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CANADIAN • CONSULTING

Engineer

March/April 2023

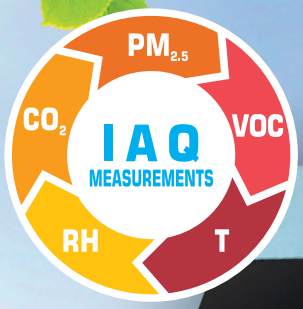
ccemag.com

For professional engineers in private practice

Innovations in Glass

New window types yield significant benefits. P. 16

Better indoor air quality with Reliable Controls



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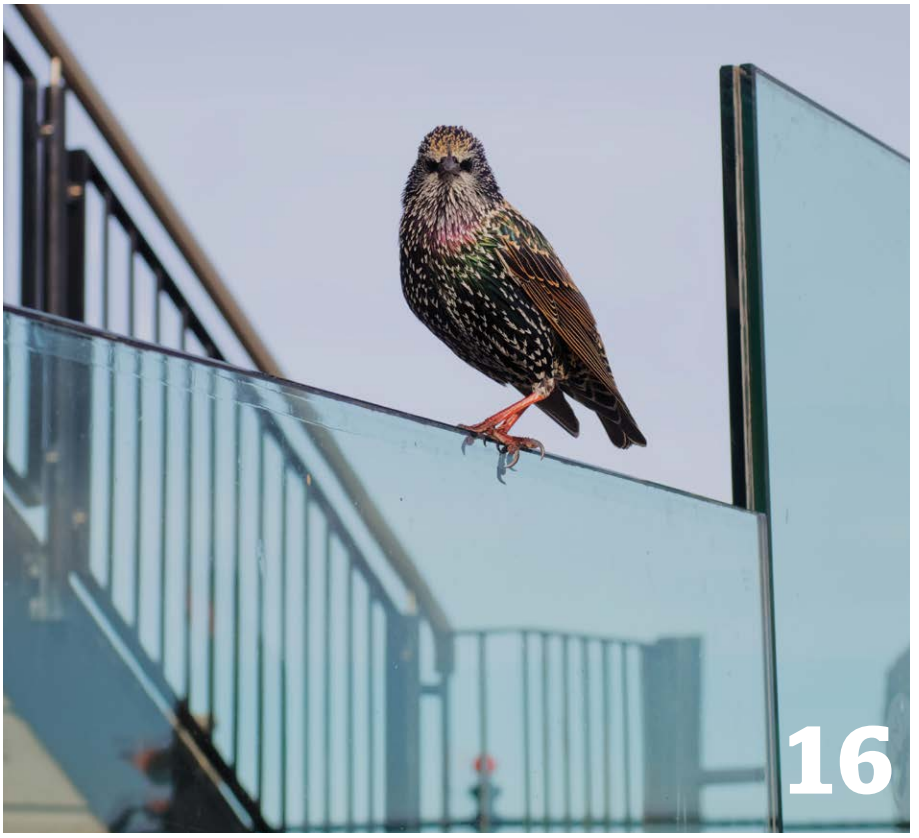

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ON THE COVER Calgary Central Library's unique façade integrates 40% triple-pane insulating glass units (IGUs) with 60% insulating metal panels. For more information on innovations in glass, see story on p. 16.
PHOTO BY MICHAEL GRIMM PHOTOGRAPHY, COURTESY VITRO ARCHITECTURAL GLASS.

Comment

by Peter Saunders

This year's AHR Expo "tremendously successful"

The Air-Conditioning, Heating, and Refrigeration Exposition (AHR Expo), which was held in February in Atlanta, Ga., drew an estimated 42,794 attendees to the Georgia World Congress Center, where 1,779 exhibitors—including 425 international companies and organizations—showcased their offerings across a 486,805-sf show floor.

By way of comparison, last year's expo—which was the first since 2020, due to the COVID-19 pandemic—drew 30,678 attendees and 1,573 exhibitors to the Las Vegas Convention Center.

The event drew visitors from more than 120 countries.

"We are thrilled to see such a strong showing!" said expo press officer Nicole Bush, calling the 2023 show "tremendously successful."

Running from Feb. 6 to 8, the event was co-sponsored by the Air Conditioning, Heating and Refrigeration Institute of America (AHRI) and the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE)—which held its winter conference in the Omni Hotel at CNN Center from Feb 4 to 8, for co-location purposes—while the Heating, Refrigeration and Air Conditioning Institute of Canada (HRAI) served as honorary sponsor.

"We are pleased to return to Atlanta, our global headquarters (HQ) city," noted 2022-2023 ASHRAE president Farooq Mehboob, referencing his association's recently retrofitted, net-zero energy HQ in nearby Peachtree Corners, Ga.

At a press briefing, Mehboob described the current society theme, 'Securing Our Future,' in part by recalling his own experiences as a chief engineer for InterContinental Hotels Group (IHG) in the 1960s and '70s, starting his own business as a consulting engineer in the '80s, joining ASHRAE and helping expand the organization's international reach across the Indian Subcontinent, Africa and the Middle East.

"Securing the future will depend on fostering global relationships," he explained. "The industry still doesn't have an international standard for ventilation to prevent the next pandemic, for example, but ASHRAE will fill that need. As an industry, we must remain focused and maintain our position of leadership and preparedness."

He also cited the recent publication of ASHRAE's first guide to building decarbonization, meeting another growing demand around the world. (And speaking of which, you can hear my post-show interview with the chair of ASHRAE's building decarbonization task force , Kent Peterson, PE, by visiting our website, ccemag.com, clicking on the Audio/Video tab and selecting 'Podcasts' from the dropdown menu).

