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CONSTRUCTION CANADA

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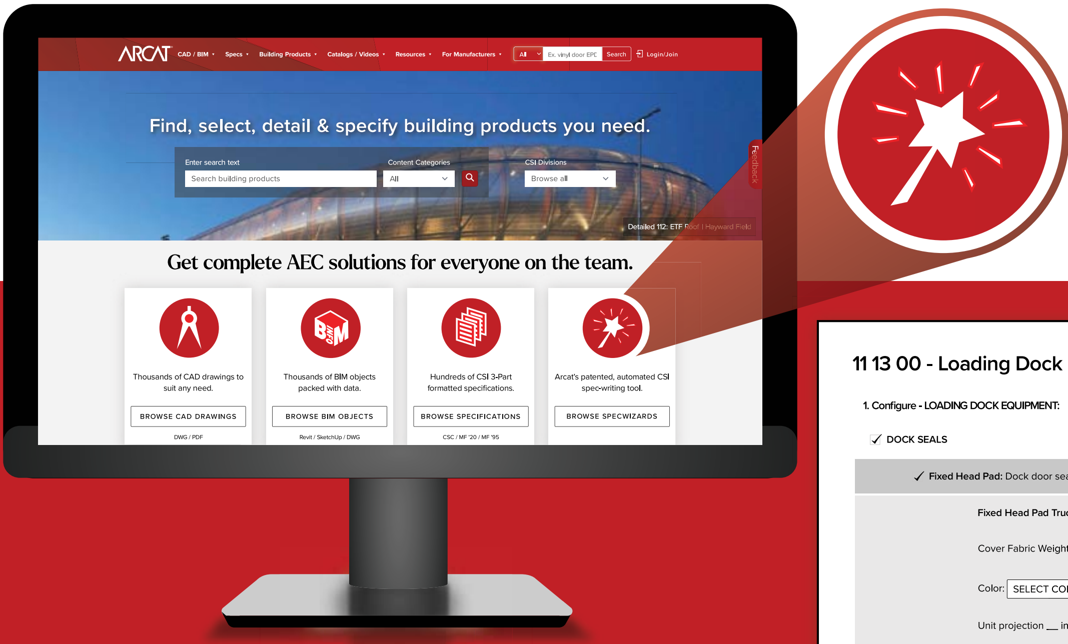

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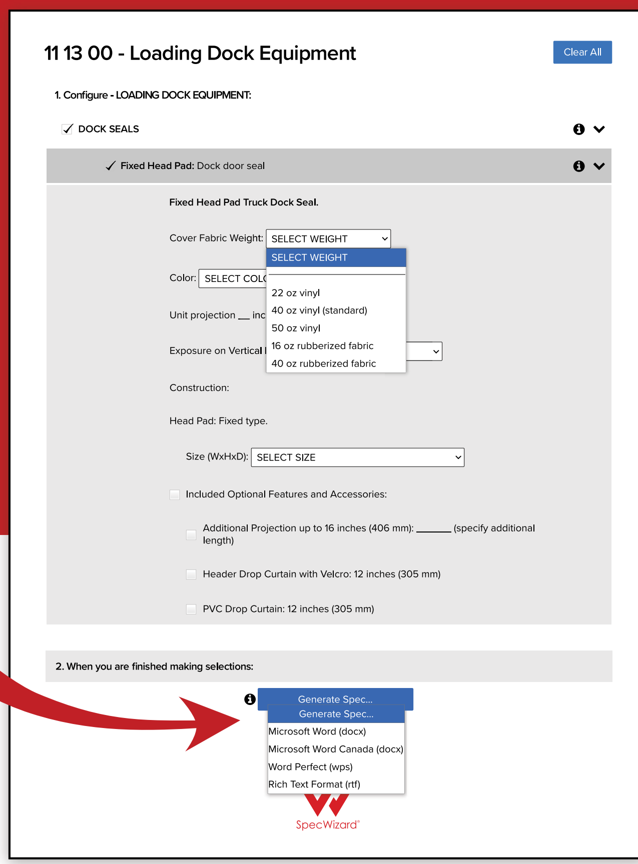

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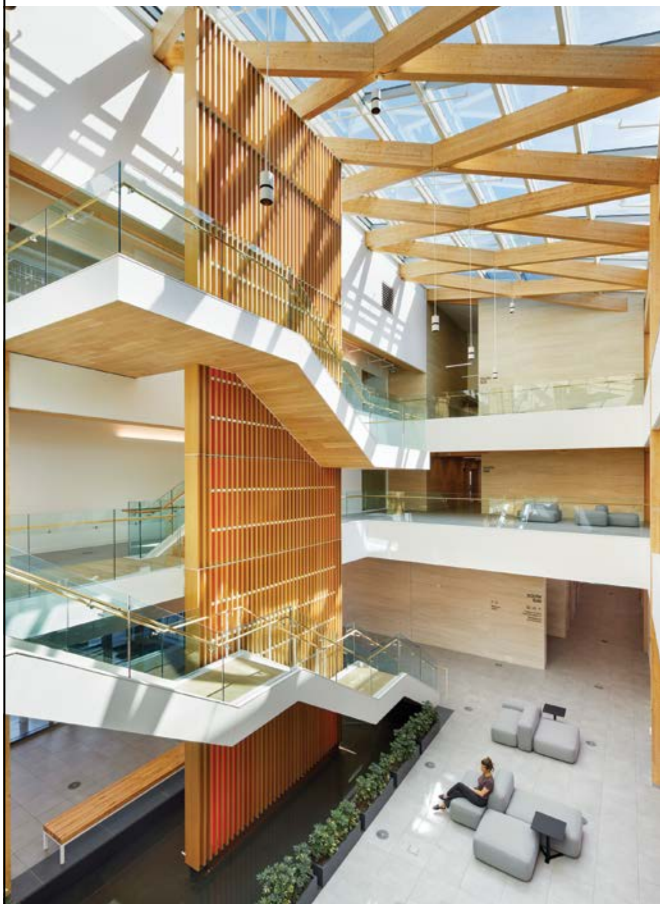

Designed by Moriyama Teshima Architects, the Ontario Secondary School Teachers' Federation (OSSTF/FEESO) Headquarters and Multi-Tenant Complex highlights the beauty and sustainability of mass timber. Exposed glulam beams and cross-laminated timber (CLT) panels define the interior, creating a warm, contemporary environment that reflects a commitment to low-carbon, high-performance design.

PHOTO BY TOM ARBAN/COURTESY V2COM

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Airtightness Testing in Large & Multi-zone Buildings

By Mohammad Fakoor, Parvin Asadi, Danielle Arciaga

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Air leakage in buildings, often referred to as "air infiltration/exfiltration" or "uncontrolled air flow," is the unintentional movement of air in and out of a building through gaps, cracks, holes, and other openings in the building envelope.[1] It is predominantly driven by pressure via wind, stack effect, and induced pressure by building ventilation systems.[2] Air leakage is a significant concern in the construction industry since it can considerably increase building energy consumption and result in moisture damage in assemblies as a result of interstitial condensation, comfort issues from local drafts, and poor indoor air quality (IAQ) due to introducing pollutants and allergens from the outside.[3]

Measuring building air leakage at normal (operating) conditions is extremely difficult and time-consuming due to the variability of in-situ conditions.[4–6] As a result, air leakage of the building enclosure is typically tested at an artificially elevated pressure difference between the test space and ambient pressure to negate the "noise" of the stack effect, wind, and humidity pressures, where the results are extrapolated to determine the air leakage at operating conditions.[7] The initial assessments of building airtightness using pressurization

methods involved the use of various prototypes of pressurization equipment, primarily driven by the need to address heat loss issues.[8–12] The practice of employing fan-based pressurization or depressurization techniques for whole-house air leakage testing gained popularity in the 1980s, initially in Sweden as a window-mounted fan[13–15] and the United States.[16–18]

Following the oil crisis of 1973, many countries developed policies aimed at reducing energy consumption in their national building stock.[19] The first airtightness testing standards for North America were ASTM E779-81, *Standard Test Method for Determining Air Leakage Rate by Fan*

FIGURE 1

Examples of sealing louvers and mechanical vents for airtightness testing.

Photos courtesy Ventana Construction Corporation

Pressurization, and the Canadian standard, CAN/CGSB-149-GP-10M, *Determination of airtightness of buildings by the fan pressurization method*.[20–22] These standards included requirements regarding flow rate, wind speed, pressure measurements, and overall uncertainty of the test.

Airtightness testing for small and single-zone buildings, such as single-family homes, is well understood, and many practitioners across the world can perform the test in accordance with the applicable standards. There is a large database of airtightness for houses; a recent review on airtightness testing outlines a few resources such as Walker's residential diagnostics database (ResDB) including 75,000 entries in 2013, the ATTMA database in the UK including 192,731 records in 2017, and national database in France containing measurements of approximately 219,000 tests in 2019.[20,23–25] The test for small single-zone buildings can be conducted by a single fan. For dwelling units that share a wall with another unit (*e.g.* row houses), the air flow through the partition wall can be cancelled out by simultaneously running the fan for the test space and the fans for adjacent suites (*i.e.* guarded test) to keep all zones at the same pressure.[26] Nonetheless, the tests for small buildings are straightforward, and minimal building preparation is required.

