridge," says Todd Collister, Director of Technical Services with Supreme Steel. "While many bridge structures can be designed simply square to another road, creek or river, some structures meet another obstacle at a skew or need to be curved, while some structures need to [be] wider at one end of a bridge than the other end," he explains. "Bridge 36A had a combination of all these geometrical challenges – being skewed, curved and flared – and this could only be economically achieved with steel."

Construction of Bridge 36A, achievable only with steel.

"That bridge was one of the most challenging ones because of its curved geometry," adds Alejandro Zuluaga, Structural Lead Engineer with Kiewit. "There wasn't another bridge like that on the project."

Building on a curve

Bridge 36A was a worthy challenge for the SWCRR cohort. The structure's design called for a highly elevated two-span bridge with a large curving radius to support an 80-kph speed limit. Moreover, each span required kinked girders measuring nearly 80m in length.

"Kinking the girders allowed for the upper alignment to follow the curve while essentially keeping each girder segment straight to assist with fabrication and handling," notes Collister.

Zuluaga agrees that utilizing kinked steel girders was integral to achieving the bridge's curved design. "The bridge spans across two major roads, and we could only add one pier to achieve the road alignment," he explains. "Concrete girders for this bridge were out of the picture due to the high skew, curved alignment and flare required to maintain the road alignment under and over the bridge."

The decision to flare the girders was also integral to the design as it allowed for the transition in road length. Moreover, the skew of the girders enabled the bridge to deliver proper support for the girders from the alignment of the upper road surface as opposed to the lower road surface.

Another noteworthy feature of the bridge's construction was the addition of a pipe stiffener detail near the abutments. This helped account for highly skewed joints near the abutments to take the high compressive forces and simplify the highly skewed connections at the diaphragms.

"Bridge quality grade pipe steel generally doesn't exist in the small quantities needed for this project, so the bridge plate was rolled to meet this tight radius, again demonstrating the flexibility of steel," says Collister.

The ability to preassemble the entire length of the girder for both spans before placement on site was another advantage for the team. So, too, was the high strength-to-weight ratio of steel, which enabled KGL to have the flexibility of spanning larger distances than would have been possible with other materials.

As for the durability of the final structure, Collister adds, "The durability of atmospheric weathering steel will exceed the 75-year design life requirement for this project and provide the owner with the greatest service life for this superstructure."

Exacting standards

Calgary Ring Road is one of Alberta's most ambitious infrastructure initiatives and is central to economic growth. As such, the team was held to high provincial standards. This included Alberta Transportation's newly introduced Schedule 18, a standard and technical specification that requires fabricators to be CISC Steel Bridge Certified, use steel from Canadian or U.S. steel mills and create an exhaustive inspection and testing plan for tighter tolerances than in previous standards.

"THE DECISION TO FLARE THE GIRDERS WAS ALSO INTEGRAL TO THE DESIGN AS IT ALLOWED FOR THE TRANSITION IN ROAD LENGTH."

"Supreme Steel stepped up to the challenge, broke down the requirements step by step and refined existing work instructions and techniques to ensure material grades were met; material handling was controlled; cutting, drilling and welding processes were dialed into tight tolerances and final checks were signed off," says Collister.

"Alberta Transportation has some very tight specs that we needed to follow for fabrication, and they were all met," adds Zuluaga. "There were no significant quality problems in the fabrication process of the steel bridges, and all the challenges that came up were addressed successfully with all parties."

The team attributes the successful outcome to ongoing communication between all team members throughout the design, fabrication and installation stages.

As for the outcome, says Collister, "Supreme Steel has a proud history of projects, and you can be sure that my kids will be sitting in the back of the car with an annoyed smile telling me, 'We know you built this bridge. You tell us every time we go under it.'"

The SWCRR is one of Calgary Ring Road's four key phases. The next is the South Bow River Bridge project, slated for completion in October 2023, for which Supreme Steel is also fabricating 40 girders for its eastbound lane and six girders for the pedestrian bridge. After that, the completion of the route's West Calgary Ring Road is scheduled for 2024. AS

ELEVATING STEEL AT CALGARY'S WESTBROOK PEDESTRIAN BRIDGE

A hybrid project done right

BY :: MATTHEW BRADFORD

It's an innovative blend of steel and concrete that gives Calgary's Westbrook Pedestrian Bridge its lift. Spanning the city's Bow Trail expressway, the 32-metre structure serves as a stylish connecting point between the Spruce Cliff community and Westbrook Mall, and is a visible example of hybrid projects done right.

