ADVANTAGE STEEL

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CANADIAN INSTITUTE OF STEEL CONSTRUCTION

NO. 73 SUMMER EDITION 2023

STEEL'S CIRCULAR ECONOMY

The material of choice on full display

Building The Stacks St. Lawrence Market North Project
Steel's Second Act The Carbon Corner ERC News

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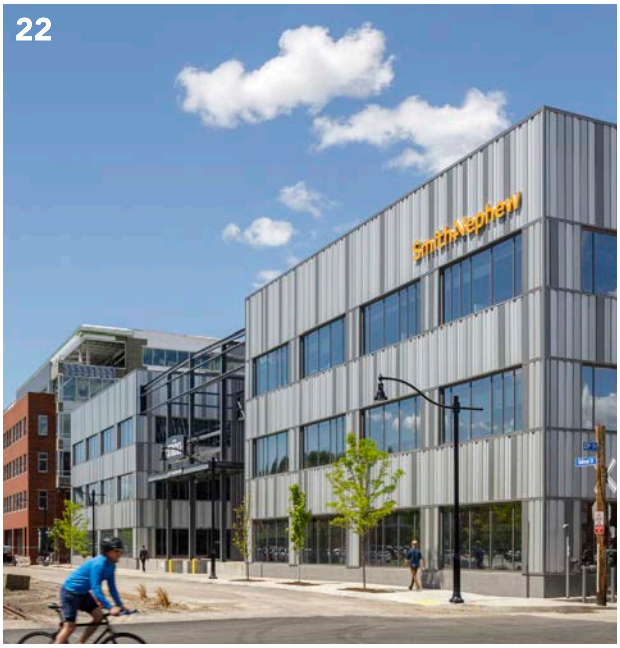

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STEEL'S CIRCULAR ECONOMY
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The Canadian Institute of Steel Construction (CISC) is the voice for the Canadian Steel Construction industry. The CISC represents a diverse community of structural steel 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

Boron Advisory Update

In November 2016, in response to global reports and international standards, the CISC issued an advisory that steel with increased and abnormal levels of boron had been detected in the international supply chain. Several international standards reacted by placing boron limits on structural-grade steel to a maximum of 0.0008 per cent.

Typically, boron is not intentionally added to most construction-grade steel and therefore has no limits (maximum or minimum per cent) in North American standards. Being an element that mills would not use, it is not tested or reported in the mill material test report. Why would you track and record alloy elements you don't add? Now, boron is added to some steel to improve hardenability and increase tensile and yield. These tend to be more brittle in nature. Machine steels are a great example. Brittle steels, however, are typically not what we want in our steel structures, so we avoid boron as an alloy element.

So why is the boron there in the first place, and why did it suddenly pop up around 2015? The issue was identified by accident in the E.U. and Australia after a number of cases of severe or extensive weld cracking took place. After investigation, it was found that the affected steels had excessively and inexplicably high levels of boron that lead to the cracking. These steels appeared to all originate from China. It was also determined that these levels could only have occurred by intentionally adding the boron during the mill production process. ASTM A6 – Standard Specification for General Requirements for Rolled Structural Steel Bars, Plates, Shapes and Sheet Piling, which governs most of our construction steels, states boron must be reported if it is intentionally added. This is the type of wording only politicians and lawyers would love. Let's be frank – boron levels above 0.0008 per cent don't happen by accident in any steel. Note CSA G40.20/.21 also references ASTM A6; therefore, this is also applicable for CSA-grade steel.

I will leave it to you and the internet as to the actual reasons why China intentionally added boron, but the question now is, is this practice still going on? It appears so. There

"ASTM A6 – STANDARD SPECIFICATION FOR GENERAL REQUIREMENTS FOR ROLLED STRUCTURAL STEEL BARS, PLATES, SHAPES AND SHEET PILING, WHICH GOVERNS MOST OF OUR CONSTRUCTION STEELS, STATES BORON MUST BE REPORTED IF IT IS INTENTIONALLY ADDED."

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MANAGING EDITOR
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have been several recent reports in Canada of pipe piling and structural steel from China having elevated levels of boron above the 0.0008-per-cent limit imposed by E.U. and Australian standards. As a result, the CISC Boron Advisory from 2016 sadly remains. The good thing is that Chinese construction steel as a percentage of total raw import tonnage is very low (or at least it was). That may change as the U.S. and E.U. increase tariffs and tighten import rules for raw and fabricated steel products, making Canada an opportune market. The CISC recommends caution for Chinese steel and other international mills using Chinese slabs and billets. The 2016 CISC advisory provides some guidance to importers, engineers and fabricators. Kudos to some of North America's steel mills that are already testing and recording boron on their material test reports. They understand this is a serious problem, and they want to be transparent and prove they are producing quality steel.

Can I use steel with elevated boron? Possibly, but in some applications, absolutely not. This should be a discussion with the engineer of record and the company's welding engineer prior to commencing work. The challenge is knowing when you have high boron, and you won't unless you test it. Most fabrication welding procedures in Canada don't take this alloy into consideration because it isn't expected. Once the percentage amount is determined, the welding engineer may be able to, for example, modify the weld procedure(s) to potentially accommodate the high boron levels and reduce brittleness and other factors to acceptable levels. A weld completed with an incorrect welding procedure with high boron could lead to cracking issues (cold, hot and stress corrosion) – not good.

In light of these recent discoveries, CISC will be bringing the discussion of boron limits back to ASTM this fall. While we wait to see the outcome of this work, here are some measures you may wish to take to address boron:

1. Restrict steel sourcing from only approved countries. Yes, this can be done, and is already in place in some provinces.
2. Continue to follow the 2016 CISC advisory on boron, understanding that the boron source appears to be China. Engineers: remember to put whatever you want and need in the project specification at the start! Everyone can then bid accordingly with open eyes and account for any additional costs, if there are any.
3. Require Canadian testing of fabricated steel. More and more steel is not only imported in its raw form, but it is also fabricated. Since the Chinese steel mills are producing steel for both export and the domestic market at the same time, contaminated boron steel may be present in the Chinese domestic market as well.

This is not to suggest all Chinese steel mills are producing steel with elevated levels of boron, but past and present history suggests that this practice is still going on. If you must use Chinese steel for your project, a bit of testing may go a long way to ensuring public safety and a better night's sleep. AS

ERC News

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

The Canadian structural steel industry has a long history of delivering a reliable and safe infrastructure that all Canadians enjoy. I recently had the opportunity to wander around downtown Toronto with my family and saw the evidence of steel's longevity and reliability. I realized that not only are many of the landmark buildings constructed from steel, but many are over half a century old and still going strong. The Toronto-Dominion Bank Tower began construction almost 60 years ago, and when it opened in 1967 it was the tallest building in Canada. While it no longer dominates the city's skyline, it remains a testament to the strength and sustainability of steel structures.