"With exhibitors and visitors from more than 120 countries, the AHR Expo continues to be where the global industry meets," added Stephen R. Yurek, AHRI's president and CEO.

The expo hosted 17 podcasters, 105 industry sessions and 152 new product and technical presentations to complement the wares on the show floor. Educational sessions for engineers focused on such topics as carbon dioxide (CO_2) refrigeration, the harmonization of standards and the fundamentals of testing, adjustments and balance.

The next AHR Expo will rotate back to the Windy City; it will be hosted at McCormick Place in Chicago, Ill., from Jan. 22 to 24, 2024. **CCE**

Peter Saunders • psaunders@ccemag.com

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CANADIAN CONSULTING **Engineer**

READER SERVICE
Print and digital subscription inquiries or changes, please contact:
Angelita Potal
Tel: 416-510-5113
Fax: (416) 510-6875
email: apotal@annexbusinessmedia.com
Mail: 111 Gordon Baker Rd., Suite 400
Toronto, ON M2H 3R1

EDITOR
Peter Saunders (416) 510-5119
psaunders@ccemag.com

SENIOR PUBLISHER
Maureen Levy (416) 510-5111
mlevy@ccemag.com

MEDIA DESIGNER
Alison Keba

EDITORIAL ADVISORS
Bruce Bodden, P.Eng., Gerald Epp, P.Eng., Chris Newcomb, P.Eng., Laurier Nichols, ing., Jonathan Rubes, P.Eng., Paul Ruffell, P.Eng., Andrew Steeves, P.Eng.

ACCOUNT CO-ORDINATOR
Cheryl Fisher (416) 510-5194
cfisher@annexbusinessmedia.com

AUDIENCE DEVELOPMENT MANAGER
Beata Olechnowicz (416) 510-5182
bolechnowicz@annexbusinessmedia.com

GROUP PUBLISHER
Paul Grossinger (416) 510-5240
pgrossinger@annexbusinessmedia.com

PRESIDENT/COO
Scott Jamieson
sjamieson@annexbusinessmedia.com

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Tel: (416) 442-5600
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ASSOCIATION OF CONSULTING ENGINEERING COMPANIES | CANADA

SHAPING CANADA'S PUBLIC POLICY:

WHY THE CONSULTING ENGINEERING INDUSTRY IS KEY

Canada is faced with many difficulties right now—whether it's our crumbling public infrastructure in desperate need of an overhaul, a housing crisis that has been generations in the making, or relentless climate-related disasters threatening our communities every day. On top of that, the current era of soaring inflation and high cost of living add layers of complication to these already-complex issues.

The good news is that our industry can play a major role in addressing these challenges. As consulting engineers, you are known for being innovative and results-driven. You are incredible collaborators, leaders, and problem-solvers. You can even prevent future problems thanks to being highly skilled in risk assessment and disaster mitigation. Finally, and perhaps most importantly, the work you do delivers concrete and meaningful results for Canadians and people around the world—from designing climate-resilient infrastructure and improving water systems, to connecting people and strengthening entire communities.

So, it's no surprise that when it comes to driving policy solutions that benefit this generation and the next, you have a lot to offer. Take the national infrastructure corridor for example—this idea has been around for over 50 years and has the transformative potential to grow our economy, empower northern and Indigenous communities, and support environmental sustainability. Today, ACEC is advocating for this idea, calling it "Canada's Infrastructure Network." If we can mobilize the political will, consulting engineering firms have the skills to bring this exciting vision to life.

Simply put, the consulting engineering industry needs to be seen as an essential partner in solving our greatest national challenges. That's why ACEC is focused on empowering our industry to take an active role in shaping federal public policy in Canada.

> The consulting engineering industry needs to be seen as an essential partner in solving our greatest national challenges. ”

As your federal advocates, we work hard to ensure the government makes investments and decisions that reflect the expertise, the knowledge, and the experience of our membership. I've been Chair of ACEC-Canada's Board of Directors for six months now, and this has been one of my main priorities since day one. I'm incredibly grateful and honoured to serve in this role, and I continue to do everything in my power to represent ACEC's membership and our entire industry at the national level. One of the best ways I can do that is to take every opportunity to promote consulting engineering firms as community-building experts and trusted advisors to society.

I'd like to give a shout out to the provincial associations who have seen great successes recently in encouraging the government to adopt smart policies that benefit our communities. Our national team will continue to highlight and build on their exciting achievements at the federal level. It can sometimes feel like the challenges we face are too big or too complex to solve, but our industry has the power to change that. It's an exciting time to be a consulting engineer; there are countless opportunities for our industry to advance significant progress on the public policy front, and ultimately, make lives better for Canadians across the country. ACEC will continue to be in your corner as we chart the path forward to a thriving, more resilient Canada.

> The work you do delivers **concrete and meaningful results** for Canadians and people around the world. ”

Tim Stanley, P.Eng.
Chair, Board of Directors
ACEC-Canada

STRONGER COMMUNITIES FOR ALL CANADIANS

ACEC'S BUDGET 2023 RECOMMENDATIONS

Canadians are facing some major challenges—from global economic uncertainty and worsening climate change disasters, to record inflation and soaring costs of living.

These vast and complex problems require ambitious action. We need to boost innovation, build resilient communities, and strengthen industries that contribute to a net-zero economy—all while creating opportunities for Canadians to succeed.

