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Tapping into solar energy. **P. 12**

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PHOTO BY STEVE EVANS, COURTESY WARD99 ARCHITECTS AND JOHN MACDONALD ARCHITECT.

Comment

by Peter Saunders

Prioritizing infrastructure and clean energy

The federal government released its 2023 budget in late March (not quite in time to be addressed within our March/April issue). It has prioritized further investments in infrastructure, electrification, clean energy and manufacturing, emissions reduction, critical minerals, electric vehicles (EVs) and batteries, among other major projects that will be relevant to the consulting engineering community.

By way of example, the budget introduces tax credits for investments in clean electricity, technology manufacturing and hydrogen; enhances exisiting tax credits for investments in carbon capture, utilization and storage (CCUS); and expands eligibility for tax credits for investments in clean technology.

A new $15-billion fund will aim to attract private capital to build the clean economy.

A new $15-billion arm's-length Canada Growth Fund, as previously announced in a 2022 economic statement, will aim to attract private capital to build the clean economy.

The Canada Infrastructure Bank (CIB), meanwhile, is set to invest at least $20 billion to support the construction of major clean electricity and green infrastructure projects. The budget also proposes $3 billion over 13 years to recapitalize funding for renewables and electrification to support regional priorities and Indigenous-led projects, renew the smart grid program and exploit Canada's offshore wind potential, particularly off the coasts of Nova Scotia and Newfoundland and Labrador.

"The budget will create a significant amount of new opportunity for many consulting engineering companies over the years ahead," said ACEC-Canada in its analysis of the government's priorities. "While there was no mention of a national infrastructure assessment or procurement reform, there was an enormous emphasis placed on attracting investment for major projects. We expect in turn that will create an opportunity for further discussions about how best to ensure infrastructure meets the needs of local communities, while connecting Canada's natural resources to a global supply chain. ACEC had advocated for investments in the electricity grid, which will spur more investments in new community infrastructure projects beyond generation and transmission."

"There is positive news on climate action, in regard to investing in clean electricity and supporting the clean supply chain through expanded tax credits," said the Canada Green Building Council (CAGBC) in its own reaction to the budget. "These changes will have meaningful impacts for our mission to decarbonize Canada's built environment by 2050. Yet, one surprise was the lack of mention of a green buildings strategy in the budget. We look forward to changes to codes reflecting the urgency of climate action and remain committed to working with the federal government on decarbonization."

ACEC, for its part, went on to host energy and resource sector stakeholders in Ottawa to discuss further how a national infrastructure corridor could drive many of the budget's long-term goals.

Finally, it is worth mentioning the budget calls for the federal government to outline a plan by the end of this year to improve the efficiency of impact assessment and permitting processes for major projects. As always, stay tuned .... **CCE**

Peter Saunders • psaunders@ccemag.com

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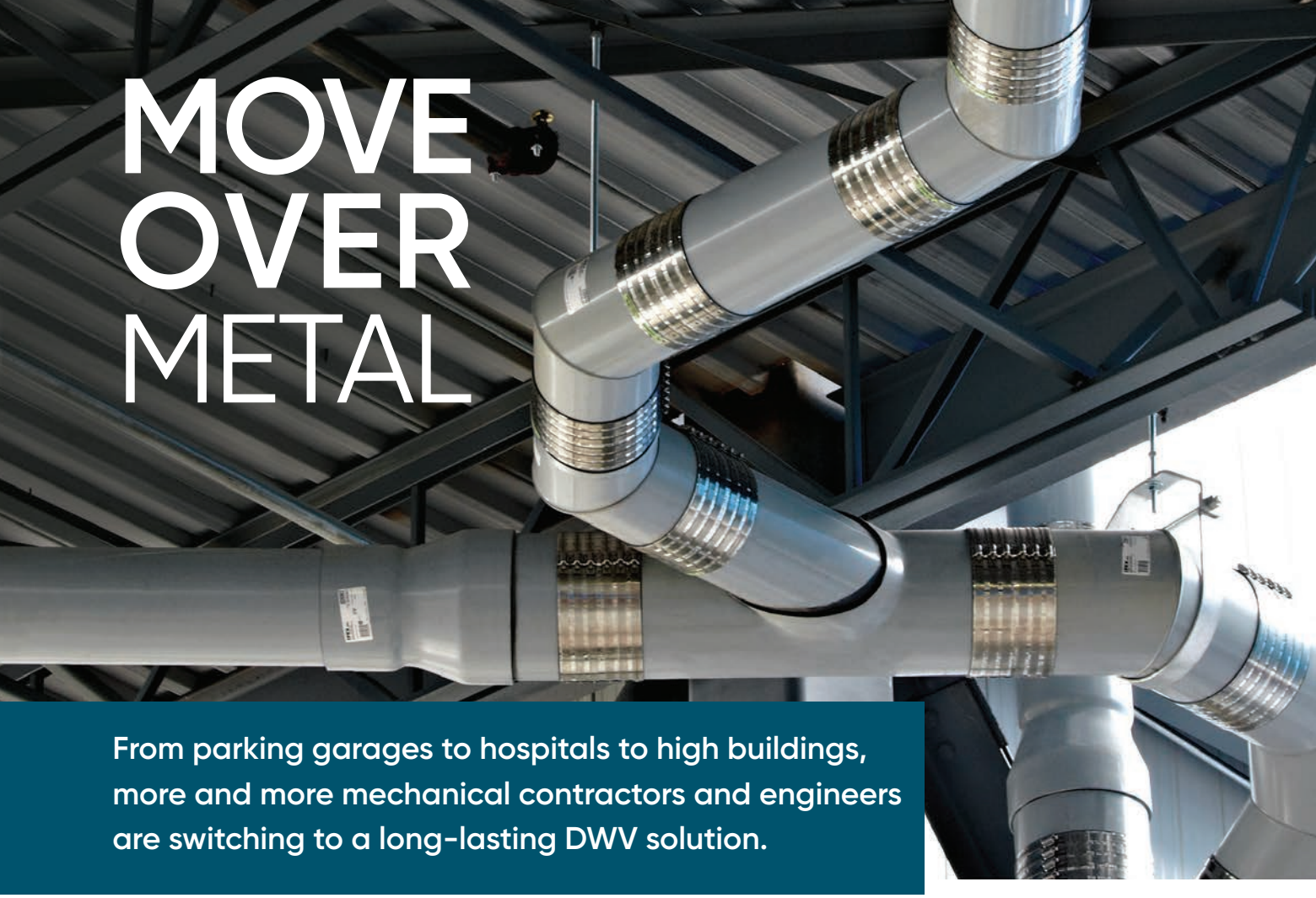