What hasn't changed is that steel remains the smart choice for a cost-effective, flexible, creative, safe and sustainable infrastructure. The CISC is committed to ensuring that steel continues to be the material of choice for construction, and we must support innovation and education to ensure the next generation is one which continues to drive innovation and change in our industry.

The Education and Research Council (ERC) plays a critical role within the CISC and the industry in achieving this objective. The ERC oversees work in several areas to support education, research and innovation in the Canadian steel construction industry. These include:

- development of training programs for existing steel professionals, helping to keep knowledge current and promote excellence;
- research grants to support innovation in steel construction;
- competitions and scholarships for engineering students and other steel professionals to encourage a focus on structural engineering and construction;
- forums and training for steel educators to ensure alignment with evolving industry needs; and
- competitions and scholarships for architecture students to drive creative thinking in steel design and highlight the flexibility of steel.

The ERC's work is focused on driving the industry forward, supporting educators and students and the ongoing training and education of steel professionals. Research and innovation are also critical as we look to make our industry more competitive and creative in the face of ever-evolving construction methods and global pressures. The ERC is also pleased to support the development of new and expanded training courses to help both novice and seasoned steel professionals upgrade and maintain their knowledge in the areas of codes & standards, design methodology, estimating, inspection and other key areas.

The ERC is grateful for the continued support of the CISC and our funding partners. Through their support, our programs continue to grow and evolve, and much has been accomplished to support our industry. But we need your help to continue to see this success. So, 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.

Please contact the CISC for more information on how you can support the work of the ERC. Working together, we can help steel continue to be the material of choice for Canada's infrastructure. AS

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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: Connection design forces in seismic applications sometimes depend on whether or not the governing failure mode is ductile. Which failure modes are considered ductile?

ANSWER: Capacity-protected elements and connections in seismic force-resisting systems are required to resist the gravity loads together with the lateral loads corresponding to the probable resistance of the yielding elements (CSA S16:19 Clause 27.1.2.2). However, the connection design forces need not exceed those based on $R_d R_o$ = 1.3 when the governing failure mode is ductile, or $R_d R_o$ = 1.0 otherwise. For *Conventional Construction* (Clause 27.12.2, $R_d R_o$ = 1.5 x 1.3), and depending on the site-specific seismic parameters, connections must be proportioned so that the expected failure mode is ductile, or else designed to resist gravity loads combined with the seismic load multiplied by R_d.

The CISC Commentary on CSA S16:19 in Part 2 of the *Handbook of Steel Construction* (Clauses 27.1.2 and 27.12) lists the following ductile failure modes for connections of primary framing members such as bracing connections, yielding in tension, bolt bearing and gusset plates detailed for ductility. For moment frames, extended end-plate and flange-plate moment connections are considered ductile if appropriately proportioned. Welded connections consisting of fillet welds may not possess sufficient ductility and should be designed for amplified loads.

QUESTION 2: When installing pretensioned bolts on a project with a heavy coating system, it was found that the bolts seem to relax after installation as the coating compresses in the joint. Are there any recommendations to ensure that the bolts retain their pretension?

ANSWER: Bolt relaxation in joints with thick coatings is a known issue. According to the *RCSC Specification for Structural Joints Using High-Strength Bolts* (2020, Commentary on Clause 8.2), joints with galvanized coatings are particularly susceptible to bolt relaxation, especially those consisting of many plies of thickly coated material. In such cases, re-pretensioning of bolted assemblies may be required after a settling-in period following initial pretensioning.

The relaxation characteristics of assemblies with galvanized plates and bolts are about twice as great as those with plain bolts and connected material, according to the *Guide to Design Criteria for Bolted and Riveted Joints* (1987, Section 4.4). Bolt force relaxation can be expected to increase as the grip length decreases. And for a given grip length, increasing the number of plies will also lead to an increase in bolt relaxation.

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.

“WHEN SINGLE ANGLES ARE DESIGNED ACCORDING TO CSA S16:19 CLAUSE 13.3.2.2 (INDIVIDUAL MEMBERS AND PLANAR TRUSSES; SEE FIGURE 1), THE VALUE OF KL/R IS NEVER LESS THAN 72, EVEN WHEN $L/R_X = 0$.”

QUESTION 3: In Part 4 of the *Handbook of Steel Construction*, the tables for single-angle struts connected through one leg indicate a factored compressive resistance of C_r = 362 for a L102x102x9.5 member of zero length. But the tables for double-angle struts indicate C_r = 1,170 kN for the same member size. Shouldn't the single-angle resistance be half the double-angle value when KL = 0?

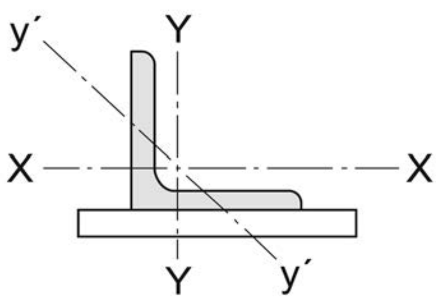

FIGURE 1
Single-angle strut connected through one leg.

ANSWER: When single angles are designed according to CSA S16:19 Clause 13.3.2.2 (individual members and planar trusses; see Figure 1), the value of KL/r is never less than 72, even when $L/r_x = 0$.

The factored “yield load,” $C_{ro} = \phi A F_y$, would be the expected resistance when the length is zero, at least in theory. In practice, however, the handbook tables are used to interpolate the resistances for member lengths between 0 and 500 mm. The interpolation is only accurate when C_r is tabulated consistently using the formula in S16 for all member lengths.

For double angles, there is no minimum value of KL/r, and these members can reach C_{ro} when $KL = 0$.

CSSBI Engineers' Corner

QUESTION 1: Within the CFS industry, there appear to be varying definitions of nominal thickness for cold-formed steel gauge. Is there a standard for cold-formed steel thickness and tolerances?

ANSWER: There are various definitions of thicknesses when it comes to cold-formed steel design such as minimum base steel thickness and design thickness, which, along with tolerances, have been defined in the CSA S136-16/AISI S100-16, North American Specification for the Design of Cold-Formed Steel Structural Members. Depending on the CFS sector, there are several standards and fact sheets the user may refer to as well.