With the consulting engineering industry top of mind, our recommendations for this year's federal Budget are focused on driving this vision forward.

DELIVERING SUSTAINABLE INFRASTRUCTURE

1

Swiftly implement the National Infrastructure Assessment

- Establishing a long-term vision for Canada's local, regional, and national infrastructure needs will result in smarter decision-making, allowing us to build prosperous and future-proof communities.
- Our first recommendation is for Budget 2023 to provide funding to establish the National Infrastructure Assessment (NIA) as quickly as possible, as well as a permanent, arms-length National Infrastructure Agency responsible for overseeing its progress.
- While the NIA will ultimately provide us with a clear vision for how best to design and revitalize this country's infrastructure, we must simultaneously ensure that our communities are able to put these plans into action. That's where building local capacity and reforming procurement comes in.

BUILDING CAPACITY

2

Create a "one-window" knowledge hub for local leaders

- When encouraging smarter infrastructure decisions that grow the economy and promote sustainability, building capacity in communities and along supply chains is key.
- Local and Indigenous leaders often struggle to deliver the projects their communities need due to insufficient capacity and resources. That's why our second recommendation for Budget 2023 is a $2 million investment per year over the next five years to engage stakeholders, review existing data, identify knowledge gaps, and design a program to provide municipalities with valuable capacity-building resources.
- A similar program called the "InfraGuide" has proven to be quite successful in the past, and the government could choose to revive it instead of starting from scratch. Reviving the InfraGuide—or developing a comparable new program—would help communities deliver much-needed infrastructure, while giving them the capacity to reduce emissions more effectively and enhance infrastructure longevity.

REFORMING PROCUREMENT

3

Adopt QBS to achieve our economic and climate goals

- To ensure we can build capacity and secure a strong future for our communities,our third recommendation for Budget 2023 is that the government reform procurement for engineering and architectural services. These services account for just 1%-2% of total costs over an infrastructure asset's life cycle, yet they dramatically impact all aspects of the financial and operational success of that asset for decades.
- We strongly believe that the most effective and cost-efficient procurement model is Qualifications-Based vSelection (QBS)—a proven approach that leads to better financial, environmental, and social outcomes.
- By adopting QBS across government, we can promote innovation, improve sustainability, reduce life-cycle costs, and set up communities for long-term success.

DID YOU KNOW?

Engineering and architectural services account for just 1%-2% of total costs over an infrastructure asset's life cycle. Yet this small investment makes the most dramatic impact on the success of the project.

Fire Endurance Testing

Fire resistance designs are published with unrestrained and restrained conditions. By G. Abbas Nanji

As per the National Building Code, fire ratings of structural steel members and floor and roof assemblies are to be determined following tests conducted in accordance with CAN/ULC-S101, Standard Method of Fire Endurance Tests of Building Construction and Materials. Based on these tests, certification and testing laboratories publish designs with unrestrained and restrained conditions.

For conventional steel construction, comprising steel beams and an open-web steel joist (OWSJ) with metal deck and concrete topping, the standard provides for both the restrained and unrestrained ratings to de determined from one fire test.

The steel members are protected by thermal insulating materials. The most common are sprayed applied gypsum and cementitious-based materials, intumescent and mastic coatings, gypsum board and ceiling membranes.

The temperature of the test specimen is measured with thermocouples installed on its unexposed surface and in the steel members. The specimen is constructed in a rigid steel frame, which restrains the thermal expansion of the structural members; rotational restraint is not provided.

The fire test is conducted with the specimen loaded as close as practical to its factored resistance. The loads are calculated in accordance with the appropriate design standard, as published by CSA Group.

The underside of the assembly is exposed to a fire controlled by a time temperature curve. The fire exposure curve increases monotonically during the entire test period, implying an inexhaustible supply of fuel. The temperature specified in the standard is based on cellulose fire.

Representative temperatures of the fire at during the test are shown in Table 1 (see p. 9). The limiting criteria to determine the fire endurance period are as follows:

1. Temperature rise limit on the unexposed surface of the test assembly.
2. No hot spots or opening created on the unexposed surface of the test assembly.
3. The ability of the test assembly to support the test loads.
4. Temperature of the structural member(s); this represents structural failure to support the test load based on loss strength at elevated temperatures.

The unrestrained endurance period is determined when any one of these four criteria is exceeded. For a restrained fire endurance period of one hour or less, the requirements are the same as for an unrestrained endurance period. For a restrained endurance period of more than one hour, the restrained rating is based on criteria #1, #2 and #3 and the temperature criteria of the structural member are at half the endurance duration, but not less than one hour and not more than twice the unrestrained endurance period.

The fifth edition of the standard was

PHOTO: © CHUNGKING \ ADOBE STOCK

revised to include requirements to address loaded unrestrained beams using deflection and rate of deflection criteria as an alternate to the beam temperature criteria. This made it possible for the unrestrained and restrained tests to be conducted separately on duplicate specimens.

This change was driven by new types of construction, like composite beams, where a steel beam is partially or fully encased in the concrete floor. In this type of construction, unprotected and partially protected parts of the steel member exposed to a fire would exceed the temperature criteria very early during the endurance test, while the test assembly would still be capable of supporting the test load.

In these cases, the unrestrained test is conducted on the specimen. For the restrained endurance period, a separate fire test is conducted on a duplicate test specimen restrained in a rigid frame.