Contrary to single-family homes, there is no large database available for the airtightness of large buildings. Previous research frequently

TABLE 1

Building number	Air barrier strategy	New construction or existing building	Archetype	Volume (m^3)	Enclosure area (m^2)	Number of storeys	Building height (m)	Flow (L/s @ 75Pa)	Air leakage coefficient, C (L/s/Pa^n) depressurization	Air leakage coefficient, C (L/s/Pa^n) Pressurization	Flow exponent, n depressurization	Flow exponent, n pressurization
1	SAM	New	Hotel	1,844	980	4	13	1,034	24.2	80.7	0.833	0.622
2	ISM	New	Mixed-use	13,112	4,931	6	20	10,455	553	642	0.625	0.691
3	TWRB	New	Residential	369	200	5	5.5	260	23.3	-	0.558	-
4	ISM	New	Residential	2,523	1,222	3	10.9	2,531	150	194	0.621	0.628
5	ISM	New	Residential	2,441	1,249	3	10.9	2,030	146	168	0.633	0.607
6	ISM	New	Residential	3,744	1,761	2	7.6	2,737	171	339	0.651	0.526
7	WW	New	Residential	29,919	7,733	13	37.2	9,076	669	1580	0.57	0.534
8	WW	New	Residential	29,920	7,733	14	37	7,772	439	984	0.662	0.532
9	WW	New	Residential	30,070	7,508	15	47.9	10,220	547	1020	0.651	0.556
10	SAM	New	Residential	12,833	4,223	4	12.4	2,327	137	144	0.629	0.667
11	SAM	New	Mixed-use	17,511	7,433	4	15.8	5,310	353	314	0.632	0.65
12	SAM	New	Residential	13,404	4,585	6	19.5	4,701	613	444	0.518	0.605
13	SAM	New	Institutional	26,149	7,740	4	19	7,983	723	819	0.537	0.545
14	SAM	Existing	Institutional	14,729	5,348	6	24.7	6,231	243	559	0.747	0.562
15	SAM	Existing	Institutional	21,998	7,339	3	16.5	4,321	369	-	0.57	-
16	ISM	Existing	Office	104,570	17,161	21	93	17,160	1070	-	0.642	-
17	ISM	Existing	Community centre	16,476	5,585	2	8.5	10,335	910	1090	0.557	0.526
18	ISM	New	Mixed-use	24,123	7,887	6	24.3	14,745	1400	1080	0.524	0.624
19	SAM	New	Community centre	8,266	3,653	1	9.6	1,030	40.7	43.1	0.714	0.764
20	ISM	Existing	Office	9,137	2,440	2	6.2	11,070	828	668	0.594	0.656
21	SAM	New	Residential	15,240	5,035	5	20	2,578	156	140	0.634	0.687
22	ISM	Existing	Courthouse	41,244	10,584	5	27.7	19,410	1470	1660	0.581	0.584
23	ISM	Existing	Office	2,191	1,293	2	7	3,550	229	224	0.629	0.629
24	SAM	New	Residential	44,238	11,113	6	21	5,427	566	334	0.568	0.591
25	ISM	Existing	Courthouse	7,700	2,740	3	17	9,086	615	558	0.623	0.647
26	ISM	Existing	Office	5,880	2,670	2	8	11,920	973	827	0.581	0.617
27	TWRB	New	Office	3,607	2,093	1	5.2	940	55.3	38.8	0.609	0.777
28	TWRB	New	Office	7,650	2,940	1	7.6	1,933	77.8713	117.043	0.744	0.649
29	SAM	New	Mixed-use	5,169	2,328	3	11.5	1,868	115	90.8	0.636	0.709

Test building data and air leakage parameters. Air barrier strategy acronyms: window wall (WW), interior sealed membrane (ISM), taped weather resistive barrier (TWRB), and self-adhered membrane (SAM).

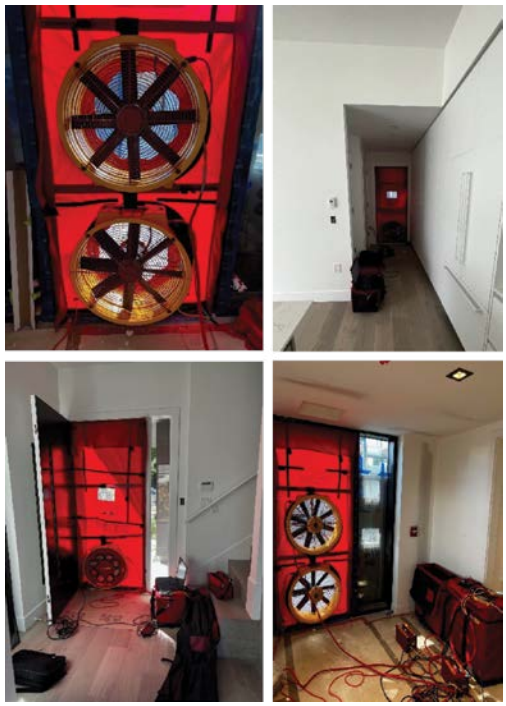
highlights the limited availability of measured data for the leakage rates of large buildings. A review study on airtightness of apartment and commercial buildings states that "the available database is extremely deficient";[27] in addition, the literature review conducted states that "the literature on air flow and air leakage measurements in high-rise multifamily buildings is quite limited."[28] Due to the scarcity of available data, a research project (ASHRAE 1478) was performed to measure enclosure airtightness of 16 non-residential mid- and high-rise buildings in the United States.[29] Another study conducted a comprehensive literature review and gathered large building airtightness data for 566 buildings, of which only 16 per cent of buildings (~90 buildings) are located in Canada.[30]

The primary reason for the limited data available for large buildings is attributed to the greater complexity of the testing process, the absence of regulations, and the need for large-scale equipment. Typically, taller buildings are exposed to higher wind speeds combined with a much larger stack effect. Such large bias pressures make it difficult to collect reliable data for mid- and high-rise buildings. In addition, there will often be several days of preparatory work to seal intentional openings. Also, the size of some buildings requires many fans to be set up with a complex arrangement of data cables and pressure tubes.[31]

To address the knowledge gaps in literature, the main objectives of this study are as follows:

- Provide additional performance data for large buildings airtightness to address scarcity of available measurements
- Compare the measured values with the existing literature to establish a benchmark for large building airtightness in British Columbia

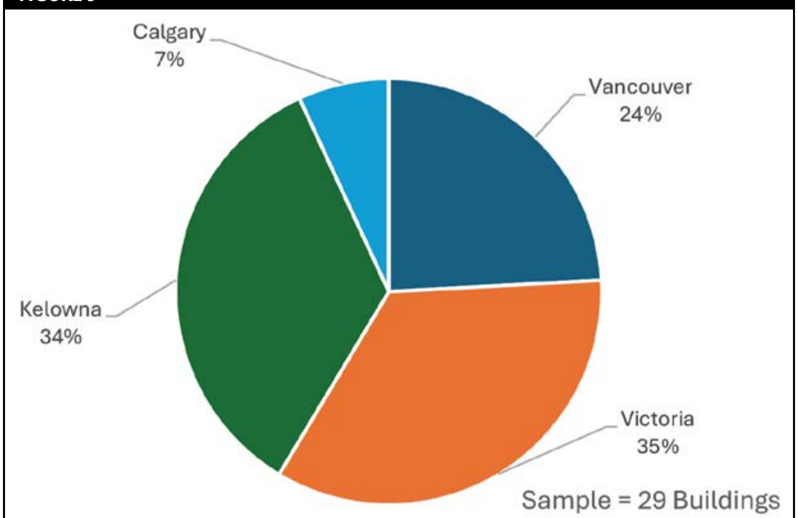
FIGURE 2



Example of a whole building airtightness test with six fans.

PHOTOS COURTESY RJC ENGINEERS

FIGURE 3



Geographical distribution of tested buildings.

- Evaluate the impacts of different air barrier strategies on large buildings airtightness

In this study, the results of airtightness testing for 29 buildings are presented (20 new construction and nine existing buildings). The data was obtained over a span of four years, encompassing more than 500,000 m^3 (17.7 million cf) of volume and 145,000 m^2 (1.5 million sf) of floor area for buildings ranging from one to 21 storeys. The tests were carried out in accordance with ASTM E779-19, and the impacts of building archetype, air barrier system, height, and enclosure area on the airtightness are investigated.

Methodology

The following sections outline the methodology used in this study to obtain the airtightness data.

2.1 Test buildings

The data used for the study are test results from 29 buildings collected over four years, comprising 20 new constructions and nine existing buildings. These buildings can be categorized into the following archetypes: residential, office, institutional, mixed-use, community centre, courthouse, and hotel. Air barrier strategies used for buildings are window wall (WW), interior sealed membrane (ISM), taped weather resistive barrier (TWRB) and self-adhered membrane (SAM). The building volume ranges from 369 to 104,570 m^3 (13,030 to 3.7 million cf) with the average volume being 17,795 m^3 (628,200 cf). Similarly, the enclosure area ranges from 200 to 17,161 m^2 (2,150 to 184,700 sf) with an average area of 5,089 m^2 (54,770 sf). An average of five storeys is seen in the data, with a minimum of one storey and a maximum of 21 storeys, and building heights ranging from about 5 to 93 m (16 to 305 ft). Table 1 (page 8) summarizes the test building data and the air leakage parameters.

2.2 Building preparation

The goal of the airtightness tests was to test the air barrier of the buildings. As a result, building preparation was required to be completed before conducting the airtightness test. All interior doors within the pressure boundary were left open to achieve a uniform pressure in every room throughout the building. All exterior doors not being used for the fan set-up were closed, locked if possible. Doors to areas excluded from the pressure boundary were sealed off. All exterior windows were closed and locked. Ventilation openings in the building envelope area were sealed through the use of poly barriers taped to the exterior louvers/openings. Figure 1 (page 7) shows building preparation for an institutional building (*i.e.* all intentional openings are sealed).

2.3 Test method

To create an induced pressure in the building enclosure, fans were used for the airtightness tests as they can uniformly pressurize/depressurize the space. Retrotec Model 6000 blower door fans were used for testing, and the number of fans required for each test was based on a calculation using the height of the building above ground, enclosure volume, building floor area, and enclosure area (floor, ceilings, and walls) of the building's pressure boundary. Those blower door fans were connected to Retrotec Model DM-32 fan control gauges, which were used to automatically control the test from a central location. The test calculated data in two conditions: pressurization and depressurization. Figure 2 illustrates the fan setup for a whole building airtightness test for a 15-storey residential building with six fans.