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Following the success of Women in Construction, our inaugural **Women in Engineering** virtual event (VE) on June 21 is strategically timed to lead directly into International Women in Engineering Day on June 23. This is a key opportunity to promote greater gender diversity in one of Canada's most celebrated areas of expertise, as consulting engineering firms seek to recruit and retain more women for roles at all levels of seniority.

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HOW EQUITY, DIVERSITY, AND INCLUSION CAN STRENGTHEN OUR INDUSTRY

Organizations across sectors have been very focused on equity, diversity, and inclusion (EDI) initiatives over the last several years, and for good reason.

Prioritizing EDI is much more than just the right thing to do—it's crucial to building healthy and productive workplaces, from promoting creativity, encouraging problem-solving, and leading to better outcomes. At the industry-level in consulting engineering, advancing equity, diversity, and inclusion is also about attracting and retaining the next generation of consulting engineers, and supporting the long-term sustainability of our sector.

Take, for instance, ACEC's Diversity and Inclusion Committee, which recently commissioned a months-long national research project on women and diversity in consulting engineering. With the aim of identifying tangible actions that ACEC can take to better support our member firms, the study examined four themes: education for employers, parental leave, flexibility, and pathways to leadership. Insight was gained through a series of focus groups comprised of people in the industry from across the country. The result? A package of comprehensive recommendations outlining how we can recruit and retain more diverse talent, and build inclusive workplaces that benefit everyone. You can read more about the recommendations on the next pages.

> If we want a stronger, more sustainable industry, we have to make some changes.

What's clear from these recommendations is that if we want a stronger, more sustainable industry, we have to make some changes. And I'm certain that in this case, change is unequivocally a good thing. It will be good for our employees, good for our member firms, and good for our entire industry.

Time and time again, it's been proven that diversity positively impacts the bottom line. So, it makes sense that we want to strive to build an industry that empowers women and diverse groups of people to join this incredible field, that upholds equal representation in leadership positions, and that ensures everyone is educated on creating fair and inclusive workplaces.

That's why we have made EDI a priority in ACEC's current Strategic Plan, as well as our forthcoming plan, which will lay out our vision and mission for the years ahead. EDI is necessary for our industry to strengthen, modernize, and grow, and it's important that our Strategic Plan reflects that, building on the work we've already been doing.

ACEC is looking forward to thoroughly reviewing these recommendations so that we can set a solid plan in motion to support our member firms and advance equity, diversity, and inclusion in the consulting engineering field. Together, we will work to build truly inclusive workplaces and ensure our industry continues to thrive for the long-term.

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

CHAMPIONING EQUITY, DIVERSITY, AND INCLUSION IN OUR INDUSTRY

In 2022, ACEC-Canada's Diversity and Inclusion Committee commissioned a national research project on promoting women and diversity in consulting engineering that focused on four themes; this resulted in a final report and fulsome recommendations. Below is a summary of these recommendations—they outline steps that ACEC-Canada (ACEC) can take to support its member firms as they recruit and retain talent, improve performance, and achieve their equity, diversity, and inclusion (EDI) objectives. To read the entire report and associated recommendations, please visit www.acec.ca/edi.

RECOMMENDATION 1:
EDUCATION FOR EMPLOYERS

- Building a step-by-step EDI framework for firms to help them create more equitable workplaces.
- Offering relevant training and fostering more honest discussion by publishing a list of existing EDI resources for all members, and partnering with EDI organizations to produce other relevant content.
- Supporting employers and women in the field by creating awareness about educational tools, developing EDI checklists for employers, and providing suggested language for communicating with contractors about equality and inclusion in the workplace.
- Providing insights, trends, and data to member firms on diversity in the industry to help them understand major shifts and fill gaps accordingly.