TIME (HOURS:MINUTES)	TEMPERATURE (DEGREES C)
0.00	20
0.30	843
1:00	927
2:00	1,010
3:00	1,052
4:00	1,093

TABLE 1

When two different tests are conducted on identical test specimens, the limiting criteria #1, #2 and #3 are also applicable. The temperature criteria of the structural member, however, are replaced with a limiting deflection and rate of deflection criteria.

From the results of the fire endurance fire test, certification and testing agencies publish fire resistance ratings to the closest shorter duration.

Appendix A in the fire test standard provides a guide to determine the conditions of thermal restraint for floor and roof assemblies and individual beams. **CCE**

G. Abbas Nanji is a professional engineer and employed as a senior materials specialist for LRI Fire Protection and Building Code Engineers. For more information, visit www.lrifire.com.

NFPA Conference & Expo

The National Fire Protection Association (NFPA) is set to host its annual conference and expo at the Mandalay Bay Convention Center in Las Vegas, Nev., from June 19 to 21. Thousands of fire, electrical and life safety professionals will meet more than 300 exhibitors and attend more than 110 educational sessions and special events.

Educational sessions will address building construction, fire protection systems, code compliance, electrical safety, emerging technologies, industrial hazards and more. **CCE**

For further details
visit NFPA.org

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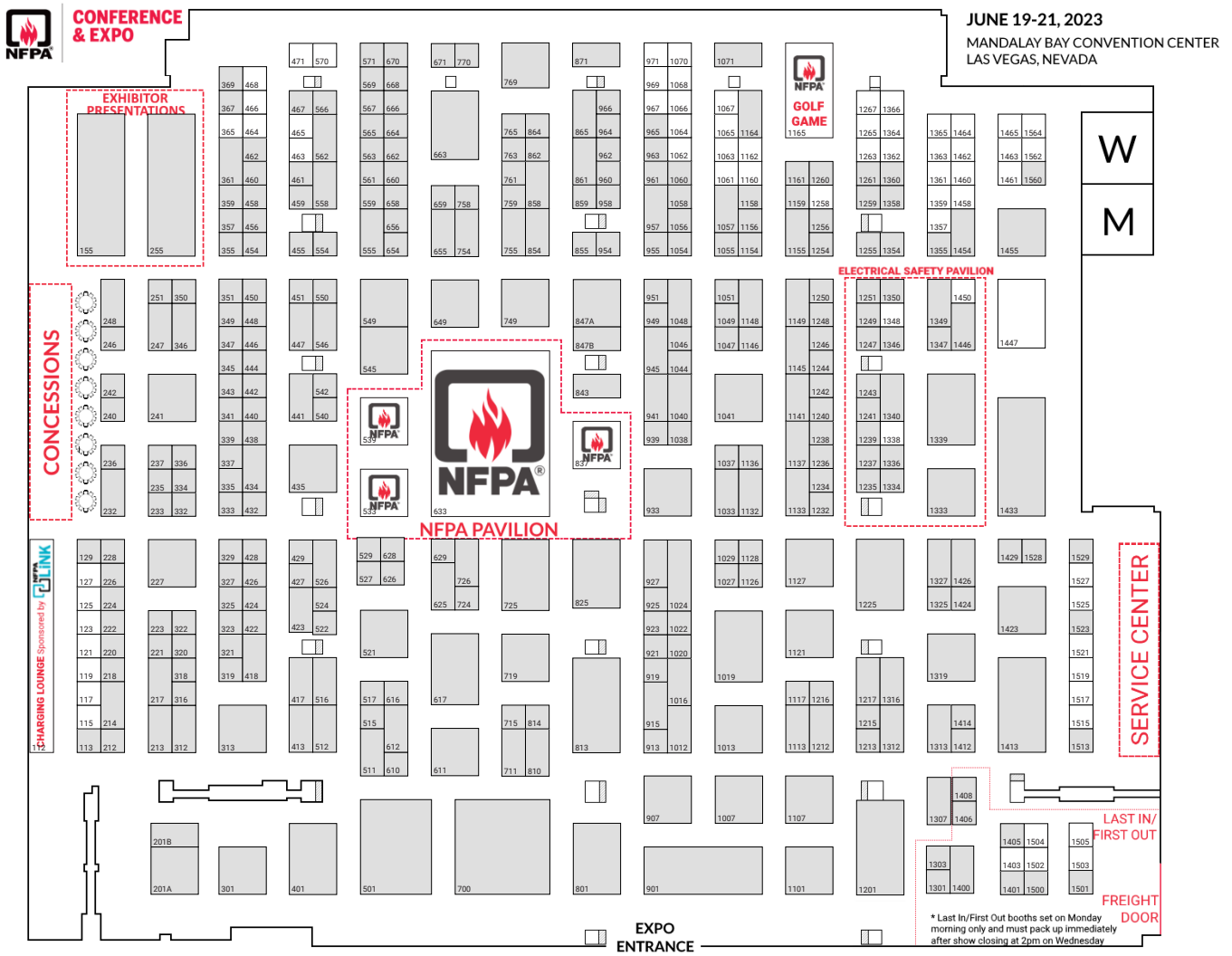

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natural gas saved

Limited-time bonus incentive

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natural gas saved for **high-efficiency boilers** and related controls

$0.40/m³
natural gas saved for **condensing boilers** and related controls, ventilation technologies, building automation controls and more

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Case Study: La Joie De Rosemont

A former medical clinic becomes an energy-efficient MURB. By Tracy Dacko

The structural engineers of Montreal's Poincaré Experts-Conseils recently helped transform Domus Médica, a local medical clinic, into a 55-unit residential co-operative dubbed La Joie de Rosemont (The Joy of Rosemont), where roughly half of the units in the rental apartment building are designated as affordable housing.