The fans were set up at exterior doors throughout the building enclosure between ambient conditions (outdoors) and the interior pressure boundary. This setup assists with achieving uniform induced pressure across the pressure boundary as required by ASTM E779. Before pressurizing or depressurizing the space, pressure sensor tubes measure the baseline bias (zero flow) pressure. Additionally, pressure sensor tubes were placed within the interior pressure boundary, and the pressure of the building interior was measured and averaged by the Retrotec software (Fantestic Pro). In accordance with ASTM E779-19, the software also calculates the pressure difference between each interior reference location and the average interior pressure, ensuring there is no more than 10 per cent difference to confirm the interior pressure is uniform throughout the building. The tests were done in conformance with ASTM E779-19 with the following modifications: i) tests were conducted for both pressurization and depressurization, ii) the test pressure range was from 25 to 80Pa (0.52 to 1.67 psf), and iii) intentional openings in the enclosure were sealed during the test.

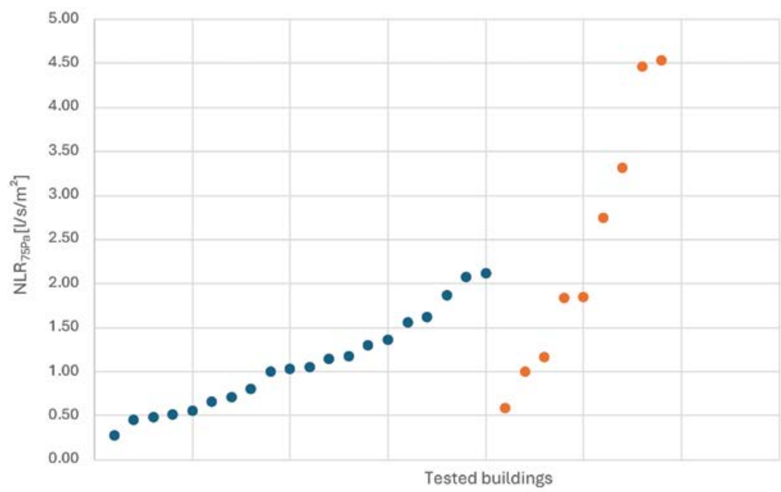
2.4 Data analysis

The power law equation in Equation (1), was used to calculate the airflow through the building enclosure where Q is the volumetric airflow rate (m^3/s), ΔP is the pressure difference between the ambient conditions and the interior pressure boundary (Pa), C is the air leakage coefficient ($m^3/s/Pa^n$), and n is the pressure exponent (dimensionless).[2]

$$Q=C(\Delta P)^n$$

Equation (1) is used to calculate the airflow rate (Q) between the ambient conditions and

FIGURE 4



Airtightness data sorted from minimum to maximum (NLR 75Pa [l/s/m²]).

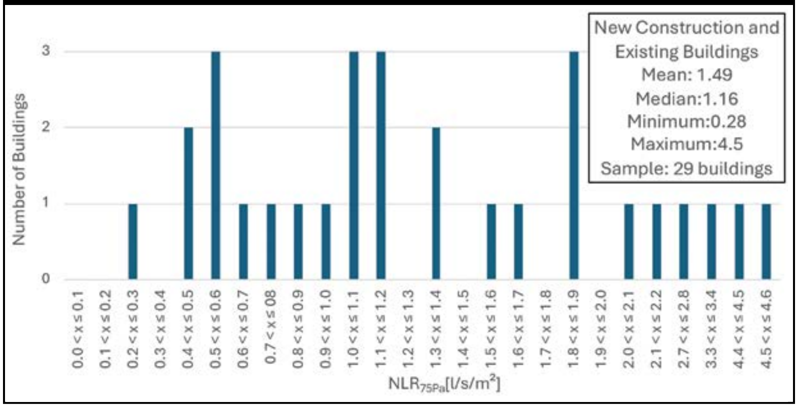
FIGURE 5

Flow exponents sorted from minimum to maximum.

the interior pressure boundary. The values for pressure exponent (n) range between 0.5 and 1.0 to conform with the power law equation and to reflect whether the flow is completely turbulent or laminar, respectively.[20] To get the values of the air leakage coefficient (C) and pressure exponent (n), unweighted, log-linearized, linear regression analyses were calculated at various pressure differences. Q was then extrapolated at the reference pressure difference.[2,20]

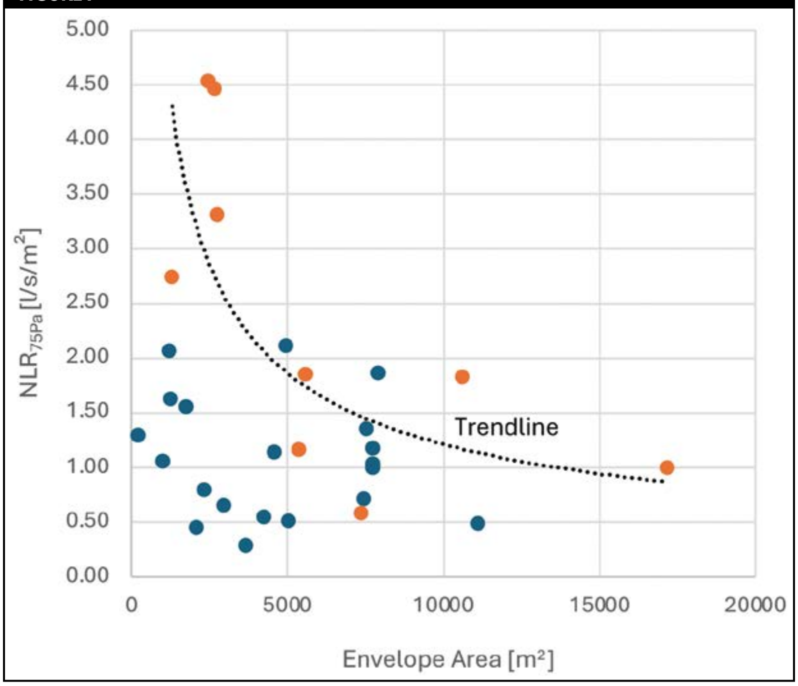
The metric that is typically used to report the air leakage of large buildings is normalized leakage rate (NLR_{75}). Test results for different projects can be compared with NLR_{75} as it normalizes the air leakage over the envelope area at 75Pa (1.57 psf). The equation for NLR_{75} is seen in Equation (2), where Q is the volumetric airflow rate at 75Pa (1.57 psf) (m^3/s), andA is the area where the pressure difference is observed, *e.g.* enclosure area (m^2).[32] The values of NLR

FIGURE 6



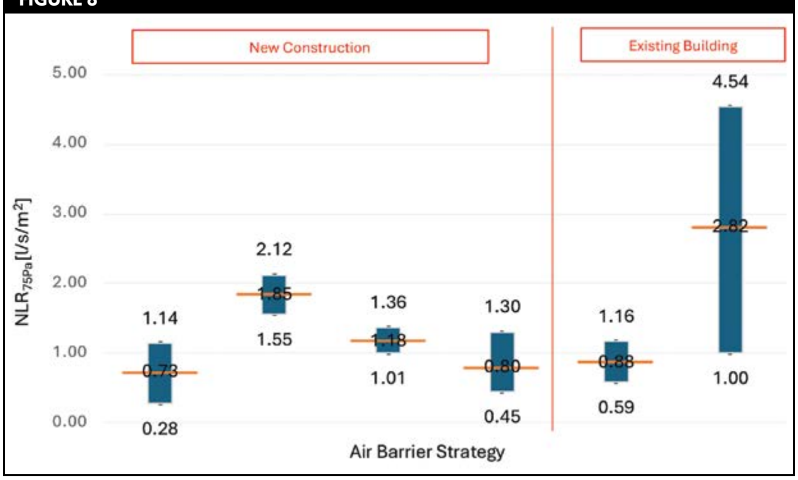
Distribution of airtightness data.

FIGURE 7



Airtightness versus envelope area for the tested buildings.

FIGURE 8



Distribution of airtightness data.

are typically reported in (l/s/m²), and the same convention has been used in this study.

$$NLR_{75Pa} = \frac{Q_{75Pa}}{A} \times 1000$$

Another metric that is typically used to report the air leakage rate is Equivalent Leakage Area at 10 Pa (0.21 psf) ($EqLA_{10Pa}$), and it can be calculated as follows:

$$EqLA_{10Pa} = \frac{Q_{10Pa}}{0.61} \sqrt{\frac{\rho}{2\Delta P}}$$

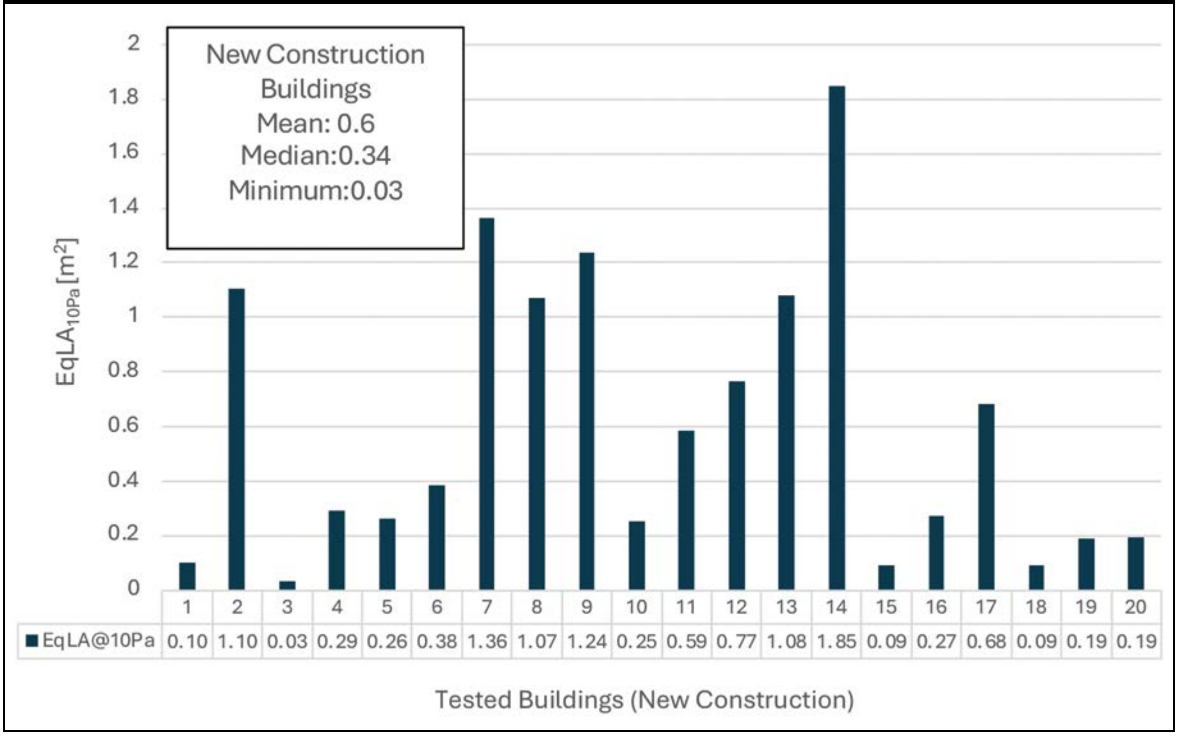
Where [m³/s] is the air flow at 10Pa, (kg/m³) is air density, and is 10 Pa (0.21 psf).