The Westbrook Pedestrian Bridge Overpass, which connects Westbrook mall with the community of Spruce Cliff.

Completed in 2019, the Westbrook Pedestrian Bridge was built to replace an existing bridge as part of Calgary's Area Redevelopment Plan (ARP), which envisions a safer and more walkable neighbourhood surrounding the Westbrook LRT Station. It was erected by general contractor Graham Construction based on designs by RJC Engineers.

"We blurred the line between the span and the support and integrated those elements aesthetically so that one flows into the other," says Geoff Kallweit, Associate with RJC Engineers. "The result is that it doesn't look like a steel span perched on a concrete base, but more like the span and the base flow into one another."

Norfab Manufacturing Inc. supplied the structural steel, and provided and installed the bridge's metal railing. The Edmonton-based fabricator's steel components were key to achieving RJC's vision for a sleek and integrated structure, as they enabled crews to slim down the connection points where steel meets concrete, making them as seamless as possible.

"Using a steel tied-arch structure for the main span of this bridge also allowed a thin, slender profile to be achieved over Bow Trail and eliminated the need for mid-span pier support," notes Ryan Loewen, Engineer with Graham Construction. "And since there was no need for piling or pier construction in the median of Bow Trail, this reduced the impact to vehicles on Bow Trail significantly."

"WE BLURRED THE LINE BETWEEN THE SPAN AND THE SUPPORT AND INTEGRATED THOSE ELEMENTS AESTHETICALLY SO THAT ONE FLOWS INTO THE OTHER." **- GEOFF KALLWEIT**

Steel's strength was also a factor in the design's success. For example, the compression portion of the bridge's arch – the steel tube – is field-welded to a steel base plate that bears on the concrete where it transitions. By virtue of steel's strength, Kallweit explains, "We were able to make that welded connection very tight in alignment with the outline of the concrete where the two meet, so there is not a big, chunky connection where you need more concrete area to bear the same load."

As for addressing the tension requirements, steel enabled the arch tie components to be embedded right into the concrete part of the end of the span. This makes the elements appear as if they are "growing" out from the concrete.

"We could do that because the component was small enough to fit within the rebar cage and have all the forces transferred through it, even though it's in a smaller area," notes Kallweit.

"Overall, using steel allowed us to make some very streamlined connections between the two materials," he adds.

Assembly time

Time was of the essence throughout the construction of the Westbrook Pedestrian Bridge. Using steel to

completely span Bow Trail allowed the bridge to be fully assembled on site in a nearby field and then transported and lifted into place, thereby accelerating construction.

"With only one full night-time closure of Bow Trail required to transport the completed main span to its final location and lift the bridge in place using a two-crane pick, the impact to traffic users for this main thoroughfare was minimized," Loewen reports.

To ensure a speedy fabrication, Norfab conducted a 3D model of the structure's steel portions, which was used to validate the geometry between the pieces. This model was also used as part of the team's quality control process, in which the steel component designs were checked carefully in Norfab's shop as they were being fabricated to confirm the tolerances of the steel geometry.

This process proved critical to ensuring the pieces would fit as intended by the time they arrived on site for installation. It also helped the team address some of Westbrook Pedestrian Bridge's most challenging design aspects, including the prefinished architectural railing design on the curved ramp.

"It was also one the most compelling challenges for Norfab and the team when it came to matching as-built anchor bolt locations, aligning with the curvature of the concrete curbs and coordinating with electrical conduit locations, all while being hot-dip galvanized," says Kevin Huot, General Manager with Norfab. "On top of that, the slope of the concrete curb and the ramp slope were different by design. That made each post unique to their own location, so no two posts were typical in their fabrication."

To address these challenges, he continues, Norfab provided Graham with templates and layouts for the anchor bolts to ensure locations and spacings were within tolerance: "And, after the anchors were cast in place, we surveyed the locations and imported the data into our modelling software to produce accurate shop fabrication drawings."