Developed by the building's owner, Montreal-based Groupe CDH, and the Rosemont Housing Committee, the retrofit and expansion project was constructed to the standards of Novoclimat, a Quebec-based program that sets energy-saving benchmarks for both new residential construction and major renovations. Among this program's measures, multi-storey structures incorporating balconies and cantilevered slabs that penetrate the building envelope must incorporate structural thermal breaks, for purposes of energy efficiency.

An unhealthy clinic

The retrofit was driven in part by health concerns. Interior and exterior partitions in the medical centre contained asbestos and, therefore, had to be removed.

Starting in the fall of 2019, the former clinic was stripped down to its original concrete shell. Next, a 752-m² (8,094-sf) reinforced concrete extension was added to the rear of the structure, doubling the footprint of the original building.

"The project combined the retrofit of the existing building with the addition of the extension at the back," says Damien Soyez, structural engineer with Poincaré.

Today, the work is complete and the building is occupied. The retrofit portion spans three floors plus a basement garage, while the extension rises four floors above grade. The total gross floor area of the completed co-op is 5,536 m² (59,589 sf).

Putting on the breaks

Previously, the medical building had no balconies.The retrofit project added 15 steel balconies, each measuring 2.6 x 1.5 m (8.5 x 4.9 ft), to the façade, while the new extension portion poured 27 reinforced concrete balconies, along with floor slabs.

To prevent thermal bridging at the balconies and to meet Novoclimat requirements, the engineers specified concrete-to-steel structural thermal breaks for the retrofit and concrete-to-concrete structural thermal breaks for the new extension.

By reducing thermal bridging between the balconies and the interior slabs supporting them, the thermal breaks reduce heat loss at the connections by up to 50%. This in turn reduces the need for tenants to raise their thermostats during long, cold winters.

Further, by preventing interior surfaces adjacent to balcony penetrations from becoming chilled and reaching the dew point, the thermal breaks prevent condensation and mould formation, which otherwise could go undetected for years before becoming visible, exposing the owner to liability and remediation costs.

Retrofit bits

Prior to anchoring the concrete-to-steel thermal breaks into the interior floor slabs of the existing structure to support the steel balconies, general contractor Devcor of Mirabel, Que., electronically scanned the building's façade to locate existing rebar on each floor and avoid drilling through it.

Once these scans and subsequent calibrations were completed, horizontal boreholes were drilled through the supporting outer concrete spandrel beam and into the interior

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slab, to optimize the anchoring of the thermal break reinforcement bars. Each concrete-to-steel thermal break required four boreholes: two measuring 19 mm (0.75 in.) in diameter by 762 mm (30 in.) in length and two measuring 13 mm (0.5 in.) in diameter and 279 mm (11 in.) in length.

After the drilling, saw cuts roughened the adhesion surface on the concrete where the thermal breaks would be placed. The boreholes were cleaned and injected with epoxy adhesive. Then, the tension and shear bars of the thermal breaks were carefully placed inside the boreholes. The epoxy produced "optimal adhesion between the thermal break reinforcement bars and the concrete," explains Jérôme Paquet, engineer and project manager for Devcor.

The project's concrete-to-steel thermal breaks were specifically designed to reduce thermal bridging on retrofitted balconies. Tension and shear force bars penetrating the insulation block transfer negative moments, positive shear forces and horizontal forces.

A waterproof sealant was applied to the thermal break surface areas contacting the existing concrete. A non-shrink grout was injected into the opening on top of each break. Finally, the new steel balconies were lifted and fastened to the thermal breaks with anchor bolts.

Each retrofitted balcony is insulated and supported by five thermal breaks—one for each steel balcony support beam. The breaks were placed between the balcony beams and the spandrel beam on each floor girding the building's circumference, reducing heat loss by up to 75% at the connection.

High extension

Meanwhile, the 27 reinforced concrete balconies were constructed with concrete-to-concrete thermal breaks for the extension. The concrete for the interior and exterior slabs was poured on the same day.

The concrete-to-concrete structural thermal breaks transfer bending moments and shear forces via stainless steel upper tension bars and bent shear bars that pass through rigid foam insulation modules and tie into the rebar of the balcony and the interior slab.

As stainless steel is approximately one-third as conductive as carbon steel rebar and rigid foam insulation is approximately 98% less conductive than concrete, these thermal breaks reduce heat loss at the penetration by up to 90%, according to their manufacturer, Schöck North America.

A multifaceted transformation

Novoclimat regulations cover more than balconies and reducing thermal bridging. Multi-unit residential buildings (MURBs) must be powered by natural gas, biomass fuel or electricity, while windows and air conditioners need to be qualified under the Energy Star program.

Balconies were retrofitted to the existing structure.

At La Joie de Rosemont, a mechanical ventilation heat recovery system also draws fresh air into the main rooms to improve their air quality. Meanwhile, the building's superior airtightness is verified by leak detection testing.

In these ways, the project has successfully transformed an old medical clinic into a more comfortable and efficient environment for its new occupants. CCE

Tracy Dacko is marketing manager for Schöck North America and a member of Passive House Canada, the Reinforcing Steel Institute of Canada (RSIC), l'Institut d'Acier d'Armature du Québec (IAAQ) and the Architectural Institute of British Columbia (AIBC). For more information, visit www.schoeck.com.