Results

This section presents the results of the conducted airtightness tests. As seen in Figure 3 (page 10), the tested buildings are primarily located in British Columbia, and two buildings are in Calgary, Alberta. It should be noted that at the time of writing this paper, there is no airtightness requirement in Alberta; however, performing a whole-building airtightness test is mandatory in BC under the *BC Energy Step Code*.

Figure 4 depicts the NLR_{75Pa} for the tested buildings, where the average NLR_{75Pa} is 1.09 (l/s/m²) for new construction and 2.39 (l/s/m²) for existing buildings, respectively. The data for new construction ranges between 0.28 and 2.12 (l/s/m²) while it varies from 0.58 to 4.53 (l/s/m²) for existing buildings. Given that a majority of the new construction buildings were under the *BC Energy Step Code*, they had a maximum NLR_{75Pa} requirement of 2 (l/s/m²), which was satisfied for most of the tests. As expected, existing buildings are generally less airtight than new construction, with the exception of existing buildings that were a full recladding retrofit project, resulting in less than 1.2 (l/s/m²). The data obtained in this study for "average" normalized leakage rate of existing buildings is fairly close to what is reported in reference 30 for post-2000 construction, *i.e.* 2.39 versus 2.12 (l/s/m²). However, the average NLR_{75Pa} for new construction is approximately 50 per cent better, *i.e.* 1.09 (l/s/m²). Considering the data presented in Figure 3 (page 10), it is evident the current New Construction Code Requirement of 2 (l/s/m²) in the *Vancouver Building Bylaw* (*VBBL*) seems fairly achievable; it appears this target should be reduced to observe a continuous improvement in the airtightness of the built environment. With respect to the data obtained for existing buildings,

FIGURE 9



Equivalent Leakage Area (EqLA) at 10 Pa (0.21 psf) for the new construction dataset.

it can be concluded that the projects with full recladding scope have the potential to significantly improve the airtightness of the buildings, given that a new continuous exterior air barrier can be installed for the building.

As discussed earlier, C (air leakage coefficient) and n (pressure exponent) are two factors that describe the physics of fluid flow, where n=1 represents a fully laminar flow and n=0.5 represents a turbulent flow through a sharp edge orifice.[20] Since flow through air leakage paths of the air barrier is a combination of laminar and turbulent flow, the values of n are always between 0.5 and 1 for the actual airtightness test. In the absence of multi-point testing to precisely determine the pressure exponent (n) value for a specific building, the industry has conventionally relied on assuming a value of 0.60 or 0.65. To evaluate the suitability of these assumptions, an analysis of the measured pressure exponents for the tested buildings within the database was conducted and is depicted in Figure 5 (page 11). The calculated average of the pressure exponents was determined to be 0.61-0.62, aligning closely with the frequently adopted values of 0.6 and 0.65. A value of 0.63 is reported in reference 33, and it is pointed out that using a value of 0.6 is gaining wider industry acceptance, which aligns well with the findings of this study.

Figure 6 (page 12) shows the distribution of airtightness data. As seen in Figure 6, the airtightness of the majority of buildings falls below 1.9 (l/s/m^2) with only six buildings (~20 per cent of the data) having NLR_{75Pa} higher than 2 (l/s/m^2). As mentioned before, most of the existing buildings in the dataset manifested high air leakage, except the ones that underwent a full envelope retrofit.

The analysis of the airtightness data was extended to examine its correlation with the building envelope area as illustrated in Figure 7 (page 12). Based on this analysis, the airtightness of buildings increases with the building envelope area. However, one may argue that because buildings with larger enclosure surface area are generally taller, a more robust air barrier system had to be used to withstand higher wind and stack pressures.

Figure 8 (page 12) further investigates the impacts of the air barrier strategy on the airtightness of the tested buildings. Four main air barrier strategies that had been used in the tested buildings were: interior sealed membrane (ISM), exterior self-adhered membrane (SAM), taped weather resistive barrier (TWRB), and window wall system (WW). It is evident from Figure 7 (page 12) that buildings with SAM and TWRB demonstrate better airtightness levels compared to other buildings in the dataset. In addition, the high-performance characteristics of SAM have been confirmed for both new construction and existing buildings in the dataset. A wide range of performance was determined for the ISM approach compared to other strategies, making the results prone to the quality of installation, detailing, and workmanship. In general, the values obtained for SAM and TWRB were almost an order of magnitude lower than other data.

Figure 9 shows the EqLA @10Pa (0.21 psf) in m^2 for the tested new construction projects. EqLA is a metric used to represent the size of a hypothetical sharp-edged orifice that would allow the same amount of air flow at a specific pressure (in this case, 10 Pa [0.21 psf]) as the cumulative air leakage through all the actual leakage paths in a building enclosure. It helps in comparing the air leakage characteristics of different buildings or assessing the effectiveness of air sealing measures. The 10 Pa (0.21 psf) reference pressure is commonly used in building performance testing to simulate real-world conditions. As seen in Figure 9, the EqLA for the tested buildings ranges from 0.03 to 1.8 m^2 (0.32 to 19.38 sf). The average EqLA was determined to be 0.6 m^2 (0.65 sf) with a median value of 0.34 m^2 (3.6 sf).

Conclusion

This paper represents the data gathered for whole building airtightness testing of 29 large and multi-zone buildings. This study was conducted over a span of four years, and the main goal of the tests was to address the scarcity of available airtightness data for large buildings. The following conclusions can be drawn from this study:

- Existing buildings which had undergone a major envelope retrofit manifested an exceptional airtightness level compared to other existing buildings in the dataset.
- New construction projects generally demonstrate a better airtightness level compared to existing buildings.
- An average of 1.09 [$l/s/m^2$] and 2.39 [$l/s/m^2$] was calculated for the airtightness levels of the tested new construction and existing buildings, respectively.
- An average value of 0.61–0.62 was determined for the pressure exponent value of pressure-flow equation, which aligns with existing literature.
- The airtightness of the tested buildings increases with building enclosure area; however, this might be related to better air barrier strategies used for larger buildings.
- The air barrier strategy has a significant impact on airtightness. Exterior SAM and TWRB demonstrate order of magnitude improvements over other methods.

This study provides a platform to establish a new benchmark for airtightness targets of new construction buildings. The current airtightness level of 2 ($l/s/m^2$) @75Pa (1.57 psf), which is addressed in the *VBBL* and other resources,[34] seems fairly achievable. It should be reduced to observe a continuous improvement in the airtightness of the built environment.

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From Niche to Nece

Fabric Structures Go Mainstream

By Eric Donnay

PHOTOS COURTESY
LEGACY BUILDING SOLUTIONS

There was a time when the mention of fabric as a cladding solution would have been limited to niche applications. Suggesting fabric for conventional building use would have probably been met with confused looks or raised eyebrows. Today, however, that outlook has greatly changed.

When examining the construction options for sports and recreation centers, municipal buildings, and various industrial facilities, modern tension fabric buildings are frequently mentioned. In fact, for certain applications, their cost-effectiveness and speed of installation make them the only viable choice.

This did not simply happen overnight. It required significant changes to the way fabric structures were designed and to the materials used to build them. Massive steps have been taken over the past 15 years to enhance the engineering behind fabric buildings, but it has not stopped there. The industry remains committed to continuous improvement, with some companies maintaining International

Organization for Standardization (ISO) and Canadian Standards Association (CSA) A660 certifications as they strive to ensure the best possible product for end users.

Proper securing of fabric

Any fabric building constructed two decades ago or longer almost certainly featured web-truss framing. Some of these structures also had a mono-cover, which used a single piece of fabric loosely draped over the frame and attached only at the ends and sides of the building.

A panel attachment system, which involves sliding 6-m (20-ft) wide fabric panels through an aluminum keder channel to connect to each framing member of the structure, was more commonly employed than a mono-cover. The challenge with this method was finding the best way to attach the aluminum extrusion channel to the frame.