NEXT STEPS

RECOMMENDATION 2:
PARENTAL LEAVE

- Advocating for better parental leave by understanding provincial differences across the country and pushing for changes that benefit members and promote gender equality.
- Building awareness and sharing best practices to:
  - Combat maternity bias by understanding how it can affect advancement opportunities for women;
  - Modernize leave policies by highlighting the improved policies that firms have already put into place, and encouraging others to set progressive targets;
  - Support employees through leaves of absence by promoting excellent resources for member firms, such as APEGA's guide, "Managing Transitions: Before, During and After Leave";
  - Boost national advocacy on leave benefits by partnering with other organizations to push for more flexible policies, and;
  - Lead by example by making ACEC conferences and training opportunities more family-friendly, with a focus on spousal programs and on-site childcare.

RECOMMENDATION 3:
FLEXIBILITY

- Creating a forum on flexibility in the workplace to explore the following topics:
  - Navigating part-time work, the gig economy, and freelance contracts
  - Mental wellness supports
  - Mentorship in a virtual environment
  - Balancing personalization and fairness in the workplace
  - Social and family events as differentiators for team-building
  - Case studies from leaders in consulting engineering
  - Avoiding the pitfalls of hybrid work
- Elevating the profession by promoting it as a desirable and rewarding occupation, and helping to ensure consulting engineers are adequately paid by educating clients on their value and expertise.
- Pushing for realistic response times for projects to ensure respectful procurement practices and promote better work-life balance.

RECOMMENDATION 4:
PATHWAYS TO LEADERSHIP

- Championing equity, diversity, and inclusion at ACEC by modernizing internal policies, providing annual EDI training for Board members, offering professional development opportunities for women, and more.
- Promoting sponsorship and allyship by ensuring members have the tools they need to foster an environment where women—and other underrepresented groups—are fully included and empowered. Consider:
  - Establishing and supporting employee resource groups
  - Making performance reviews more objective and KPI-driven
  - Outlining transparent career pathways to support advancement
- Improving salary transparency so that employees, particularly women, can enforce their right to equal pay for equal work. ACEC can work with provincial and territorial Member Organizations to make salary data publicly available, which study participants indicated has become unavailable over the years.

The ACEC-Canada Board and management are now prioritizing the various recommendations to build an action plan that will keep this conversation at the forefront and develop tangible tools for member firms. Stay tuned to *Source* newsletter and ACEC's website in the coming months for updates.

Building a Barrier-free Canada

There is still much to accomplish.
By Kay Penn

Some 22% of Canadians aged 15 and up live with a disability that limits their daily activities. Accessing transportation, eating at a restaurant or shopping for necessities can involve many challenges. Over the past 20 years, municipal, provincial and territorial governments have developed policies and guidelines aimed at improving accessibility, with regulations covering public and private spaces, including buildings and dwellings. As the Accessible Canada Act moves toward making the country barrier-free by 2040, there has been considerable progress, but there is also still a lot to accomplish.

In 1990, CSA Group published the first edition of CSA B651, Barrier-free design, focusing on how buildings can be designed and constructed—and how products can be manufactured—to improve accessibility. In retrospect, that standard's initial recommendations—such as installing ramps at main entrances, widening doors, adding contrasting nosings to stairs, extending handrails and expanding washroom stalls—may seem rudimentary, but they were important features that helped improve overall access to public and private spaces for people with disabilities.

The standard has been recognized by accessibility advocates, industry and government stakeholders and referenced in the National Building Code (NBC) and legislation across the country.

Earlier this year, in collaboration with Accessibility Standards Canada, CSA Group published the latest edition, CSA/ASC B651:23: Accessible design for the built environment. The relevant technical subcommittee, a third of whose members live with a disability, developed and updated numerous requirements and recommendations to increase both safety and accessibility. The resulting edition supports universal design principles, so all people can access the built environment to the greatest extent possible, regardless of age, size, ability or disability.

Among the changes introduced in the 2023 edition are updates of di-

mensions based on current anthropometric data (*i.e.* relating to the proportions of the human body). The standard's annex provides details on the anthropometrics of mobility aid users, including reach ranges for a person in a wheeled mobility device, walkway widths for people using crutches, walkers or a service animal, detection spaces for people using long white canes and dimensions and turning areas of wheeled mobility devices.

The new edition also provides a detailed explanation of luminance colour contrast and guidance on minimum contrast levels for general, glossy or shiny surfaces, such as brushed stainless steel.

Further, CSA/ASC B651:23 provides updated guidance on functional and cognitive barriers, recommending simple and logical spatial layouts with consistent features, *e.g.* the same location for washrooms on each floor. It includes recommendations for measuring excessive noise interferences and improving both indoor and outdoor lighting.

Requirements and recommendations have been updated.

Other updates include guidance for addressing functional and cognitive barriers, for tactile direction indicator positioning and controls for power-assisted doors and water fountains, for water bottle filling stations and for the minimum size of platform lifts along an accessible path of travel.