Innovations in Glass

Types range from bird-friendly to wired and vacuum-insulated.
By Amy Roberts

Several innovations in the glass industry are adding value to new buildings and retrofits alike, through novel and improved technologies. Glass types continue to evolve, including vacuum insulated glass (VIG), bird-friendly glass and safety glazing. Such innovations can improve sustainability, energy efficiency and injury mitigation.

VIG

With this type, a strong vacuum exists between two plates of glass. The gas space slows down conduction, while the vacuum space itself cuts back on it even further.

Bill Davis, a senior insulated glass (IG) technical service and product manager with Vitro Architectural Glass, spoke about VIG at a panel during the Fenestration and Glazing Industry Alliance (FGIA) 2022 Fall Conference. He pointed out it is very customizable, which can lead to more benefits in terms of higher R-values, indicating better thermal resistance.

"When you get into dual IGUs," he said, "you can add coatings or an exotic gas to improve performance. Triple panes can get you even better performance—up to R-16."

Fellow panelist Dave Cooper, chief technology officer (CTO) for VaccuumGlass, emphasized the importance of removing barriers for low-cost manufacturing, tempered VIGs and make-to-order supply strategies to better enable a significant market opportunity and adoption. He pointed to retrofits, new commercial construction, new residential windows, ultra-high-end residential replacements, renovations of historic structures and skylights that could all be well-served by VIG.

"With daylighting, we can stop thinking about window-to-wall ratio when we start thinking about VIG," Cooper said. "VIG supports a greater window-to-wall ratio with significantly enhanced thermal performance."

However, VIG is not without its challenges. For one thing, despite growing interest and investment, there is still no cost-effective option. Manufacturers may still be conducting today's research and development (R&D) for tomorrow's anticipated policies.

Bird-safe design can help building owners avoid legal exposure.

Bird-friendly glass

There are provincial and federal laws in Canada to protect birds. Bird-safe design can help building owners avoid legal exposure, whether their structure was originally intended to be bird-friendly or was retrofitted later.

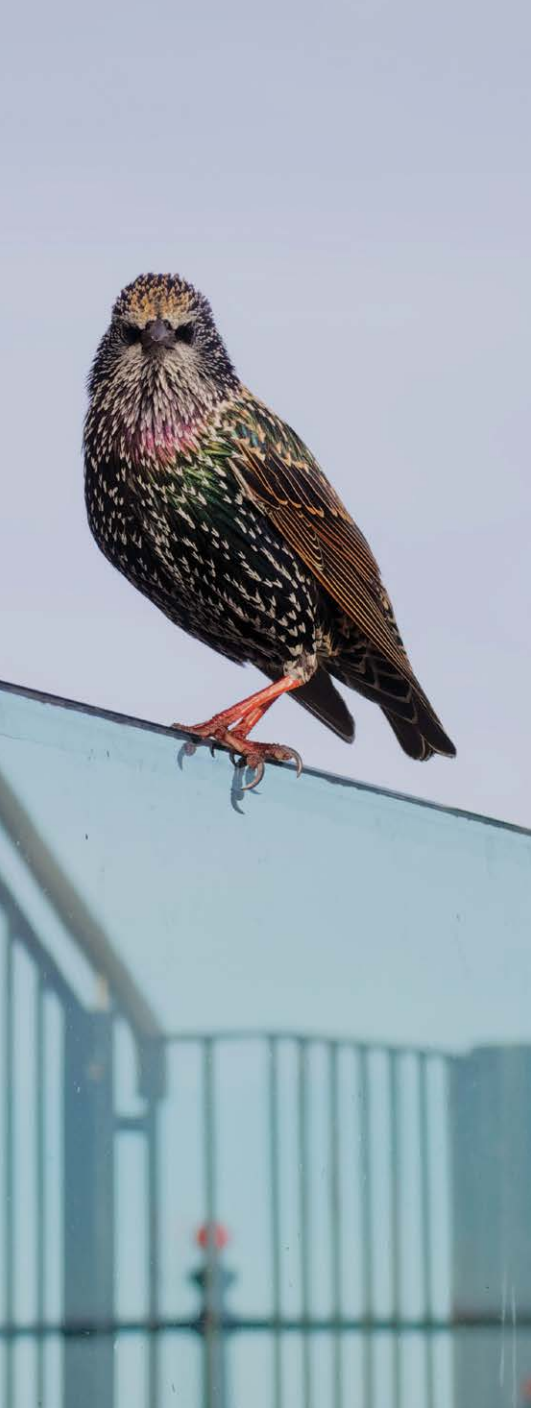
A bird-friendly design reduces the amount of glazed surfaces in a building's envelope, thus reducing the risk of a bird attempting to fly through it. Considerations like high-thread features, such as clear glass walkways, are also taken into account, as are lighting and opaque features, like grilles or shutters, to deter birds.

PHOTOS COURTESY FGIA

Another option is to treat glass with a subtle pattern that is perceptible to birds. Multiple suppliers offer a 'bird-friendly glass' featuring patterns of lines or dots.

CSA A460:19, Bird-friendly building design, addresses such visual elements as acid etchings, ultraviolet (UV) markers, fritted glass, film or non-film adhesive markers. They are designed to be in high contrast to the glazing material.

According to BirdSafe, an organization led by Fatal Light Awareness Program (FLAP) Canada, there are many other benefits to embracing bird-safe architecture, such as incorporating



green building best practices and meeting sustainability goals.