CANADIAN INSTITUTE OF STEEL CONSTRUCTION
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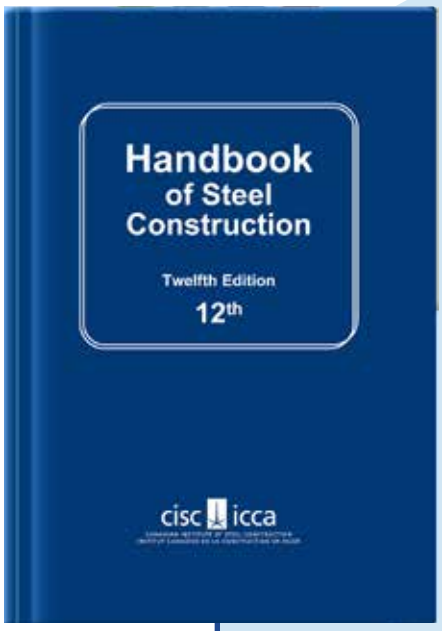
The NEW 12th Edition of the Handbook of Steel Construction

Published by the CISC since 1967, the Handbook of Steel Construction is the standard reference for the design and detailing of structural steel in Canada. The 12th Edition, intended to be used in conjunction with the National Building Code of Canada 2020, includes the new CSA S16:19 and the steel section data.



(Used with NBCC 2020)

Major Changes in this NEW 12th Edition

▶ **PART 1 - Includes CSA S16:19**
New provisions for built-in cantilevers, single angles used as beams, beams with flange holes, new seismic systems including moderately ductile plate walls and truss moment-resisting frames, inelastic analysis, and third-party inspection.

▶ **PART 2 - Includes the CISC Commentary on CSA S16:19**
Updates cover new provisions and new systems.

▶ **PART 3 - High-strength and twist-off bolt grades:**
Referenced in accordance with ASTM F3125/F3125M.

Range of eccentricities in tables for eccentrically loaded bolt groups has been extended.

Net section calculations for framed beam shear connections are based on updated bolt hole diameters in S16:19.

Additional details are provided to explain how tabulated resistances were calculated.

▶ **PART 4 - Tables of factored axial compression** resistances are now based only the effective area method, for consistency with the intent of S16:19.

▶ **PART 5 - The Beam Selection and Beam Load Tables** include shear resistances for beams subject to combined shear and moment. A new design table is introduced for beams with flange holes.

▶ **PART 6 - New W-shape sections listed** in the latest ASTM A6/A6M standard.

38 new large (jumbo) hollow structural (HSS) sections produced to CSA G40.20 and ASTM A500 have been added to the tables of properties and dimensions.

Tables have been expanded to include the new asymmetry parameter (βw) for laterally unsupported unequal-leg angles and detailing dimensions (a, k, k1) for structural tees.

▶ **PART 7 - M/D ratios for contour protection** of both beams and columns are now provided for all member sizes.

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To further accelerate the installation, Graham marked work points on the steel arches and surveyed to within a few millimetres during assembly. The arch segments were also temporarily supported on shoring towers to achieve the final required geometry before being completely welded together.

"Because we were basically assembling a bridge in a field 150 metres away from its final location, to the precision of within a few millimetres of its final design and as-built abutment geometry, setting up a usable on-site grid system that correlated with Norfab's fabrication geometry was critical," explains Loewen.

Looking back over the entire process, he adds, "Norfab's on-site assembly crew of ironworkers and welders completed the steel portion of this bridge assembly with expert skill and precision and were a main factor in the success of the project."

A unique accomplishment

The completion of Westbrook Pedestrian Bridge brings Calgary one step closer to bringing its ARP ambition to life. It also gives Graham Construction, RJC and Norfab a stand-out project to add to their portfolio.

Says Loewen, "It took a lot of planning and preparation to build a bridge that consisted of both precast concrete and steel arches and crossbeams, and to support these components so that they not only fit [with] each other, but matched the final geometry of the cast-in-place abutments and architectural components on either end of the bridge. To do so successfully is an amazing feeling of accomplishment."