Over the next decade and beyond, CSA Group plans to work in lockstep with industry and regulators to help ensure its portfolio of accessible built environment standards continues to strengthen, while also applying an 'accessibility lens' across a range of other standards. The organization is investing in accessibility research in such areas as connected and automatic vehicles, the effects of powered mobility devices on loading and design requirements for platform lifts and the impacts of new technologies for self-service devices on usability for people with disabilities, just to name a few.

Standards play a critical role in helping to build a barrier-free Canada. CSA Group is continuously looking for new volunteer members to contribute expertise and lived experiences to develop the accessibility standards of tomorrow—and to share feedback during the public review process. CCE

22%

of Canadians aged 15 and up live with a disability that limits their daily activities.

Kay Penn is CSA Group's director of health and safety standards. For more information, visit www.csagroup.org.

Low-carbon Heating Goes Mainstream

By Victoria Hollick

The new Waterloo Public Library features a black solar air heating system.

PHOTO BY STEVE EVANS. COURTESY WARD99 ARCHITECTS AND JOHN MACDONALD ARCHITECT.

The energy performance of a building is usually a product of when the structure was designed. One watershed year was 1997, when two important events occurred that continue to shape the energy performance of modern buildings today.

The first noteworthy event was the creation of the Model National Energy Code for Buildings (MNECB), which was developed by Natural Resources Canada (NRCan), provincial governments and other stakeholders. It changed the way buildings were designed. And then it was updated in 2011 and 2017—when it was renamed the National Energy Code for Buildings (NECB)—to include more stringent energy-efficiency requirements.

The second noteworthy event of 1997 was the signing of the Kyoto Protocol, the first global treaty that established mandates to reduce carbon emissions. This pivotal development began shaping a discussion that today centres on how to design low-carbon, net-zero and even carbon-free buildings.

It has become routine for consulting engineers to hear client requests for solutions that go above and beyond NECB to meet their environmental, social and governance (ESG) objectives, achieve low-carbon or net-zero targets or earn Leadership in Energy and Environmental Design (LEED) certification. As Canada's federal government seeks to accelerate this energy transition, one of its current areas of focus is low-carbon heating.

Federal policy strategies

Given Canada's 'heating climate,' it may not be surprising that indoor space heating and industrial process heating are among the country's largest users of energy and emitters of carbon. The government has addressed this issue with two policy strategies: (a) a federal carbon tax and (b) a newly announced clean technology investment tax credit. These strategies will help make it easier for low-carbon heating to become mainstream.

The carbon tax was launched in 2019. As it increases, from approximately $1 per GJ of energy in 2019 to approximately $5.50 in 2026, it is accelerating the escalation of natural gas heating costs to a meaningful degree.

The clean technology tax credit, meanwhile, will be refundable and equal to 30% of the capital cost of eligible equipment. The technologies eligible for this credit will include low-carbon heat equipment, such as active solar heating systems and heat pumps.

1997

Natural Resources Canada and other stakeholders introduce the Model National Energy Code for Buildings.

The question arises, how realistic is the notion of transitioning our building stock to low- or zero-carbon heating? Fortunately, there are already many examples the engineering community can rely on that show how this aim is achievable, using current technologies.

Solar air heating, for example, has a long history in Canada. It has been applied to several thousand commercial, industrial, institutional and agricultural buildings to heat incoming ventilation air. These systems are typically wall-mounted and made of metal, allowing for significant architectural flexibility.

When the sun's radiation heats the surface of the system, the fresh, solar-heated air accumulates on the surface of the collector, where it is drawn in under negative pressure though thousands of tiny perforations. This air can be heated from 15 to 40 C on a sunny day before it reaches the fresh-air intake side of the building's heating, ventilation and air-conditioning (HVAC), heat recovery ventilation (HRV) or energy recovery ventilation (ERV) unit. This

helps minimize the building's consumption of natural gas throughout the heating season, thus assisting a low-carbon heating strategy.

Buildings evolve

One facility that has achieved net-positive energy and zero-carbon heating in Canada's climate is the evolv1 office building in Waterloo, Ont., which the Canadian Green Building Council (CaGBC) has certified LEED Platinum.

"Our vision was to build a replicable net-positive energy building that could be leased at market rents," explains Thor Neumann, P.Eng., senior project manager for The Cora Group, which owns the building and developed it in collaboration with the University of Waterloo, Sustainable Waterloo Region and Ernst & Young (EY) Canada, with Stantec preparing a feasibility study first. "A holistic approach was taken, but a significant amount of attention was given to understanding the building envelope and its associated heating and cooling demands."

The construction of evolv1 implemented on-site renewable energy technologies, including a solar air heating system (designed into the front façade), a geothermal system, a very large photovoltaic (PV) array on the roof and a PV charging station. A building automation system (BAS) uses these technologies together to help achieve a zero-carbon outcome.

Solar air heating has been applied to thousands of buildings.

PHOTO COURTESY THE CORA GROUP.

The evolv1 building's front façade is an all-metal air heading system, integrated with the building envelope and the mechanical system.

"The project was used as a baseline for a simple comparison of a well-understood building type and the additional attributes a net-positive building would require, which were outlined for further consideration and review," says Neumann. "It ultimately became a pilot project in CaGBC's Zero Carbon Building (ZCB) program. Since we commissioned the building in 2019, the solar air heating system has complemented the geothermal heating system very well by seamlessly incorporating 'free' heat energy into the fresh-air delivery stream, with very few and simple controls."