The federal government recently announced the certification of 14 new bird-friendly cities in British Columbia, Alberta, Saskatchewan, Ontario, Quebec and Nova Scotia, based on a certification standard developed by Nature Canada. They join Vancouver, Calgary, London, Ont., and Toronto, which were the first cities to be certified, in 2021. The certification encourages municipalities to protect birds from human-caused threats, including but not limited to windows.

Safety glazing

First introduced some 130 years ago, wired glass represented the first attempt at developing 'safety glass.' It involved embedding steel wire mesh into annealed glass, while the glass was still soft during processing.

However, while wired glass may appear strong, it typically has only about half the strength of regular plate glass. The wire is a weak link in the glass, such that it may be broken more easily when impacted.

In the mid-1970s, most North American codes and/or standards granted wired glass

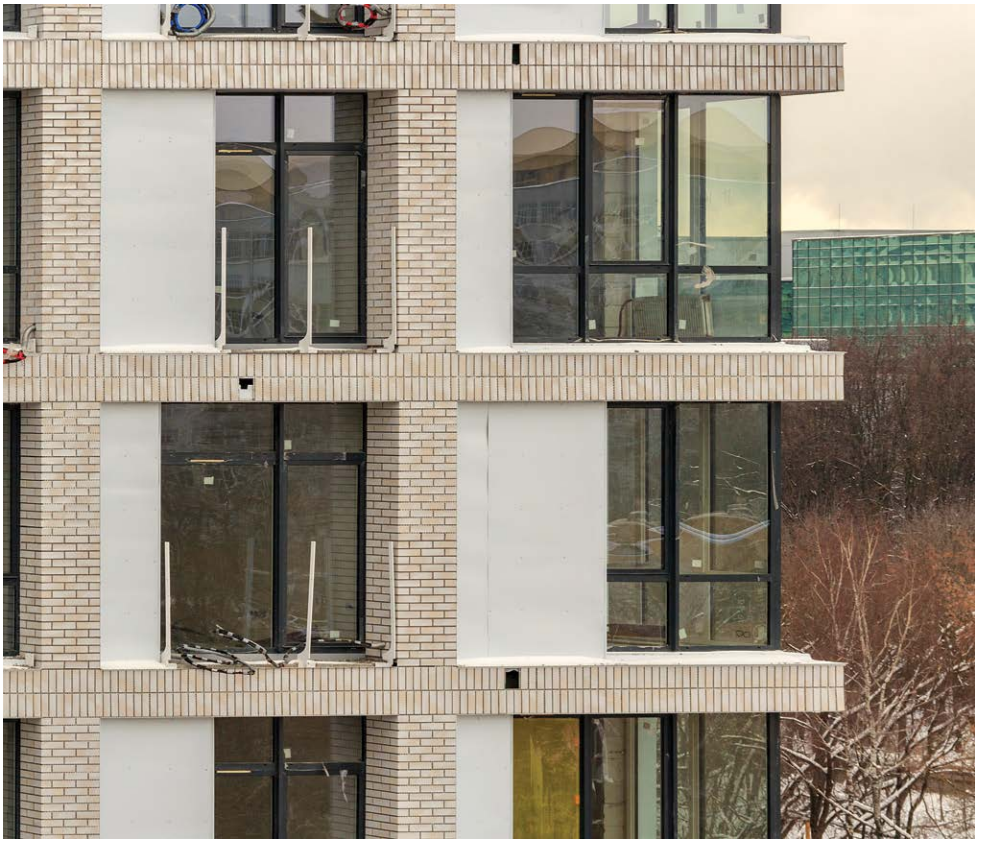
an exemption from strength requirements. This was because, at the time, it was the only type of glass that slowed the spread of fire and smoke when broken, *i.e.* by retaining shattered glass within the frame.

Wired glass is not safety glass. It breaks into shards held together by wires that can snare victims, lacerating, maiming or even killing them. In general, it should not be used where safety glazing is required and human impact is possible.

"Triple-pane IGUs can get up to an R-value of R-16."
– Bill Davis, Vitro Architectural Glass

In its 2020 edition, the National Building Code began to address this issue by requiring safety glazing in assembly occupancies to conform to the new safety glass standard, CAN/CGSB 12.1, Safety Glazing. Wired glass does not pass this standard. Instead, safety glazing is required in windows and doors where human impact is possible in assembly occupancies.

It is important to note that while these code changes eliminate the use of traditional wired glass in areas where safety glazing is required, they do not constitute a complete ban. Traditional wired glass can still be used in fire-rated window assemblies in locations out of reach for most human contact, such as transoms.



VIG window panes enhance efficiency by reducing conduction.

Wired glass should not be mistaken for safety glass.

Confusion still exists, however, between the terms 'safety glass' and 'fire-rated glass.' References to "wired safety glass" in the National Building Code and the withdrawn standard CAN/CGSB 12.11-M90, for example, should be removed.

And indeed, the Canadian General Standards Board's (CGSB's) committee on glass has submitted a code change request to remove these references and to replace them with references to CAN/CGSB 12.1, Safety Glazing, which would apply to all occupancies where glass is subject to potential human impact.

As glass safety has evolved, the need and desire for traditional wired glass have declined and other options have risen to take its place, such as specialty tempered glass, heat-reflective specialty tempered glass and specialty fire-protective glass for door lites or safety ceramics that block radiant heat.

Further, several manufacturers now provide wireless safety glazing products that are fire-rated for 20 to 45 minutes. In essence, fire safety no longer needs to supersede impact safety.