The CSSBI also published the Steel Facts Sheet 10-12, Sheet Steel Gauges and Thicknesses, which includes and expands gauge references:

Table 1: MSG Sheet Steel Gauge Numbers and Thicknesses

Gauge Number	Minimum Base Steel Thickness (95% of Design Thickness)		Design Thickness (Nominal Base Steel Thickness)	
	inches	mm	inches	mm
8	0.1562	3.967	0.1644	4.176
10	0.1278	3.245	0.1345	3.416
12	0.0994	2.524	0.1046	2.657
13	0.0852	2.164	0.0897	2.278
14	0.0710	1.802	0.0747	1.897
15	0.0639	1.624	0.0673	1.709
16	0.0568	1.443	0.0598	1.519
18	0.0454	1.153	0.0478	1.214
20	0.0341	0.866	0.0359	0.912
22	0.0284	0.721	0.0299	0.759
24	0.0227	0.577	0.0239	0.607
26	0.0170	0.432	0.0179	0.455
28	0.0142	0.359	0.0149	0.378
29	0.0128	0.326	0.0135	0.343
30	0.0114	0.290	0.0120	0.305

CSSBI Steel Facts Sheet 10-12, Sheet Steel Gauges and Thicknesses.

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TIPO A CNC Drilling, Marking and Thermal Cutting Systems
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> "THERE ARE VARIOUS CFS DESIGN SOFTWARE OPTIONS WHICH CAN BE UTILIZED TO ASSIST WITH THE DESIGN PROCESS AS WELL."

QUESTION 2: Does the CSSBI produce curtain wall (non-load-bearing) loading tables beyond the published 60 psf design loading for stud limiting heights?

ANSWER: The CSSBI 58-2018 Member Selection Tables are produced in imperial units and metric units. These documents have a specified load range with a minimum of five psf (0.25 kPa) and a maximum of 60 psf (3.00 kPa) in the "Curtain Wall Limiting Height Tables – Single or Double Spans." All table notes must be considered when utilizing these values. Additionally, these load tables cannot be used with cold-formed steel framing members which are loaded axially (load-bearing).

When the loads of a project fall outside of the design table range produced by the CSSBI, the engineer should complete the structural design of the cold-formed steel framing members using the "Stud Section Properties" chart as published in the CSSBI 58-2018 tables and the design standards outlined in the AISI S100-16/CSA S136-16, to determine the members' resistive properties. There are various CFS design software options which can be utilized to assist with the design process as well.

Note that along with the standard resistance (moment, shear, deflection, lateral stability), you must also complete design checks for web crippling and any considerations outside of those listed above as applicable. AS


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CISC Carbon Corner

Steel's true narrative, not the spun truth!

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)

Welcome to the first Carbon Corner! For this segment, I will be focusing on high-level concepts. Future columns will tackle many topics one by one, with the objective of providing clarity and sharing the truth about steel's true carbon footprint!

To understand the carbon footprint of steel is to appreciate the objective of a circular economy, whose goal is to keep materials out of the waste stream by influencing the upstream behaviours of the various actors in the construction supply chain. This philosophy aims to influence the design and manufacture of products and the design and optimization of buildings in a way that reduces the overall carbon footprint.

The term "embodied carbon," referring to construction materials and products, has become synonymous with the term "carbon footprint." But there is a distinction: the complete carbon footprint. lifecycle of the building includes the embodied carbon and the in-use carbon emissions from the operation of the building (operational carbon). The embodied carbon is a subset of most lifecycle assessment studies as an environmental impact category.

Nearly 200 members of the United Nations Framework Convention on Climate Change are parties to the Paris Agreement, a treaty adopted in 2015 with the goal of mitigating global temperature increase through reductions in emissions. Canada signed the treaty in its first year and passed the Canadian Net-Zero Emissions Accountability Act into law in 2021, committing to a 40-per-cent to 45-per-cent reduction in greenhouse gas (GHG) emissions by 2030 and net-zero GHG emissions by 2050. Canada has set goals with an ultimate objective to reduce the amount of waste generated through improved efficiency in design and construction, to decrease the amount of waste through improved reuse, recycling and retrofitting, and find end value for waste materials that can then re-enter the economy and reduce upstream impacts of producing new products.

To achieve these goals, the design community must understand how to use and consider accurate and transparent reporting and how it can be appropriately used to compare materials. So, in the analysis of environmental impact, whether steel, concrete, wood or any other

Production Stage			Con-struction Stage		Use stage							End-of-life stage				Benefits and loads beyond the system boundary
A1	A2	A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D
Raw material supply	Transport	Manufacturing	Transport	Installation	Use	Maintenance	Repair	Replacement	Refurbishment	Operational energy use	Operational water use	Deconstruction, demolition	Transport	Waste processing	Disposal	Potential net benefits from reuse, recycling and/or energy recovery
Covered by LEED EPDs			Excluded									Excluded				

Credit: etoolglobal

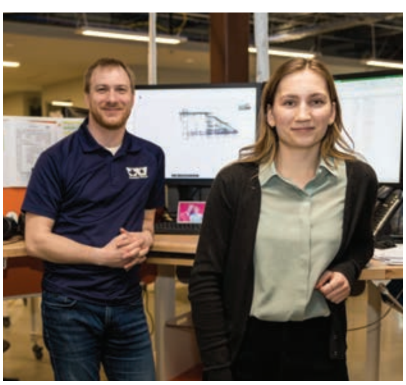
material, it is important to consider certain elements based on facts and not fiction. In weighing the options of selecting a material of choice for a project, factors to consider include project location, scale, design optimization, expected service life, reuse potential, etc.In other words, there should be an awareness of how to analyze the carbon footprint at various segments. Unfortunately, industries are angling to make their products more appealing, and rather than stating facts as the steel industry does, they often instigate hype with fiction and false extrapolations.

The steel story is straightforward – produced structural steel, which comes from electric arc furnace (EAF) mills, has a recycled content of 93 per cent. Because EAF mills run on electricity, they are largely as green as their power source and different from the blast furnace as they produce steel by using an electrical current to melt scrap steel and direct reduced iron and/or pig iron to produce molten steel. The process is therefore approximately four times less carbon intensive than a basic oxygen furnace (BOF). So, as the energy footprint for EAF becomes neutral, steel can boast about its part in a fully circular economy, since scrap plays a key role in reducing industry emissions and resource consumption. As a result, it should be kept in mind that the majority of North American EAF mills have the lowest global warming potential (GWP) values.

Here is the challenge that the concrete and wood industries have: they push the use of EPDs (Environmental Product Declarations) to architects and engineers, failing to be transparent about the fact that material EPDs are just not comparable.

Yes, the CISC has produced four verified & registered industry-average EPDs to represent the steel sector, with data averaged from our participating members across Canada for both hot-rolled structural steel and cold-formed steel. And yes, detailed EPDs can be obtained from mills or manufacturers (information is available on our website www.cisc-icca.ca), but that is just not enough! Why? Because we can not compare the incomparable.