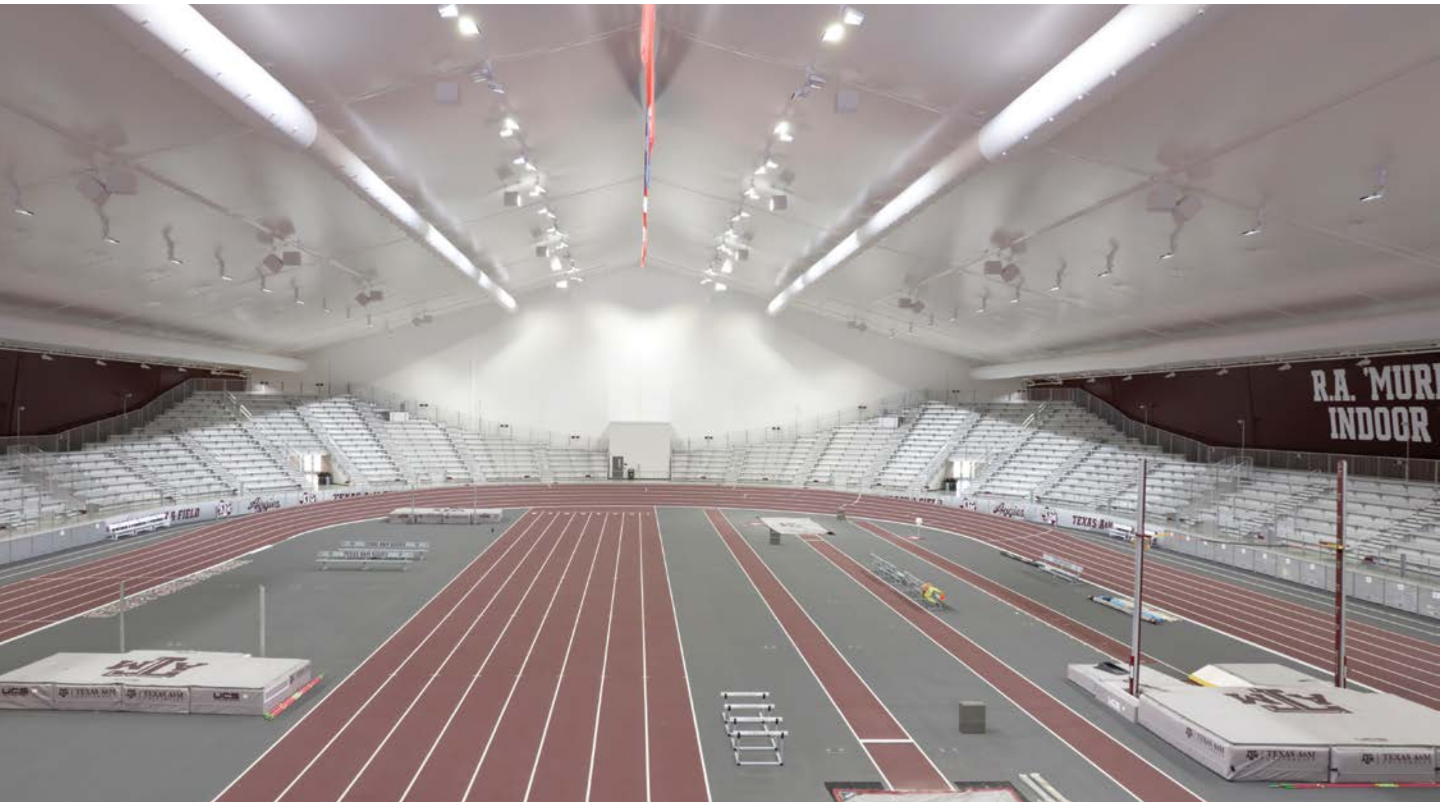
Many installers use tek screws, but those are sometimes over-torqued during installation, causing sheared heads or stripped-out threads. Further, motion-type pressure can cause fatigue at the extrusion's pressure point. Water can also settle into the holes around the screws, leading to corrosion.

A bigger problem than the screws themselves is that this process often requires secondary bracing to be disconnected while trusses are literally pulled out of plane to apply horizontal tension to the fabric during installation. Flexing the building frame after it has been erected could weaken the structure and reduce its load-bearing capacity.

Properly attaching fabric to the structure was not the only issue on the table. Web truss design, in general, has long frustrated architects and customers who felt there is too much subjectivity in the engineering from one fabric building company to the next. With multiple problems begging to be solved, some leading manufacturers ultimately made the decision to use solid I-beams instead of web truss framing. With structural-steel framing universally recognized within the engineering community, the change instantly advanced the credibility of tension fabric buildings.

Going hand in hand with the shift to rigid I-beams, a patented fabric attachment system was developed that uses stronger 13 mm (0.5 in.) diameter bolts to clamp a keder rail to the top flange of the structural steel frame. The key advantages of this method, as opposed to using screws, is it enhances corrosion resistance by eliminating any areas where water could accumulate, and it makes the attachment much more secure.

The real game-changer for this system, however, is that the frame can remain permanently in place during panel installation. There is no need to twist the frame or remove bracing, which helps ensure that fabric panels are pulled into place



Cladded with high-quality polyvinyl chloride (PVC), rigid-frame fabric structures allow for long, clear-span designs without the need for support beams.

with properly calculated horizontal and vertical tensions. The process works so smoothly that a fabric structure can be clad in one-third the time it takes to screw down all the siding on a similarly designed metal-clad building.

Polyvinyl chloride (PVC) fabric for all

Historically, the type of fabric specified would depend on the building project. For many years, the most commonly used material across North America was polyethylene (PE), a fabric that is easy to work with but carries an average warranty of only 15 years. For higher-end fabric facilities looking for a roofing solution that would last much longer, users turned to PVC, a fabric that contains a heavier yarn and also usually comes with a higher price tag.

Another push for the industry came with the introduction of a new PVC to the market that was designed to provide exceptional strength while remaining cost-competitive with PE. The end goal was to bring greater longevity to tension fabric buildings across all industries, giving every user the option to have a premium roofing material without breaking the bank.

While the price may be in the same ballpark, a closer look at this advanced PVC shows why it is so much more durable than a standard PE fabric. With PE, there is a scrim layer where the fabric weave is, which is then sealed in by sandwiching it between two layers of polyethylene.

The newer PVC option has seven layers instead of three. In the middle is a high-strength woven base fabric, with top and bottom primer layers applied to that. Next, topcoat layers are added to both sides—this is the actual PVC that gives the product its shape and flexibility. Lastly, to deliver a smooth, slippery, and durable finish, everything is sealed with lacquer layers on the top and bottom. Weathering tests have shown this PVC to possess twice the tensile strength of typical PE material.

Rigid-frame engineering

While the industry has greatly benefited from improved cladding offerings, it was the marriage of a fabric membrane with rigid-frame engineering that truly opened a world of possibilities for tension fabric buildings.

In the heyday of web-truss "hoop" structures, buying a building was like ordering off a menu. Customers had to pick from the limited standard structure sizes made available by a given manufacturer. In cases where customizations were requested, the cost would go up significantly. This is a major reason why fabric structures were historically confined to niche uses, where often the only priority was meeting the bare minimum requirements.

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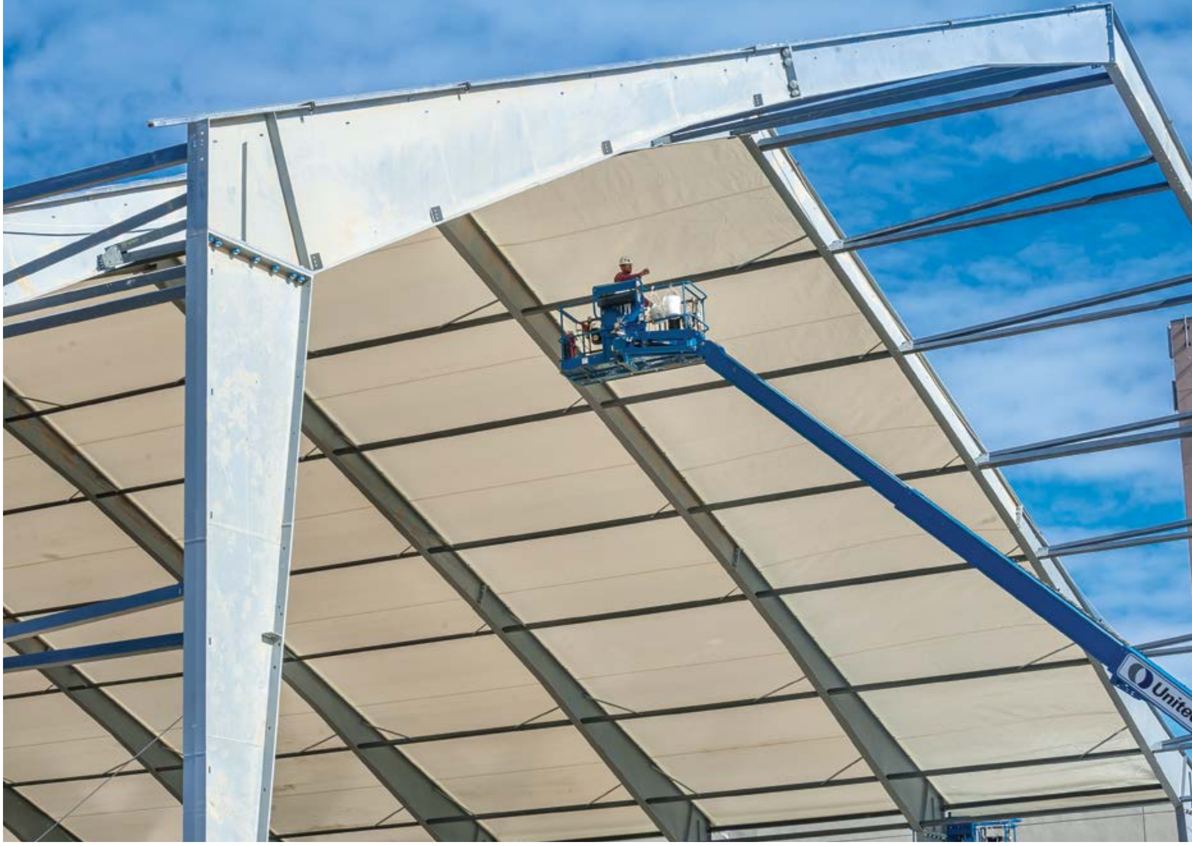

A patented fabric attachment system allows the I-beam frame to remain in place during installation, helping ensure fabric panels have the proper horizontal and vertical tensions.