As the carbon tax and clean technology tax credit support the trend that is already in motion with low- and zero-carbon buildings, evolv1 serves as a realistic example of the type of new construction that could become mainstream in the future, with more consulting engineers, architects and building owners embracing renewable energy as standard. **CCE**

Victoria Hollick is vice-president (VP) of SolarWall technology developer Conserval Engineering. For more information, visit www.solarwall.com.

Direct Pipeline Installations

Ground conditions can challenge other trenchless methods.

By Jon L. Robison

PHOTO COURTESY ASCE.

Pipelines of various types, sizes and purposes are routinely installed below the ground in communities around the world. The most common method of installation is open cut, also known as trenching, which results in obvious—sometimes significant—unwanted ground disturbance. Consequently, trenchless methods of pipeline installation have been developed to reduce surface impacts and public inconvenience, including pipe ramming, horizontal auger boring, microtunnelling, guided boring, shielded pipe jacking, horizontal directional drilling (HDD) and utility tunnelling.

Direct steerable pipe thrusting (DSPT), in particular, was developed relatively recently to fill a need for installation in ground conditions challenging for other trenchless methods. It combines some of the characteristics of HDD and microtunneling. Direct Pipe, developed in Germany by Herrenknecht, was the first commercially available system in this category. Since its initial use in 2007, more than 200 installations have been completed worldwide.

How it works

DSPT is a near-surface launched, thrusted microtunnel method of pipeline installation. It can be used to install steel pipe in a single pass along both horizontal and vertical curves.

The soil or rock in the heading of the pipe is removed through slurry microtunnelling methods. A clamping device on the exterior (perimeter) of the pipe is used in combination with a thrusting machine to hold and push a steel installation pipe—which is typically prefabricated on-site—along its heading. Excavated materials are removed by a closed slurry system, located within the installation pipe. The pipe is thus installed in compression by the thrusting machine.

DSPT incorporates the sequential process of a typical HDD installation, including site preparation, pre-welding long sections of thrust pipes, integrity testing and certification of joints within these long sections, application of joint coating and tunnelling. In most cases, even the necessity for intermediate or golden welds, non-destructive testing of the welds and final field-joint coating remains unchanged.

However, DSPT differentiates itself from traditional multi-step processes like HDD by combining the process of tunnelling and simultaneously installing the thrust pipe in one pass. The two key components for this process are the microtunnel boring machine (MTBM) and the pipe thruster or pusher.

More than 200 DSPT installations have been completed worldwide.

Comparable to a traditional jacking frame used in microtunnelling or to pipe jacking for pushing short pipe sections of 8 to 10 ft in length at a time, the pipe thruster or pusher provides the forward thrust in DSPT to the prefabricated pipe. However, instead of applying force to the end of the pipe as in conventional microtunnelling, the thruster or pusher clamps and grips the outside of the thrust pipe, pushing it forward into the

ground.

The joining of prefabricated pipe strings requires connecting the internal umbilical lines of the MTBM, which run through their full length, and then joining the strings together with golden welds. Section welding is typically followed by non-destructive testing/examination (NDT/NDE) procedures and field-coating of the joint(s).

The tunnel is excavated by the MTBM, which is based on slurry-type microtunnelling machines and cutter heads or wheels. The MTBM is attached to the forward end of the thrust pipe and they are pushed into the ground together.

A rotating cutter wheel excavates the ground at the face of the tunnel. The excavated material is broken down by the cutting tools before entering the crushing chamber, where it mixes with drilling fluid and passes into the slurry circuit through openings in the chamber. The slurry is then pumped back through a dedicated discharge line inside the thrust pipe to the separation plant on the surface. At the separation plant, the cuttings are removed from the slurry and the clean drilling fluid is then returned to the face of the MTBM through a dedicated feed line, also located inside the thrust pipe. With the slurry circuit flow contained in the feed and return lines, DPST can operate at low annular pressures relative to HDD, which reduces the risk of hydraulic fracture and inadvertent drilling fluid surface release.

During the excavation process, the overcut or annular space created by the cutter wheel's gauge cut is filled with a bentonite-based lubricant. This reduces friction between the bored hole and the thrust pipe. And if the lubricant is maintained slightly above ambient ground pressure, it supports the ground to maintain the integrity of the surrounding formation.

The bentonite lubrication system is separate from the feed and slurry return system. All of the control and support units are located above ground near the launch area, workspace permitting.

DSPT can install pipe as the final product or as a casing. Most of the activity and required workspace during construction is at and behind the entry location. After the drive is complete, the MTBM is disconnected and the umbilical removed from the jacking pipe. A relatively small workspace is typically required at exit, which is often unoccupied until just before the drive is complete and the MTBM punches out.

While DSPT will not completely displace HDD and conventional microtunnelling, it provides an important niche tool for trenchless engineers, contractors and owners to consider for challenging sites. **CCE**

Jon L. Robison, PE, is a principal at GeoEngineers. This article is based on the American Society of Civil Engineers' (ASCE's) new Manual of Practice (MOP) 155, Direct Steerable Pipe Thrusting, which details how engineers and construction professionals can use the direct steerable pipe thrusting (DSPT) method to design and install pipelines. For more information, visit www.asce.org.