Fabricated Hot-rolled Structural Steel Sections

Impact categories		A-D Total
Global warming ($kg\ CO_2$ eq.)	1 mt	1.20E+03
	1 ton	1.09E+03

Fabricated Steel Plate

Impact categories		A-D Total
Global warming ($kg\ CO_2$ eq.)	1 mt	1.50E+03
	1 ton	1.36E+03

Fabricated Hollow Structural Sections

Impact categories		A-D Total
Global warming ($kg\ CO_2$ eq.)	1 mt	1.07E+03
	1 ton	0.97E+03

Cold Formed Steel Panels

Impact categories		A-D Total
Global warming ($kg\ CO_2$ eq.)	1 mt	0.95E+03
	1 ton	0.86E+03

Cold Formed Steel Sections

Impact categories		A-D Total
Global warming ($kg\ CO_2$ eq.)	1 mt	0.82E+03
	1 ton	0.74E+03

The International Organization for Standardization (ISO) 14025:2006 defines an EPD as a Type III declaration that "quantifies environmental information on the lifecycle of a product," from raw material extraction and manufacturing through installation, use and maintenance to disposal. All these stages contribute to the total embodied carbon impact of a building. Why does wood or concrete fail to declare past the production stage A1 to A3 (cradle to gate)? Steel declares from A1 to D (cradle to grave).

Significant critical variations exist between cradle to gate and cradle to grave (only considered by steel) boundary conditions and inconsistencies in the varying materials product category rule (PCR) when preparing EPDs. Many building sector professionals were first introduced to industry-wide and product-specific EPDs through the LEED v4 materials and resources credit building product disclosure and optimization. It's now time to move on!

Comparison between EPDs should only be made if their impacts were calculated using the same methodologies, if the products being compared are functionally equivalent and if, for the equivalent stages, the environmental performance of two different materials cannot be compared using EPDs. "Materials cannot be compared." This contention is confirmed in small print in the EDPs of other materials.

In view of these inconsistencies, the CISC has published its global warming potential summaries for a full cradle-to-grave summary A to D for fabricated hot-rolled structural steel sections, fabricated steel plates, fabricated hollow structural sections, and cold-formed steel panels and cold-formed steel sections. Again, why? Steel does it because it can!

So, you need to ask the right questions. What data are we looking at that will accurately reflect the carbon footprint of a material during its full lifecycle? Many claims fostered by special interests do not clearly define the assumptions and contain nuggets of spun truth and hype used to develop their environmental statements and rely on false equivalencies when comparing competing systems. The sheer volume of often contradictory claims is overwhelming. However, we need to compare apples to apples!

For an analysis of environmental impacts, it's important to consider the assumptions, considerations, comparisons, boundaries and methodology to be better informed and to best consider the impacts of both short- and long-term effects. Steel's inherent durability and recyclability make it an ideal fit for a circular economy. AS

Steel's Circular Economy

The material of choice on full display!

BY :: HELLEN CHRISTODOULOU, PH.D. Ing., B.C.L., LL. B, M.B.A.
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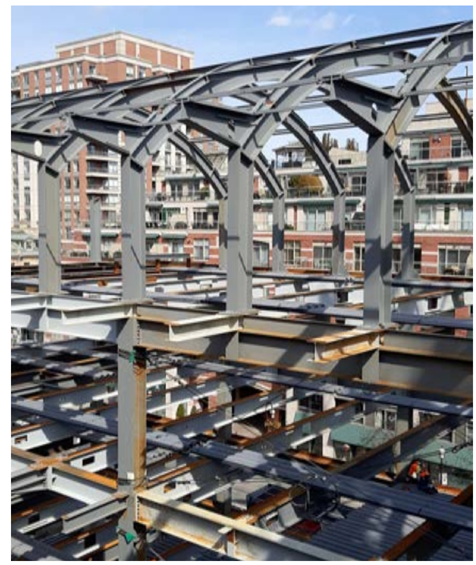

Environmental factors are dominating decision-making processes. Architects and engineers are veering towards determining the environmental impact of a building and choosing materials that are most efficient for the intended building use, and then optimizing and economizing the design to save on quantities while also finding ways to decrease the carbon footprint of that material choice. This is where steel comes in – for it is easily recycled, reused and sustainable.

The steel sector has always advocated the more meaningful full lifecycle assessment approach – or whole-life carbon approach – which takes account of how, or if, a material can serve a meaningful purpose beyond simply being reduced to hardcore, for example, after its original use has ended. Steel has exceptional circular economy credentials as it is typically either reused or recycled. This issue of *Advantage Steel* will look at three features that will best capture this mindset.

The Stacks at 3 Crossings in Pittsburgh, Pennsylvania is a testament to steel reuse. Perkins Eastman, an architectural firm comprised of world-renowned studios with a history of overseeing notable building reuse and upgrading projects across North America, showcases a perfect example of the ultimate recycling project. Their choice to recycle the building's superstructure certainly had its financial advantages, but more importantly, their decision led to achieving the building's LEED Silver certification by diverting waste from landfills and minimizing the need to manufacture, transport and install new build materials.

In the Steel Construction Institute's (SCI's) recent publication, *Structural Steel Reuse* (P427), the use of structural steel in the U.K. is a clear indicator that, worldwide, there is a clear vision for reusing and recycling structural steel, influenced by financial decisions and benefits of the circular economy as we appreciate how reusing steel reduces the carbon footprint. The benefits are many for all stakeholders. The concept raises awareness and supports the circular economy contentions of the steel industry.

Lastly, the St. Lawrence North Market building in Toronto is also a testament to how steel has had a major impact on redevelopment. The design fulfilled the requirements set by the city and resulted in a display of how steel was the only material that efficiently blended the structural and aesthetic aspects and historical perspectives of this area. Ease of constructability and less waste proactively meets future challenges. Steel is the game changer with a smaller short-term and long-term carbon footprint. AS

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A showcase for steel reuse

BY :: MATTHEW BRADFORD

Steel has long proven its adaptability and reusability in the field. Still, there is always a spotlight for projects that showcase steel's versatility and reinforces its industry reputation.

One such project is The Stacks at 3 Crossings in Pittsburgh, Pennsylvania. Here, architect Perkins Eastman was engaged by Oxford Development Company to transform a former cardboard manufacturing plant into a cutting-edge hub that would cater to the neighbourhood's emerging tech community and weave into the urban fabric of the city's up-and-coming Strip District.

As the firm describes on its website: "Oxford Development Company purchased the building with the intent of clearing the seven-acre site and linking this property with the first phase of its highly successful 3 Crossings mixed-use development. Instead, we helped guide the client to repurpose the building's existing 18,000 sq. ft. into creative office space – both to capture the unique and authentic characteristics of the building and to create a higher level of value than all-new construction could afford."

Revitalizing the former industrial factory was a task befitting of Perkins Eastman. The architectural firm comprised of world-renowned studios with a history of overseeing notable building reuse and upgrade projects across North America, including Los Angeles's iconic Griffith Observatory in Colorado Springs' Charles L. Tutt Library and the University of New York's Tyler Hall, among a number of other building reuse and revitalization initiatives.