"It was certainly one of the more interesting pedestrian bridge design projects that I've been a part of," adds Kallweit. "This hybrid approach was pretty novel and a very interesting engineering challenge that made the whole project exciting." AS

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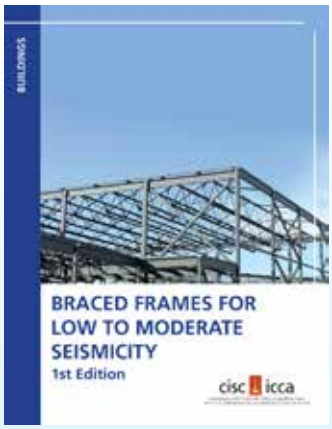
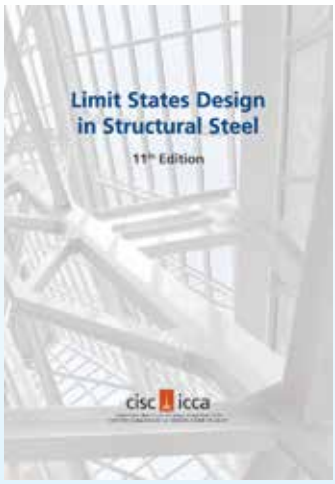


This publication illustrates the design of seismic-force-resisting systems (SFRS) and bracing connections for buildings with concentrically braced frames in areas of low to moderate seismicity according to the National Building Code of Canada (NBC 2015) and CSA S16-14. The example structures range from 1 to 6 storeys and feature tension-only and tension-compression bracing, chevron and X-bracing, conventional construction, and limited-ductility (type LD) systems. Two design examples of brace-to-gusset connections for type LD braced frames (chevron and X-bracing) are also included.

Limit States Design in Structural Steel, 11th Edition

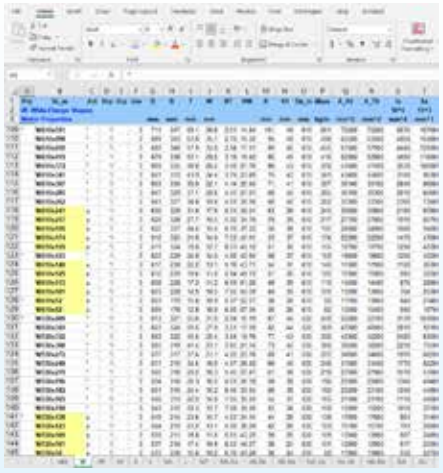
G.L. Kulak and G.Y. Grondin

456 pages
ISBN 978-0-88811-243-9



This book serves as a complete teaching text for universities and technical colleges, and as a valuable reference for practicing engineers. It explains the philosophy and practical applications of limit states design procedures and provides comments on design requirements in CSA S16:19. Comprising 11 chapters, the book covers: types and grades of structural steel, tension members, columns, beams, composite construction, plate girders, beam-columns, bolted and welded connections, building design and fatigue behaviour. There are numerous updates included in this 11th edition, also incorporating changes from the National Building Code of Canada 2020.

Structural Section Tables (SST12)



The CISC SST12 Excel database contains the North American structural steel sections listed in the CISC Handbook of Steel Construction, 12th Edition. All dimensions and section properties are given in Metric units, except for the section designation, nominal depth, and nominal mass, which are given in both Metric and Imperial units.

The following steel shapes are included: W, HP, M, S, C, MC, L, WT, HSS (square, rectangular and round; CSA G40.20 and ASTM A500), 2L (equal legs, long legs, and short legs back-to-back). Commonly used and readily available W-shape sizes are highlighted in yellow colour. The database has been updated with the addition of new "jumbo" HSS and new section properties in CSA S16:19 such as the asymmetry constant for unequal-leg angles. Additional section properties for torsional analysis not found in the Handbook include the normalized unit warping function and warping statical moment for W and HP shapes, and the torsion modulus for HSS.

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

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

WHY IS IT IMPORTANT?

MEET REQUIREMENTS

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

MEET DEMAND

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

REDUCE COST

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

IMPROVE SAFETY

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

WHAT IS IT?

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

HOW IS IT DONE?

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