To provide more permanent corrosion protection than hot-dip galvanizing, building manufacturers can apply an epoxy coating to the I-beams and other steel framing members.

With the shift to rigid-frame, I-beam engineering, manufacturers were now able to start every building design with a clean sheet. Every project could be fully optimized to the individual user's specifications without adding a single extra step to the process.

Engineered steel I-beams also deliver superior structural strength compared to web truss, which further expands the abilities of fabric structures. For example, if a building user wanted to install a conveyor, fire suppression system, or any other hanging load on the building frame, those items could be accounted for while using finite element analysis (FEA) software to create the initial design. Engineers can optimize each framing member based precisely on the anticipated loads, rather than over-engineering an entire building.

A strong structural frame also allows for long clear-span designs without the need for support beams. Fabric buildings are extremely popular for athletic facilities, providing wide open floor space for numerous sports. The advantages also go beyond simply having enough room. Scoreboards and lighting can be easily mounted on the building frame. Mezzanines and spectator seating can be accommodated.

Not to be overlooked is that the I-beam design also gives the building a conventional look, which is not an insignificant factor when trying to make inroads with clients who are only familiar with traditional construction.

Interior liners can be added to any rigid-frame fabric structure as well. In some instances, the project owner may desire insulation for their building application, where at other times the insulation may be required to meet energy codes. Comprised of the same PVC used to clad the exterior, a liner serves both to seal off insulation and to provide a soft interior ambience within the facility.

Brick facades and other architectural elements can be applied to the exterior to further enhance the building's esthetics. Functional items like ice breakers and gutters can also easily be added to assist with snow and water mitigation.

Corrosion resistance

For applications where corrosive elements or high moisture content are potential threats to the longevity of a building, fabric's natural resistance to corrosion has always made it a preferred cladding option. Historically, however, even tension fabric buildings have been vulnerable in such environments, since the framing structure is still made of metal.

The truss frames used in older style fabric structures were actually hollow tubes, meaning corrosion could originate inside the tube, unseen, and rust the frame from the inside out. With solid I-beams replacing hollow tubes, one major weak point was addressed, but more work was left to be done to protect the steel surface.

Fabric building manufacturers primarily turned to hot-dip galvanizing to safeguard structural I-beams against corrosion. Galvanizing adds a thin 3.9-mil layer of zinc around the steel by immersing the entire steel beam into a molten zinc bath. That layer is essentially sacrificed over time, with corrosion eating away the zinc before it can reach the steel. In effect, galvanizing just slows the corrosion process, so the protection will degrade over time.

To provide more permanent protection, manufacturers considered the use of epoxy coating to create a true barrier between corrosive elements and the steel framing members. Epoxy had been frequently considered cost-prohibitive due to the outsourcing involved in producing and shipping the coated steel. To bring down the cost of offering epoxy-painted I-beams, leading suppliers have added in-house steel beam fabrication and painting to their services.

The epoxy treatment process begins by sandblasting the I-beam to create a consistent blast profile on every inch of steel. For the highest level of protection, the steel gets a commercial blast to remove any impurities or defects. After blasting, a 3-mil layer of zinc is applied with a paint method rather than dipping. This first layer offers protection similar to the final product with hot-dip galvanizing. Two separate 5-mil coats of epoxy are then layered over the zinc paint. The result is a 13-mil barrier that prevents corrosive elements from contacting the steel.

I-beam engineering gives fabric structures a conventional building look, unlike the curved shape of web-truss buildings.

To determine the level of corrosion protection provided by epoxy coating compared to hot-dip galvanizing, manufacturers have put these methods through stringent 2,000-hour salt fog tests. In one such test, a hot-dip galvanized steel beam and an epoxy-coated steel beam were placed in the same controlled environment. The galvanized steel came out fully corroded. The epoxy-coated steel was clear of corrosion, outside of a thin line that was intentionally etched beforehand; even in that purposely damaged area, the corrosion did not penetrate below the epoxy coating.

Firmly in the mainstream

Advances in engineering, material selection and construction techniques have transformed fabric structures from a niche commodity to a mainstream building solution. From implementing rigid-frame design to innovating better methods for attaching fabric panels, manufacturers have redefined what tension fabric buildings can achieve, offering the engineering flexibility and durability to meet modern construction demands.

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Beyond RSI-value

Canada's Carbon Shift in Construction

By Rockford Boyer

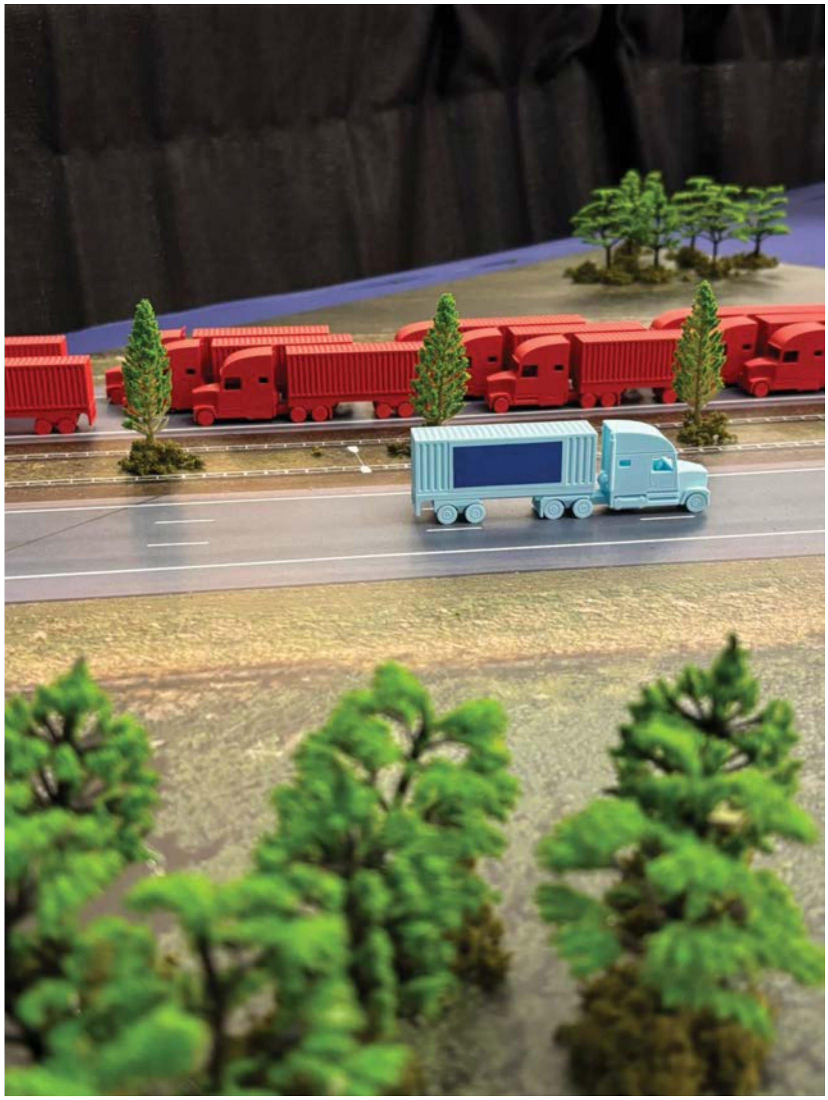
IMAGE CREATED USING OPENAI'S DALL·E/CHATGPT

This year, the author attended two national conferences focusing on resource reduction and sustainable building practices. The first was the 2025 Canadian Circular Economy Summit in Montreal and the second was the 2025 Passive House Canada Conference in Ottawa. Although the two conferences focused on two different topics, one focused on resource reduction, resource recycling, and resource recovery, and the other focused on sustainable building practices to reduce material use, and energy consumption—the underlying theme of these conferences was the reduction of carbon and minimizing the impact of climate change due to excessive material and energy use. Discussions on carbon have been circulating around certain circles in the industry; however, carbon and its impact on buildings and the environment will be at the forefront for years to come. There has also been some interest from the Canadian Board for Harmonized Construction Codes (CBHCC) who emailed looking for input on embodied greenhouse gas emissions in the National Model Codes.

CO2 and its impact

More recently, in St. John's, at the Construction Specifications Canada (CSC) 2025 National Conference, there was a discussion on carbon and its impact on the construction industry. The question posed to the architects and specifiers was, "Do you see designers and specifiers using embodied carbon as a medium for choosing building materials?" The answer was an enthusiastic yes. There are efforts to currently integrate low-carbon material solutions into designs and specifications. It is great to see the industry innovating and incorporating climate change reduction practices prior to it becoming the norm. To help with the progression of low-carbon solutions in the built environment, this article will discuss what carbon is and how building materials, more specifically thermal insulating materials, impact climate change.