"There's a human aspect to building preservation," notes Heather Jauregui, Director of Sustainability for Perkins Eastman. "Sometimes the projects that are the most rewarding are those that people didn't want

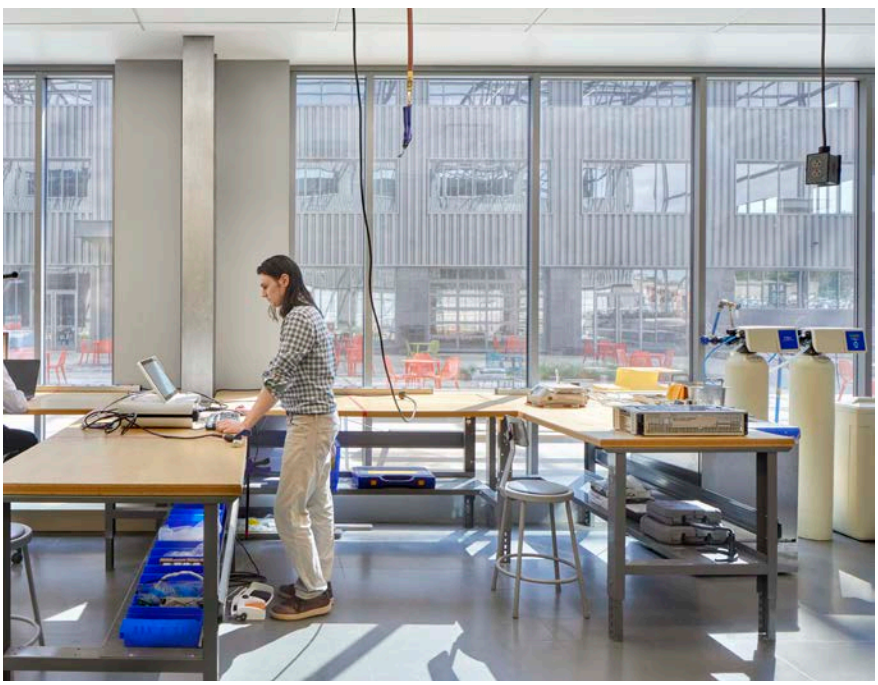

Photo credit: Perkins Eastman

to save to begin with. If we knock them down, we risk losing a part of our diverse urban character.

"With urban revitalization, re-use aids in our collective memory, our sense of belonging," she adds.

The Ultimate Recycling Project

Perkins Eastman's philosophy for building preservation is imprinted in The Stacks. At the onset of the project, Jeff Young, Managing Principal of the firm's Pittsburgh studio, visited the site with the intent to discover which elements of the 20th-century industrial building could be carried forward throughout its transformation.

"One of the first things we did is take the opportunity to walk through and look at what might be salvageable, and not just the cool features like a metal sliding door that we could convert into artwork, but the structural elements we could keep and build onto," Young recalls.

After getting a lay of the land and taking in the factory's steel superstructure, Young and the team went to work on a design that would see the three spacious bays reimagined as an office complex featuring a central open-air hub.

"We wanted to turn that middle bay into urban court space that can be useful, not just for the tenants of these buildings, but for the larger [3 Crossings] development, as more and more tenants and residents come down to this part of the Strip District," Young describes. "The idea was to activate this centre space with restaurants and other amenities lining the edges of this urban core."

To that end, Perkins Eastman's design called for the middle bay's roof to be removed while leaving the steel components in place. The result is a stylishly framed outdoor space featuring café seating, landscaping elements, flexible outdoor activity zones and a public walkway connecting users to major streets at opposite ends of the building.

The existing steel superstructures were also retained in the outer bays. Here, however, the team