Exiting Beyond An Exit

Codes leave gaps on the path to safety. By Avinash Gupta, P.Eng., Mohamed S. Mohamed, P.Eng., and Dominic Esposito, P.Eng.

IMAGE COURTESY AVINASH GUPTA.

Whenever there is a fire emergency in a building, the most immediate response is to evacuate occupants before the environment becomes unsafe. Every area of occupancy must provide an adequate number of exits. Considerations for the effective design, protection and maintenance of these means of egress, as well as fire protection of exits, obstruction-free means of egress, exit signs and emergency lighting, are critical features.

As per the definition in Canada's National Building Code (NBC) and National Fire Code (NFC), exits include doors or doorways leading directly to an exit stair or outside. An exit from a building does not stop at the exterior door, but must continue to provide access to (a) a public thoroughfare or (b) an exterior open space protected from fire exposure from the building and with access to a public thoroughfare. That said, the scope of NBC and NFC ceases at the termination of the means of egress.

A continuous, unobstructed path of travel from any point in a building to a public thoroughfare comprises three separate, distinct parts: access to an exit; exit; and exit discharge. It is important to address the challenges of exterior discharge and public thoroughfare.

Exterior exit discharge

The terminology of exterior discharges was introduced in the 2015 edition of NBC, but not defined. Exit discharge is a path of travel from the termination of an exit to a public thoroughfare, but the path could be inside or outside a building, such as where an exit opens onto an alley, enclosed space (court) or small, uncultivated or unpaved area (yard).

Horizontal exits are helpful in facilities like detention, treatment and care centres. In detention occupancies, where security is critical, horizontal exits provide relocation for residents, instead of allowing them to be evacuated outside. In treatment or care homes, horizontal paths help move non-ambulatory occupants from one fire compartment to an adjoining, temporary, safe fire compartment, rather than moving them downstairs.

Path of travel from exit

NBC requirements cease to apply at the termination of an exterior exit door, but as occupants will continue to move away from a burning building until they reach a safe area, further components should be implemented to make evacuation safer, such as illuminating the means of egress outside the building, emergency lighting, handrails

and maintaining an obstruction-free environment of sufficient width.

Illumination and maintenance of public thoroughfares, alleys or unpaved or uncultivated lands or streets are not enforceable by municipal building departments, but instead are supported by wings of the provincial or federal government.

Exterior exit door location

A minimum distance between exterior discharges, applicable to exit doors and stairwells, was introduced in the 2015 edition of NBC to mitigate the risk of such exits being simultaneously blocked by an exterior incident (*e.g.* bomb threat). The provision, which does not cover all types of buildings, could be revisited.

Width and location of exterior path

NBC and NFC do not regulate the width of an exterior exit discharge or its distance from the outer surface of an exposing building face.

Designers should ensure adequate exterior walkways for high-occupancy buildings will facilitate the continuous flow of movement and prevent overcrowding and blocking of exits. Exterior unpaved walkways, grass or similar surfaces are acceptable. Based on the expected occupant load, a designer can calculate the width of the exterior path, using the concepts already provided in NBC.

Where an exit discharges to the roof of another section of the building or an adjoining building, the roof or ceiling assembly must provide fire resistance equal to or greater than that required for an exit enclosure.

Often, the exterior exit door terminates at an open space surrounded by exterior walls, such as a parking garage. Such an enclosed court should offer adequate exits to the public thoroughfare.

The determination of a 'safe place' could be based on a fire radiation analysis. A holding space could be considered, based on a risk analysis of credible worst-case scenarios.

Generally, a 3-m distance from an exterior path of travel to a building is used to address fire exposure. There are discrepancies, however, in how the distance is measured (*i.e.* along horizontal and/or vertical planes) and situations where it is not feasible. In some jurisdictions, the length of the exterior path of travel to the public thoroughfare is based on NBC provisions for a single direction of egress travel within buildings.

The design of the exterior path could be based on the radiation intensity (heat flux) from a fire in the building relative to a scenario-based analysis.

Maintenance

NFC requires exterior passageways and stairs to be kept free of snow and ice accumulation, but does not address the maintenance of other elements of the exterior path of travel.

Within the walls or perceived boundaries of a building, the owner could be held responsible for such maintenance if the local authority promulgates it in zoning bylaws.

Yet to be addressed

Thus, several elements of exterior paths of travel are not currently addressed by NBC or NFC, including design (*e.g.* width and surface type), exit signs, illumination and maintenance. While many safety measures are feasible within a building, exterior means of egress need co-ordination with municipal governments for their efficacious enforcement.

For now, an exterior discharge from a building is not in NBC's territory. This leaves a massive gap between the code and what is essential for an occupant's safe evacuation—an unconventional problem that probably needs an unconventional solution. **CCE**

Avinash Gupta, P.Eng., is chief code compliance engineer and assistant fire marshal for the government of the Northwest Territories. Mohamed S. Mohamed, P. Eng., is East Canada manager for Jensen Hughes. Dominic Esposito, P.Eng., is a senior project consultant for Jensen Hughes. For more information, contact Gupta at avinashguptap.eng@gmail.com.