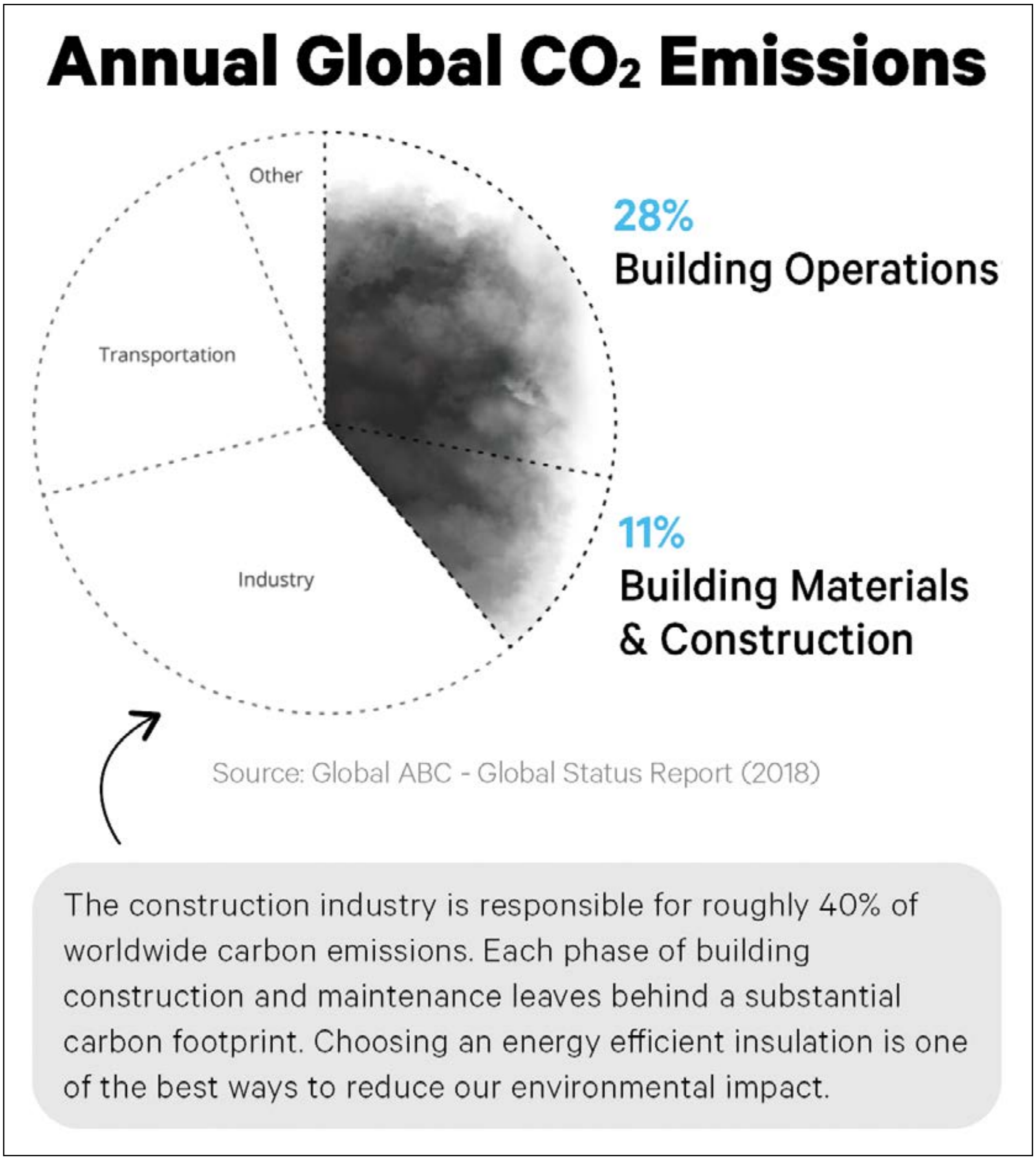
Fifteen years ago, when the word "carbon" was heard in Canada, everyone associated the word carbon with "stick." For example, if the Toronto Maple Leafs did not use those carbon fibre sticks that break all the time, they would win the Stanley Cup (here's hoping this will happen soon). Fast forward to now, when the word carbon serves as a reminder that the reduction of carbon is needed to reduce the impacts of climate change and severe weather events. Canada's global carbon impact is only 1.6 per cent, however, reducing net carbon impact is key. More importantly, Canada must be seen as a global leader in low-carbon built and operational buildings.



Transportation-related carbon emissioEPns vary considerably depending on the insulation material. Due to its high yield and volume efficiency, spray polyurethane foam can supply sufficient insulation for a 7,154-m^2 (77,000-sf) commercial building using a single truckload.

PHOTOS AND ILLUSTRATIONS COURTESY ELASTOCHEM

When the term "carbon" is used, it is generally referring to "carbon dioxide" or its chemical formula name CO2. Carbon dioxide is an odourless gas typically created from the burning of fossil fuels and is the primary cause of climate change. It impacts climate change by absorbing



The construction industry accounts for approximately 40 per cent of the total global CO2 emissions on an annual basis. The impact can be separated into two distinct carbon contribution paths, the first being from the building materials/construction and the second from the operation/maintenance of the building.

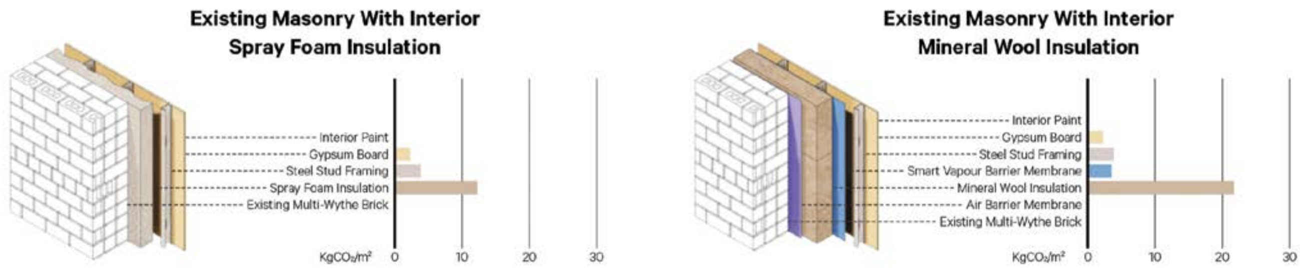
infrared radiation and holding the radiation for hundreds of years, essentially creating a blanket around the atmosphere and keeping the heat in (greenhouse effect). Almost 100 per cent of the carbon created by humans goes directly to the atmosphere, except for the one per cent that can be recovered. CO2 is needed for life on Earth, however, there must be a defined balance of absorption (plants) and creation (burning of fossil fuels). Canada has more than 318 billion trees within its borders, and each mature tree absorbs 25 kg (56 lb) of CO2 per year. Deforestation and forest fires can significantly decrease the amount of CO2 absorbed by the nation's forests; therefore, other precautions must be taken to reduce the CO2 creation, especially by the construction industry.

The construction industry accounts for approximately 40 per cent of the total global CO2 emissions on an annual basis. The impact can be separated into two distinct carbon contribution paths, the first being from the building materials/construction and the second from the operation/maintenance of the building.

Embodied carbon from the building materials and the construction practices accounts for approximately 11 per cent of the total emissions, whereas the operation of the building accounts for approximately 28 per cent of the total CO2 emissions. Industry, transportation, and other

FIGURE 1

Spray Foam vs Mineral Wool: What The Data Tells Us



Insulation Type	Spray Foam	Mineral Wool
Effective R-Value of Enclosure	R-24 $ft^2 \cdot °F \cdot h/BTU$	R-24 $ft^2 \cdot °F \cdot h/BTU$
Embodied Carbon per m^2 of Enclosure	19.2 kg CO_2/m^2	33.7 kg CO_2/m^2

This visual breakdown highlights the embodied carbon of two similar wall assemblies, one with closed-cell spray foam insulation and the other with mineral wool. The wall system with ccSPF uses 40% less embodied carbon compared to mineral wool.

Embodied Carbon Resource guide developed by RDH Building Science, Toronto Metropolitan University (TMU), and The Atmospheric Fund.

account for the remaining 61 per cent of the total global emissions. When narrowing down both the embodied carbon and operational carbon of buildings, thermal insulation has a significant impact on both paths of total annual carbon creation. Using low carbon thermal insulations and using these insulations effectively can significantly decrease the CO2 developed from inefficient building operation.

Thermal insulation and sprayfoam

The author has been in the insulation industry for 20 years (this is one-third of the time since the Toronto Maple Leafs won the Stanley Cup). In those 20 years, there have been major differences between the types of thermal insulations and how they are manufactured. There are two ways to manufacture traditional thermal insulation, the first method uses fossil fuels (*e.g.* natural gas, electricity, coke) to melt rock/sand/glass and spin them into fibres. The second method is to blend various raw materials with a blowing agent to create a foam-based insulation. These products can be either manufactured in a stationary manufacturing plant (board stock) or can be manufactured onsite by a certified professional (sprayfoam). Both types of thermal insulations provide value for the project; however, their embodied carbon and inherent product properties can dictate the enclosure performance and carbon impact.

Manufacturing thermal insulation as mentioned above can differ substantially, therefore reviewing a product Environmental Product Declaration (EPD) can assist in choosing a product that will have the least amount of site-specific environmental impact. Reviewing the thermal insulations performance qualities will also ensure any inefficiency or redundancy is avoided. A total enclosure carbon footprint should be calculated in its entirety instead of its individual components. An example of this is a closed-cell sprayfoam, which can be a thermal insulation, air barrier, moisture barrier, and vapour barrier; whereas fibrous insulation is typically a thermal insulation only and a secondary membrane is required to control the air, vapour, and moisture. Research and case studies have started to appear demonstrating the total carbon footprint of the overall wall enclosure and not just the embodied carbon of thermal insulation.

EPDs are valuable third-party verified tools which can assist in determining how much CO2 was created from the extraction, manufacturing, transportation, and disposal of the product in question. Results from the EPDs are derived from the data obtained by the life-cycle analysis (LCA) and can assist the designer or stakeholders in making informed decisions on the products used in their buildings. Typically, manufacturers have their specific EPDs for the products they manufacture; however, industry organizations such as Spray Polyurethane Foam Alliance (SPFA) or North America Insulation Manufacturers Association (NAIMA) have conducted industry-wide EPDs for their members. As previously stated, these EPDs are for thermal insulations only; looking at the total embodied carbon footprint of the enclosure is needed to understand the full dynamics of the calculation. These calculations will include the cladding, insulation, structural components, air/vapour/moisture barriers, minor structural components, finishes, etc.

Resources

A new design resource from RDH Building Science, Toronto Metropolitan University (TMU), and The Atmospheric Fund is helping designers better understand the carbon impact of building assemblies. Titled "New Design Resources for Embodied Carbon Targets," the guide evaluates the embodied carbon footprint of 26 different wall, roof, and floor assemblies using a consistent methodology. The aim is to provide architects, engineers, and specifiers with practical, material-specific data to support low-carbon design decisions early in the process. What sets this guide apart is its detailed breakdown of each assembly, showing the contribution of individual materials such as insulation, sheathing, structure, and cladding to the overall embodied carbon total. The scope of the study includes carbon generated from raw material extraction through to the building's use phase, offering a clear picture of carbon impacts up to occupancy. While end-of-life considerations are not included, the data still represents a major step forward in transparency and comparability for enclosure design.