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– JEFF YOUNG

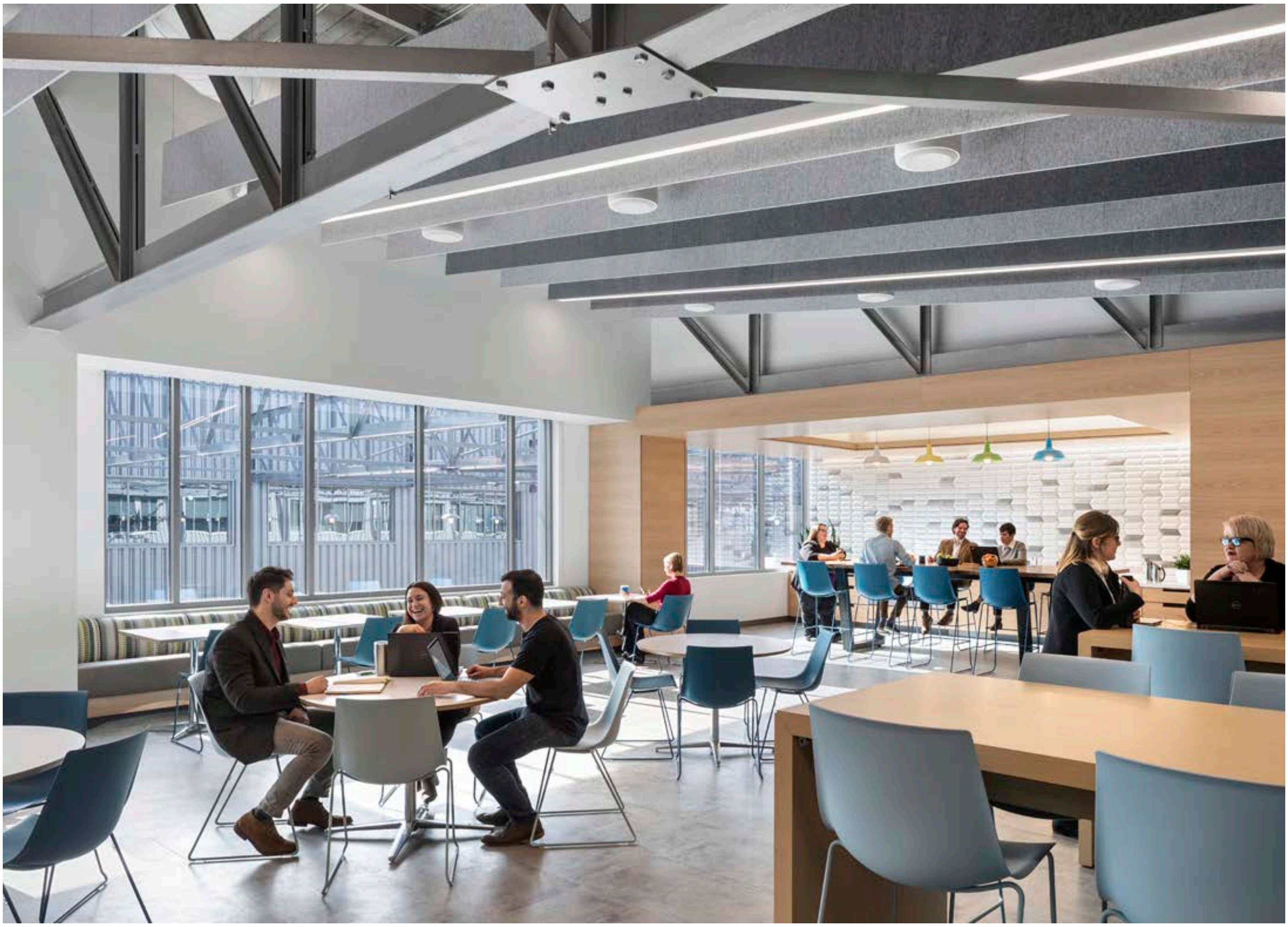

Photo credit: Perkins Eastman

installed two new floors to dramatically increase the amount of rentable office space.

"With the addition of those floors, what started as a tall, one-storey building is now a three-storey building with each footprint measuring about 18,000 sq. ft.," Young explains. "Since each of those bays, or wings, is roughly 55,000 sq. ft., that means we were able to make around 110,000 sq. ft. of occupiable office space out of what was originally three empty steel armatures for old industrial use."

"We kept as much of the superstructure as we could in the existing space," he continues. "There are columns at the outer edges, which were probably for lateral stability when it was built, but as you go more inboard, they disappear. Elsewhere, we kept the truss, and that same truss runs through into the ceiling of the third floor of the two adjacent office buildings."

Within those outer bays, the goal was to take advantage of the existing rectangular forms without

Photo credit: Perkins Eastman

burdening them in any significant way. To that end, Perkins Eastman added a simple metal and glass skin to the building, using various colours and profiles to give the building its distinct look.

"We were not getting fussy about the ins and outs because, again, all of those steel locations and column locations existed in the first place. We didn't feel it necessary to glom on things or create eccentric loading on the existing structure unnecessarily," Young explains.

Steel wasn't the only material that was repurposed for The Stacks. The existing wood plank within the outer bays was kept in place to form the ceiling of the new offices, while reclaimed wood from the centre bay was also reused in several areas.

"We convinced the owner not to destroy any of this wood and, instead, throw it into a pile and let us effectively reuse it as a screening wall for the transformer walls and the trash area," says Young. "As a result, The Stacks now has these wooden features that came right off the roof of the building, and all we did was add some simple steel tubes to attach it to."

Construction on The Stacks was completed in June 2020 and has since seen its offices filled with tech firms representing

multiple industries. In addition to breathing new life into a once-abandoned factory, the redevelopment has shown Pittsburgh and the construction industry at large the possibilities that lie in wait for project partners who recognize the long-term sustainability of steel.

As Young aptly states, "This turned out to be the ultimate recycling project."

A Cross Between Character and Eco-forward Design

The Stacks may have started life as a new build, but the decision to take a more preservative approach has created more of a buzz among Pittsburg's Strip District while generating economic and eco-forward advantages for its owners.

"Companies, and especially those in the tech sector, love a bit of story behind the building they're moving into as opposed to a completely new, anywhere-U.S.A. design. So, for us to capture the patina of this old building, and expose it inside of what would ultimately become some contemporary office space, that became a very compelling component for the owner," says Young.

Choosing to recycle the building's superstructure as opposed to tearing it down and building a new building from scratch also had its financial advantages. Moreover, this approach greatly contributed to the building's LEED Silver certification by diverting waste from landfills and minimizing the need to manufacture, transport and install new build materials.

Proof of Concept

Perkins Eastman's affinity for building transformation is also on display at 27 51st Street in Pittsburgh. Like The Stacks, the firm was asked to turn a 260,000 sq.-ft., one-storey steel superstructure warehouse into a new working hub.

"This developer came in from out of town and asked how we could turn this massive, one-storey warehouse building into creative office use," recalls Young. "So, we came in, and we took a similar thing, where we carved a hole out of the centre of the building to create a courtyard space, bring that natural light in and create this fun, open-office environment."

Unfortunately, the building was sold to another owner, and the firm's innovative vision did not come to light. Nevertheless, Young says the project served as a welcome way to hone its building reuse design strategies.

What's Old Is New

Both The Stacks and designs for 27 51st Street are indicative of a larger movement to explore innovative and more eco-friendly ways of revitalizing our built environment. Promisingly, they are only two of many taking shape across North America, many of which are leveraging existing steel to begin their second life.

"There's a tremendous amount of opportunity to reimagine these seemingly obsolete buildings through adaptive reuse," says Young. "We can do that by maintaining their 'essence' – or their bones – and give them entirely new purposes." AS


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STEEL'S SECOND ACT

The issues and benefits of reusing structural steel

BY :: JAMES PETERS

Industries worldwide appear to be more invested than ever in reusing and recycling structural steel, influenced by both financial decisions and, perhaps more importantly, an understanding of the benefits of the circular economy. According to the Canadian government's definition, "In the circular economy, nothing is waste. It means the economy retains and recovers as much value as possible from resources by reusing, repairing, refurbishing, repurposing and remanufacturing products and materials." Whatever your perspective, it's obvious that medium- and large-scale construction projects everywhere are recycling steel in a big way, and in tandem with other methods and materials.

David Brown, Associate Director at the U.K.'s Steel Construction Institute (SCI), says, "Steel doesn't have a shelf life, so it can certainly be reused. In the U.K., there are many additional checks for what's considered 'old' steel, which is steel that was used for construction between 1932 and 1970. So, it's true that older steel may not have been produced to the same manufacturing standards as modern steel – generally considered as that produced after 1970. The period encompassed by old steel also includes WWII, when steel was in short supply and considerations for future construction were a lower priority at the time. Based on the history of that period, the brittle behaviour of the older steel was clearly recognized, which led to new, modern manufacturing standards."

Brown, a technical specialist involved with training, frame design, connection design and product certification, points out that older methods generally involved riveting and bolting, so steel suitable for welding was less important. But for more than 50 years, steel has been manufactured to modern standards at the mill, meaning the newer forms are much more suitable for recycling and come complete with comprehensive technical data on origin. His involvement with the reuse of steel came through the development of design guidance for reuse in the U.K.

Structural Steel Reuse (P427)

The SCI technical research institute is headquartered in Ascot, England, with roughly 450 members. Brown adds, "Many of our members are consulting engineers and steelwork contractors who undertake project work on behalf of companies, ranging from developing guides on best practices, determining design resistances of some bespoke component, completing advance analysis in fire or under explosion loading. But we're really known for our advisory service to members and for training and writing technical guides."