The Benefits of PEX

Almost every aging facility requires repiping.
By Kevin Wong

Nearly half a million commercial and industrial structures are in service across Canada. Many are past the 50-year mark. The cost to renovate aging buildings now equals that of new construction—and continues to increase every year.

From floor to ceiling and mechanical room to rooftop, these buildings demand material and equipment upgrades that meet today's standards for health, safety, comfort and sustainability. Keeping projects on schedule and budget can also be a challenge, given significant labour constraints.

While some of a building's existing materials and equipment may be kept in place during essential renovations, nearly every aging facility requires repiping for its domestic water and/or hydronic distribution systems. One preferred solution, which began to be adopted in the early 1980s as an alternative to copper and other metals for radiant floor heating, is cross-linked polyethylene (PEX).

PEX is lighter and more flexible than metal, enabling faster and easier piping connections, without the need for an open flame on a job site. It increases safety, halves installation time and ensures minimal invasiveness when repiping historical buildings.

Early adopters mainly valued the speed, reliability and cost of PEX when they used it to replace copper and other metals. Today's building owners have discovered the material also offers sustainability benefits, including corrosion resistance and resilience in freezing conditions.

Indeed, with a life expectancy of up to 100 years in a properly designed system, PEX can outlast many buildings! And with cold expansion connections that cannot be dry-fit, it eliminates the added concern of blowoffs with an unmade fitting.

As for cost, PEX is not a traded commodity, so it does not experience price fluctuations like metals do. Its stable material cost is typically lower than copper's, making it easier to budget for long-term projects. And its ease of installation saves on labour costs.

30%

PEX offers up to 30% better insulating value compared to uninsulated copper pipe.

PEX manufacturing varies by degree and uniformity of crosslinking.

Types

As more engineers begin to specify PEX, it is important to understand the material's various characteristics and design considerations.

There are three different types of PEX, which vary by manufacturing method: PEX-a, PEX-b and PEX-c. Manufacturing varies by degree and uniformity of crosslinking; the higher the degree and uniformity, the more durable, flexible and freeze-resilient the pipe.

PEX-a offers the highest degree of crosslinking at around 85%. PEX-b offers 65 to 70%, while PEX-c pipe provides 70 to 75%.

Temperature and pressure

Hydrostatic temperature and pressure ratings for PEX are 93 C (200 F) at 5.5 bar (80 psi), 82 C (180 F) at 6.9 bar (100 psi) and 23 C (73 F) at 11 bar (160 psi). Operating temperature and pressure ratings in domestic hot water and recirculation should not exceed 60 C (140 F) at 5.5 bar (80 psi).

PHOTOS COURTESY UPONOR.

PEX's low weight and flexibility help reduce installation time and ensure minimal invasiveness when repiping historical buildings.

Sizing

PEX's outside diameter (OD) is equal to copper tube size (CTS) and its wall thickness is one-ninth the OD, for a Standard Dimension Ratio (SDR) 9 classification. This allows the material to use the same hangers and supports as copper, in addition to any CTS insulations.

The inside diameter (ID) of PEX is slightly smaller than copper pipe, but since PEX is three times smoother than new copper pipe, it can be designed for higher velocities, reducing the difference in flow characteristics.

The smaller ID also offers system volume water savings, whereby smaller pumps, heat sources and tanks can deliver the same level of comfort and hot water to the user.

Thermal conductivity, expansion and contraction

PEX has a very low co-efficient of thermal conductivity of 0.38 W/(mK), so it does not 'sweat' like copper pipe. Its thicker walls offer insulation values of approximately R-0.19.

Additionally, the heat transfer from copper is much greater. PEX offers up to 30% better insulating value, when comparing uninsulated PEX to uninsulated copper pipe.

CSA Group has validated the performance of complete PEX systems.

Further, PEX pipe expands and contracts at a rate of 27.94 mm per 30.48 m of pipe with every 5.56 C temperature change. Using a support steel channel in suspended-piping applications in conjunction with fixed anchor points can reduce this expansion and contraction rate to an acceptable level.

Support spacing

Maximum vertical spacing requires support at the base and at the floor of alternate storeys. The spacing should not exceed 7.5 m. Maximum horizontal spacing for bare PEX is 0.8 m, but using pipe support steel channels increases the support spacing to 2.4 m.

Direct burial

PEX pipe and certain certified/listed fittings are approved for direct burial in soil or concrete. There is also pre-sleeved PEX with a high-density polyethylene (HDPE) corrugated sleeve that provides added protection for installations in concrete slabs or rocky soil. The sleeve allows for quick and easy removal and replacement of the PEX pipe, if necessary, without having to break up the slab or soil.

Specifying the system

Finally, it is worth noting that in some cases, CSA Group and other third-party certification agencies have validated the performance of complete PEX systems, including the pipe, ring and fitting. Thus, specifying a complete system can help prevent poor performance.

Kevin Wong is the Canadian codes manager for Uponor. For more information, contact him at kevin.wong@uponor.com.