The future of glass is exciting, as these types of products will only continue to evolve and improve with time and testing. **CCE**

Amy Roberts is director of Canadian and technical glass operations for the Fenestration and Glazing Industry Alliance (FGIA), overseeing the organization's Canadian standards and regulatory building and energy codes, as well as the Insulating Glass Manufacturers Association of Canada's (IGMAC's) certification program for insulating glass units (IGUs). She has more than 20 years of experience in glass manufacturing for both residential and commercial windows. For more information, please visit www.fgiaonline.org.

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Teaching the Next Generation of Engineers

A veteran engineer provides some advice for mentors.
By David Clark

The COVID-19 pandemic demonstrated we can no longer rely only on how we did things in the past. Old ways and outdated solutions don't necessarily work in the hybrid engineering workplace and construction industry of the future.

Unexpected shifts will continue to be the norm, as the rate of change accelerates. We need to train up-and-coming engineers to prepare for change and guide them in navigating immense problems, such as climate change. The junior engineers of today will, as leaders, encounter problems we can't even imagine right now.

How can we mentor junior engineers and equip them with tools to help solve those problems? Higher education doesn't always teach the skills the industry will need, particularly soft skills that will be highly sought-after in the future.

Here are some ideas.

Build emotional intelligence for working with others

Great design doesn't happen in isolation. Big problems require complex, multidisciplinary solutions. Encourage mentees to learn about their colleagues' roles in the design team, so they can understand each other's needs, goals and perspectives.

By developing their emotional intelligence, especially empathy, mentees will be better able to resolve conflicts, see how their own work and emotions impact others and have the humility to apply course correction when required.

Teach problem solving and curiosity

It is important for junior engineers to learn how to approach problems they've never encountered.

Guide them to possible solutions. Has anyone else encountered something similar? Can the problem be broken down? Does going back to first principles help?

Ensure you provide support. Be ready with a lifeline if they appear to be heading down a rabbit hole—and help them figure out what matters and focus their time on those priorities.

Encourage creativity and innovation

Good design is elegant. It could include a mechanical process that uses energy efficiently or a structural system that minimizes embodied carbon. Engineers are naturally creative and we need to understand, value and celebrate engineering design.

Engineers need to be increasingly digitally literate, as computers and artificial intelligence (AI) impact our work. I expect iterative design, for example, which allows engineers to generate and test many solutions in a shorter period, will become increasingly common. Indeed, engineers will likely be co-designing with AIs in the future.

Making the creative leaps required to develop new solutions requires adapting to emerging challenges. I encourage teaching analogue skills, such as sketching on paper and storytelling.

PHOTO: © GALINA ZHIGALOVA / ADOBE STOCK

Develop critical thinking

As a junior engineer, I was lucky to work with senior engineers who had an open-door policy (or rather no-door, as it was an open office). They were prepared to invest time to help me and answer my questions.

In my role now as a leader, I try to apply that approach and investment by helping junior engineers ask questions of multiple colleagues (they may get different, conflicting answers about the best solution), challenge assumptions and critically analyze the information provided to them.

Push for adaptability and resilience

Encourage engineers to get out of their comfort zones. While the industry will need both generalists who can quickly assess problems and specialists with specific know-how, the rate of change will require both types of engineers to re-skill.

Junior engineers should expect more than one mentor over the course of their careers, representing various roles—*e.g.* project managers, tradespeople, constructors and clients. Mentoring may be formal through their firm (or engineering institution) or informal through networking.

Model good behaviour

As a junior engineer, I learned how to behave by observing others and overhearing conversations. It was professional development by osmosis, whether meeting clients, interacting with design professionals or dealing with contractors on-site.

This is increasingly difficult in a virtual setting, so find opportunities to invite junior engineers to client meetings and site visits. As a mentor, be aware of how you behave and are perceived by others.

Emphasize real projects' real problems

It is important to understand how our work relates to the real world. Just because you can draw it in 3-D doesn't mean it can be built! Nothing focuses the mind like being asked, "Who designed this?" on-site by the person trying to build it. Seeing your design being constructed is a critical part of learning practical design skills.

Establish strong communication

Mentors need to get better at supporting mentees. Building relationships can be difficult in a virtual environment; we must look to other opportunities for connection. A dedicated time for interaction, either face-to-face or over video, helps force discussions. With a regular date in the calendar scheduled for a mentor meeting, it's more likely to happen.

Support a diverse future

A diversity of ideas, opinions and experiences requires diverse mentors, particularly from underrepresented groups. I encourage all engineers to get involved, providing fresh voices and new faces for junior engineers to look up to. Unconscious bias training is a great way to challenge your own assumptions.

Learn as a mentor and mentee

In working with engineering and architecture students over my career, I have realized I don't have all the answers. Their projects are often outside my own experience, novel or very niche. "How many air handling units do you need to inflate an ethylene tetrafluoroethylene (ETFE) roof?" "How much sensible heat does a sheep produce?" "How do I make optically pure ice for an ice hotel chandelier?"

I might not know the answer, but I can help figure out where to look. I usually ask them to come back to me and let me know when they've figured it out, so I can learn from them, too.

I've yet to meet anyone in the construction industry who knows everything. There's always new stuff to learn. Be both a teacher and a sponge. **CCE**

Building engineer David Clark is practice leader for Stantec's buildings engineering group in Southwest Ontario and champions the expression of integrated design. For more information, please visit www.stantec.com/en

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