Indeed, Brown was one of the co-authors of SCI's recent *Structural Steel Reuse* (P427) publication, which proposed a system for investigating and testing to establish material characteristics of reused steel. The publication places important responsibilities on the holders of reclaimed steelwork – responsibilities that include identification, assessment, control procedures and declarations of conformity. The guidebook – which covers steel used in construction from 1970 – has been well received in the industry and used by many builders and designers. Brown adds, "A new publication, called P440, has just been completed, which extends the guidance back to 1932."

Reuse of structural steel in the U.K. has clearly accelerated, and as Brown points out, "The main driver for this is environmental – reusing steel reduces the embodied carbon. So of course there are economic advantages, but carbon reduction is the main thrust. Reuse is not taking down and rebuilding the same structure elsewhere, but recovering steel from buildings being demolished, testing the steel so its properties are known and re-fabricating that steelwork for use in other structures. In the U.K., around 70 per cent of all inquiries for new buildings from owners and contractors request some degree of re-used steelwork. The current problem is that there is not enough recovered steelwork being stocked to meet the demand."

And the problem appears to be global. Brown says, "Electric arc furnaces – which use scrap – produce steel with lower embodied carbon, but global demand outstrips the tonnage available through that method. So that means the more carbon-intensive processes necessary to produce virgin steel are still required. Some contractors request electric arc steel to demonstrate lower carbon in their projects, but this ignores the fact that somewhere across the globe, many other builders must use steel from a blast furnace."

He adds, "Other forms of construction, such as concrete, are 'down-cycled' into things like hardcore and aggregate. But steel can be reused without any down-cycling. In the U.K., the steel market is very competitive, but when you're talking about reuse, then everyone wins. The client gets a cheaper, eco-friendly project, the steelwork contractor fabricates the project, the suppliers of recovered steel enjoy business, and the demolition company gets a bonus for carefully recovering steel. It's a win-win, many times over."

As a research institute, SCI doesn't benefit directly from reuse, but has seized the opportunity to develop the appropriate

"ELECTRIC ARC FURNACES – WHICH USE SCRAP – PRODUCE STEEL WITH LOWER EMBODIED CARBON, BUT GLOBAL DEMAND OUTSTRIPS THE TONNAGE AVAILABLE THROUGH THAT METHOD."

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> “THE CONCEPT OF STRUCTURAL REUSE IS SIMPLE: A SECTION IN GOOD CONDITION CAN BE RECOVERED FROM ONE BUILDING AND REUSED IN ANOTHER, CUTTING OUT A LARGE PROPORTION OF BOTH THE CARBON AND COST ASSOCIATED WITH NEW STEEL.”
>
> **- THOMAS HOWARTH**

design rules. And in the U.K. and elsewhere, the advice provided by the institute is relied on and taken as authoritative. “The real challenge is to recover steel – it’s simply easier to demolish a building and sell the steel for scrap than recover it carefully,” says Brown. “But there also needs to be an inventory of the recovered steel held by the many suppliers, so that designers can see what is available and then reserve it.”

Benefits and Misunderstandings

As Thomas Howarth, an engineer with Elliott Wood in London, said in a recent article of *The Structural Engineer*, “The concept of structural reuse is simple: a section in good condition can be recovered from one building and reused in another, cutting out a large proportion of both the carbon and cost associated with new steel. But if the benefits are so clear, why is it standard practice to cut up structural steel in good condition and send it to be melted down and rolled into new sections?”

Howarth explains that in the U.K., the challenges to recycling include financial implications, time consequences and a general lack of experience with reuse. But those with the motivation and determination to understand the benefits of reuse are working to overcome the challenges. Anyone familiar with reusing steel understands why recycling is still preferred.

With still more kudos to the release of SCI’s P427 guidebook in 2019, Howarth says, “The publication was a major milestone in the creation of a framework for structural steel reuse. It lays out the steps necessary to validate a section of steel as suitable for reuse, as well as providing guidance for designs incorporating it.” The guide breaks down many of the barriers to steel reuse and serves as an educational tool, providing an important source for new projects and contractors to incorporate it on new architectural sites.

In structural reuse, every stage of the process is important and comes fully equipped with its own set of challenges. Steps include pre- and post-demolition surveys to assess the condition of the steel at the outset, and the methods and machinery required to recover the sections.

Steel in situ can then be tagged with a reference ID where the pieces are inspected against the acceptable criteria, as described in P427.

Designing with reclaimed steel is similar in scope and practice to designing with new steel. However, aesthetic considerations also remain for those considering it. Reclaimed steel retains many of its imperfections and doesn't look like new steel. Holes, steel plates and other features from previous uses don't often impact their performance and, subject to assessment, can remain on the steel.

Communication Issues

On the human side of the equation, clear lines of communication – with every team or individual working on each stage of the process – are essential. Howarth says, "As with all aspects of engineering, the methodologies agreed upon and developed by managers are only as valuable as their implementation." In other words, take nothing for granted and err on the side of sharing information rather than making assumptions.

Contributing to these issues is a lack of precedents, meaning plans are fluid, often revised and updated on the day – also emphasizing the need for thorough communications. In addition, openly sharing information from the reuse experience with other stakeholders, in whatever region or country where steel reuse is being considered, is another important part of the communications process.

Questions Remain

Although much has been learned about structural reuse, there remain many unanswered questions. Some of those questions will always relate to the specific donor buildings where reuse is being considered such as:

- How does steel damage impact the viability of reusing a section?
- What, exactly, constitutes critical damage?
- Is recovering concrete-encased steel viable?

As reuse continues worldwide, these and other questions are expected to be answered and will become part of the global database and guidelines available to all. Returning full circle, Howarth points out that raising awareness and encouraging circular economy principles in the industry, and beyond, will be a big factor in helping to address some of the issues around our world's ongoing climate crisis. AS

ST. LAWRENCE MARKET NORTH PROJECT

Construction using steel is a game changer

BY :: WARREN HEELEY

Steel has had a major impact on the redevelopment of the St. Lawrence North Market building in Toronto, which is set to open in 2023. The historic St. Lawrence Market, made up of the St. Lawrence Hall, the South Market and the North Market, has been an icon in Toronto and served as a city landmark for more than two centuries. Originally designated a "market block" in the early 19th century to accommodate the growing city, this historical site has been a downtown mainstay for the city, providing a meeting place and focal point for shoppers, vendors and visitors.

Located at Jarvis and Front Street, the former single-storey North Market is being replaced by a multi-storey, multi-purpose 11,000-sq.-metre building. The new building will house the Saturday farmers market and Sunday antique market, Toronto court services, administration offices and a 250-space parking facility below ground.