Improving Efficiency for the Park Hyatt Hotel

Energy consumption was reduced by 60%.
By Paul Scarafile

After a major refurbishment to event spaces and 219 guest suites at Toronto's 17-storey Park Hyatt Hotel, the building's managers also wanted to improve its heating efficiency and reduce its energy consumption.

The managers collaborated in this effort with locally headquartered consulting engineering firm The Hidi Group—more specifically, with its commissioning business, HRCx, which works with building owners, architects, engineers, contractors and operations staff throughout projects' design, construction and occupancy phases.

The hotel site's flow requirement specification was 600 gpm at a 75-ft head. Local manufacturer Armstrong Fluid Technology recommended replacing one of two existing pumps with a Design Envelope Permanent Magnet (DEPM) vertical in-line pump, so as to provide a head-to-head efficiency comparison.

With its high-efficiency design, the pump promised to deliver the required output with just a 15-hp motor—and both the smaller pump and motor would reduce capital costs. The hotel's managers agreed to try out the newly developed pump, which at the time was not yet available to the general public.

The hotel added a vertical in-line pump.

Pump Systems Interfacing (PSI) of nearby Markham, Ont., performed the installation. Armstrong then started up the new pump and completed commissioning in May 2022.

The commissioning report showed the pump reduced average energy consumption by 60%, from 1.66 to 0.66 kW, and promised annual energy savings of $17,626. Related average carbon dioxide (CO_2) emissions were reduced by 16,452 kg (from 96,283 to 80,831 kg).

There were no on-site challenges during the project. Installation, start-up and commissioning all proceeded smoothly. The Park Hyatt Hotel's facilities manager, after receiving the results of the commissioning report, asked the executive team to invest further in fluid pumping technology.

Paul Scarafile is Toronto-based Armstrong Fluid Technology's commercial director for Canada. For further information, please visit www.armstrongfluidtechnology.com.

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Literature review

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Professional directory

Saving energy with sewage

Lynn Mueller is CEO of SHARC Energy Systems in Port Coquitlam, B.C., which manufactures wastewater energy transfer (WET) systems that extract and reuse heat and help reduce carbon emissions. The company recently announced the provision of five systems to Vancouver's False Creek Neighbourhood Energy Utility, roughly tripling its capacity from 3.2 to 9.8 MW, making it the largest WET project in North America upon completion this year.

What's the history of recovering heat from wastewater?

It has been used in Europe with low-tech, low-yield applications, where they put heat exchangers in the bottom of sewer lines. That's fine in cities where ancient sewers have cathedral-style ceilings, but here in North America, as a rule, people aren't allowed to put things in sewer systems!

There have also been WET technologies in Asia, but the equipment always had to be fixed. When we started this venture, our goal was to provide reliable systems that require minimal servicing.

What were the keys to improving the approach?

For one thing, the odour issues were unacceptable. Our systems would have to be hermetically sealed. In False Creek, for example, we were not involved in the first stage of the utility's heat-recovery system, which used to smell.

Another key is collecting data for predictive monitoring purposes. If a unit detects a problem coming, it can email a service person to come fix it. That notion came from the Microsoft Innovation Hub, which taught us that data is more valuable than hardware. We've embraced that idea with intelligent units and 24-7 cloud-based monitoring. Every system around the world reports back to us.

And another was high capacity for big cities. All of the sewers in downtown Vancouver feed into the pumping station under the Cambie Street bridge in False Creek; 200 million gallons a day pass through there. We take just a little of that heat and it's enough for 22 million square feet of apartments!

That station has been our proving ground. I'm beholden to the city because they let us test technology close to home, which helped us develop systems that can work reliably anywhere in the world. And now everybody is developing WET and every city has it on their list of things they want to investigate doing.

How are you working with engineers?

We recently teamed with Salas O'Brien, a firm with offices across Canada and the U.S., to deliver WET systems to their customers, with their expertise. Their engineers can now do WET designs very quickly for big projects and we are getting a lot of jobs coming in we never heard of before.

That said, we are 'engineer-agnostic.' We know engineers like to put their own stamp on projects and they can really make this system do whatever they want, with an energy source they'll never run out of, for all sorts of buildings—with the notable exception of office-only buildings, which just don't use enough water unless they tap into a nearby sewer line.

As the world trends toward 'green energy,' WET is about as green as you can get. Sewage flows are ubiquitous and continuous. You can tap anywhere into a line and you've got a renewable source of recyclable energy, available at about 70 F. And as rules tighten to get buildings off of natural gas, we'll continue to get busier.

"A lot of cities are interested in investigating the use and benefits of WET systems to meet their sustainability goals."

What's next?

We want to develop a solar-powered hot water system for single-family homes, where sewage heat recovery would be driven by solar energy stored in phase-change material, so as to take hot water completely off the grid. That's the next frontier. We've built some prototypes, but the battery technology still needs to improve. I think in the future, the grid will be a convenience, not a necessity. **CCE**

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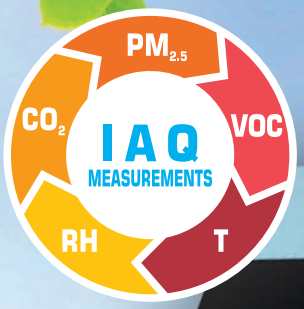

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