The new $70-million market building, designed by Adamson Associates Architects and Rogers Stirk Harbour + Partners (winners of the City of Toronto design competition) is a six-storey complex with an indoor environment of natural light created by floor-to-ceiling glass walls and a central atrium that runs through the entire height of the building. This design is an excellent example of how steel, both in the structural and aesthetic aspects of the building, has been used to create a new look in the historic St. Lawrence Market area.

The Process

The City of Toronto's decision to replace the North Market building involved a competition to design a new building "relevant to the future that is sustainable, energy efficient and expresses its function as a place to be." There has been a public market on this site since 1803, and the City felt replacing the north building with a more modern structure was needed to push the market area into the 21st century.

The winning design for the building was announced in 2010. According to the City, the building design creates an "open indoor market that resembles a fresh, outdoor setting" where shoppers can view life and activities in the entire St. Lawrence Market area. With the farmers market and antique market using the ground floor, the upper floors will include retail space and bring together Toronto's provincial court offices.

The City's comments on the winning design noted that it was successful in determining a way to bring together "civic architecture" and "market architecture" in a building that flows into the street similar to the old North Market. The design also draws people into the new market area on the ground floor and through the entire space to the St. Lawrence Hall.

The design successfully linked the new building with the other two St. Lawrence buildings on the site. Most importantly, as noted in the City's report, "the plan design opens the market to the streets and public spaces on three sides, which was an important element for the users of the building. This effectively creates an indoor street through a market."

The City summarized by saying that "the scale, texture and context are in keeping with the architecture of the district, including the historical precedents. The original market building on this site had similar proportions to this building making this scheme better suited to the area and to a market building."

Natural light is another important aspect of the building design. The curtain wall on the southern-street wall facing Front Street allows natural light into the atrium and creates a more consistent look between the inside of the building and the outside. The atrium skylight, which goes the entire length of the building from north to south, is an interesting mix when compared to the shape of the two

adjoining steel roofs. The atrium also allows natural light from the sixth to the ground floor.

Prior to commencing construction in 2019, three years were taken to archaeologically investigate the site for artifacts from previous markets. The architectural design resembles “two barn-like volumes that are connected via a central atrium space.” Essentially made of steel and glass, the building is designed to open its ground floor to allow natural ventilation during warmer weather and is properly sealed for cold weather. At the time of writing this article, the building was entering the final stages of construction.

Sustainable aspects of the building include geothermal heat pumps that add or remove heat from the structure and reduce energy costs. Natural daylighting and shading approaches reduce solar heat loss and gain from the sun and a green roof reduces heat gain and rainwater run-off.

Erecting the Steel

Steel is the main structural material used for the North Market project and presented a number of challenges for the constructor E.S. Fox Ltd. Fox was responsible for supplying and installing both the structural and decking steel for the new building. “In my mind, steel is the best option when building structures like the North Market,” said Steve Matthews, area manager of Fox’s structural steel and bridge division. “Scheduling projects are simpler than using other materials like concrete and it provides easy solutions to fix or make adjustments when mechanical problems arise.”

The interesting yet difficult project dealt with a wide variety of challenges including:

- the congested location in the market area;
- detailed planning and trade coordination to ensure straightforward erection of the steel;
- custom cast steel nodes anchoring the main steel columns;
- the use of architecturally exposed structural steel;
- arched steel roofs;
- extensive shoring of floors to permit use of man and steel lifts; and
- the COVID-19 pandemic.

The Market Area

The area around the project site was very tight for space and highly congested during the steel erection phase. There was no space for staging materials close to the site so they could be easily accessed when needed. As a result, construction work was essentially done one truck at a time. To accommodate this, the work schedule had to be carefully planned for each construction day and required good trade coordination to smoothly execute the steel erection process.

“Because of the jobsite location, each truck that came to the sight was bringing materials for that specific day’s work plan,” said Matthews. “We virtually did ‘order picking’ for each truck based on the work plan which added greatly to the scope of the site planning.”

Anchoring the Columns

Each of the steel columns that reached from the ground up to the top of the six-storey building had to be perfectly positioned and anchored on the ground level. To connect each column at its base, a custom cast steel node with a rebar cage attached to it had to be set in concrete, perfectly level and on-grid in the right location. To meet these unique circumstances, temporary

bracing was placed on each node, and surveying was continually done during the concrete drying process.

"This was a zero-tolerance process to ensure the height and positioning exactly met the architect's specifications," said Matthews. "Shims or other means of levelling the nodes after a column was in place was unacceptable." Once the concrete for the node was completely dry, the column was bolted in place.

Architecturally Exposed Steel

One of the interesting aesthetic features of the design was the use of architecturally exposed structural steel (AESS) in the atrium between the six-storey sections of the building. AESS meant using significantly different guidelines for this part of the erection, as well as different safety rules and material handling. When installing AESS, care has to be taken during installation to not mark or make any extra holes in the steel which routinely happens with hidden structural steel in normal installations.

"This process significantly increased the time needed to erect the steel in this area," said Matthews. "The steel also had to be painted in the field after installation versus in the factory because of colour matching issues." The AESS in the North Market building is finished in blue paint, which has been applied over a fire-resistant white coat.

The Steel Roof and Shoring the Decks

The roofing on the six-storey sections involved arched panels of corrugated curved steel. Because of the size of the roof sections, the panels had to be spliced for shipment and assembled at the site. Another challenge was shoring the ground floor over the underground parking portion of the building to permit the use of man and steel lifts.

The COVID-19 Effect

The majority of the steel erection work was done in the middle of the COVID-19 pandemic. There were some inherent problems when the Ontario government was determining whether construction sites should be left open. This issue, however, was resolved reasonably quickly by the Province. However, supply chain slowdowns in receiving construction materials and the increase in health and safety requirements had a certain effect on the schedule. "The most disruptive aspect of the pandemic was the jobsite shortage of workers who contracted or were concerned about contracting the virus," stated Matthews. "In the end, the pandemic put the construction schedule behind by about one year before the structural steel erection began."

Though there were no new innovative steps in the erection process, the atrium involved a number of interesting processes for cantilevering and bracing walkways on the mezzanine level. "We also electronically 3D modelled the entire steel framing and decks to determine the bracing necessary during the process to maintain stability of the steel," noted Matthews.

Steel, the Game Changer

The St. Lawrence Market North Building project is an excellent example of how steel can be used to create "a new building with an old feel," which was needed in this historic area. The project was a finalist in two award categories at the Canadian Institute of Steel Construction Awards for Excellence in Steel Construction in 2022.

Steel has had a significant impact both structurally and aesthetically on the North Market project and was a key component in the winning design by Adamson Associates Architects and Rogers Stirk Harbour + Partners. This building design creates a new look in the historic St. Lawrence Market area that will hopefully endure for another 200 years. AS

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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