This type of resource is especially timely as more design teams begin integrating embodied carbon targets into their project goals. Understanding how each component contributes to a wall or roof's overall footprint allows for more informed substitutions and optimization without compromising performance. A sample wall assembly from the guide is shown in Figure 1 for reference. For those interested in diving deeper, the full set of assemblies and carbon data is freely available on the RDH Building Science website.[1]

The intent was to demonstrate the carbon impact of upgrading two existing masonry wall assemblies with an R-24 solution with either a closed-cell spray polyurethane foam (ccSPF) or mineral wool type of insulation. For the ccSPF retrofit, 102-mm (4-in.) steel studs were installed on the interior face of the masonry, filled with 95-mm (3.75-in.) of ccSPF. The assembly was completed with a standard gypsum finish and interior paint. However, the mineral wool option required a few additional layers. Since mineral wool is strictly thermal insulation and does not manage air, vapour, or moisture movement, additional control layers had to be added. The assembly included a continuous air barrier applied to the brick, 152-mm (6-in.) steel studs, 152-mm (6-in.) of mineral wool insulation, a smart vapour retarder, plus the standard gypsum and paint finish.

This is where the carbon story gets interesting. Despite mineral wool often being seen as the "greener" option, this assembly had a higher embodied carbon impact. The ccSPF assembly resulted in approximately 40 per cent less embodied carbon compared to the mineral wool version. Why? Fewer materials, fewer layers, thinner structural elements and integrated performance. The example from the guide is a good reminder that reducing carbon in an assembly is not just about the insulation type, but how all the components come together in the full assembly to control the four layers of performance. It should be stated that even though some insulation types can have higher embodied carbon, they do minimize the impact of energy use in the operation of our buildings. The higher carbon insulation types, such as mineral wool (higher density equals higher carbon), will be a

Toronto Metropolitan University (TMU) and RDH Building Science study and resulting database—funded by The Atmospheric Fund (TAF) inform design decisions at the earliest stages (before details are established) with critical consideration of embodied carbon.

net carbon benefit; however, it may take a longer return on carbon (ROC).

Additional work is already underway to build on the Embodied Carbon Resource guide. RDH Building Science, along with industry partners, are digging deeper into the carbon side of enclosure design to give the architectural and specifier community better tools to make informed, performance-based decisions. While EPDs are a solid starting point, they offer verified data on material-level embodied carbon; they do not give us the full picture.

The reality is, no single product defines the carbon story of an assembly. To truly understand a building enclosure's impact, every component, cladding, sheathing, structure, insulation, membranes, and finishes need to be broken down and labelled with their embodied carbon value. Only then can people see how each piece contributes to the overall carbon footprint of the enclosure.

This level of transparency will move the industry from theoretical carbon targets to real, design-based decisions. Once working with full-enclosure data, the industry will be in a better position to rethink how walls, roofs, and floors are detailed and specified, not just for thermal performance or durability but also for long-term climate impact.

Conclusion

In recent months, carbon reduction has dominated the conversation across industry events, from the Canadian Circular Economy Summit in Montreal to the Passive House Canada Conference in Ottawa. While the discussion varied from materials reuse to energy efficiency, the common thread was clear: carbon matters, and the building enclosures are a key part of the solution. Thermal insulation plays a central role here, influencing both embodied and operational carbon.

While Canada's global carbon share sits at 1.6 per cent, its reputation as a global leader in climate resilience depends on lowering that footprint, starting with how buildings are designed and built.

Material choice matters, but how materials work together matters more. While EPDs are a solid starting point, they do not tell the whole carbon story—full enclosure assessment is where meaningful change happens. The ongoing research by RDH, Honeywell, and Elastochem aims to expand these tools and bring more clarity to designers and specifiers. Until then, the industry needs to be asking the right questions: not just "what's the RSI-value?" but "what is the carbon cost and is there a smarter way to get the same performance?"

Let's get the buildings to net-carbon zero before the Toronto Maple Leafs have a chance to win the Stanley Cup, or maybe let's not wait that long.

Notes

[1] Refer to rdh.com/wp-content/uploads/2024/01/RDH_TMU_Embodied-Carbon-Resources-01-30-2024.pdf

Rockford Boyer, B. Arch. Sc., MBSc, BSS, is an experienced building science leader at Elastochem with more than 20 years of expertise in sustainable building design. He holds an undergraduate degree in civil engineering and architecture and a master's in building science. He is also a member of Passive House Canada and the Ontario Building Envelope Council (OBEC). He is also a part-time professor at Sheridan College, teaching in the architectural technology program and sharing his knowledge and expertise with future generations of architects and designers.

Strength in the Scorch

Timber's Secret to Surviving Fire

By Mike Banta

PHOTOS COURTESY JANA BANNAN

Embracing timber as a primary construction material brings a multitude of benefits that extend far beyond esthetic appeal. Timber's innate qualities, marked by its versatility, sustainability, and strength-to-weight ratio, position it as a favourable choice in contemporary construction. However, heavy timber stands out not only for these impressive features but also for a remarkable and perhaps surprising quality—fire resistance. Several inherent properties add to heavy timber's fire-resistant properties, especially when coupled with additional measures that can enhance and complement its resistance.

Charring process

Heavy timber's distinct fire-resistant attribute is its capability to char in a controlled manner when faced with flames, rather than burning through and combusting. As observed and documented over years of research and testing, heavy timber's behaviour in a fire is highly predictable. When heavy timber is exposed to fire, its outer layer undergoes a charring process, creating a protective barrier. Understanding this charring process is crucial in designing and assessing the fire performance of heavy timber structures.

Insulating properties

As the outer layer of heavy timber chars, it insulates the inner, unburned wood from the flames. This insulation significantly slows down the fire's progression, preventing it from penetrating deeply into the timber, and providing a crucial advantage in terms of safety and structural integrity.

Predictable behaviour

Unlike some materials that may behave unpredictably under intense heat, heavy timber's response to fire is well documented. This predictability allows for effective design and engineering, facilitating the incorporation of safety measures that meet stringent building codes and regulations. The National Fire Protection Association (NFPA) and the *International Building Code* (*IBC*) provide prescriptive information for heavy timber

Above: This exposed ridge beam highlights the clean engineering and dependable fire performance heavy timber brings to modern construction.

Right: This intricate beam network demonstrates the design versatility and fire-protective charring properties of heavy timber construction.

fire safety within their standards. Recently, the *IBC* released many revisions and updates to mass timber building height allowances and associated fire safety requirements.

Comparative advantage

The reliability of heavy timber in fire scenarios enhances its appeal as a construction material in various applications. Traditional construction materials such as concrete and steel do not possess inherent fire-resistant properties. While concrete may offer better fire resistance than steel, both materials conduct heat more rapidly and can undergo significant loss of strength and structural compromise when exposed to high temperatures. Thus, while concrete and steel have their merits in construction, heavy timber's unique characteristics make it a compelling choice in builds where fire resistance is a critical consideration.

Additional measures

In addition to inherent fire resistance, a strategic combination of design, technology, and preventative safety measures further fortifies protection against fire hazards. Applying fire-resistant coatings to slow the speed of charring, installing automatic sprinkler systems for rapid fire suppression, and implementing fire barriers and compartmentation to contain fires are just a few examples of design and technology solutions. These preventative and proactive measures also contribute to an intentional and comprehensive approach to fire safety within heavy timber structures:

- Performing environmental assessments
- Installing early warning systems
- Emergency egress planning
- Conducting regular inspections
- Co-ordinating with emergency services

When faced with fire, heavy timber's unique charring process, insulating properties, and predictable behaviour position it as a reliable choice in construction. The comparative advantage it holds, coupled with additional safety measures available, solidifies heavy timber's place as not just a building material but a safeguard against unforeseen challenges.

From a young age, Mike Banta was fascinated by the exposed structural elements of timber framing and admired the longevity and character of the timbers. For more than 20 years, he has been designing timber frame structures and has advanced expertise in structural steel and other architectural materials, including cross-laminated timber, glue-laminated timber, and reclaimed and recycled timber. He is also experienced in mechanical, restorative, and sustainable design, technical drafting and detailing, CNC programming, prototyping, and quality control. He currently serves as general manager of Mid-Atlantic Timberframes in Lancaster, Pa.

Planning for Green Public Spaces

A Case for Smart Surveillance

By Sophie Laplante

PHOTOS COURTESY
AXIS COMMUNICATIONS

Urban planners have embraced green public spaces as essential in cityscapes because of their positive effects in building a vibrant community life and offsetting the urban heat island effect. Tree-filled parks, winding hiking trails, and other open-air natural spaces enhance the beauty of urban environments and serve as a city's lungs by offering pockets of land through which heat can escape. While accessibility makes these areas appealing to many visitors, it also underscores the importance of ensuring visitor safety, protecting facilities, and ensuring long-term sustainability. Urban planners can rely on smart surveillance systems to create and maintain safe, sustainable, green public spaces that enrich city living through proper integration, use, and management.

The urban heat island effect

In recent years, cities across Canada have faced record-breaking temperatures, largely due to climate change. However, within highly industrialized settlements, another factor contributes to the rising heat: the urban heat island effect. This phenomenon persists in high-population areas that are densely packed with buildings, paved roads, and cars, where heat is trapped and, therefore, intensified within, causing a spike in temperature.

In urban landscapes, tall buildings play a significant role in creating hot and humid environments. These structures, often tightly clustered, elevate temperatures because they trap heat in their construction. Paved roads receive and store this heat, gradually releasing it throughout the day and even the night. Energy consumption

from building operations, power generation, and car use also contributes to rising temperatures. The cumulative effect is a heat-concentrated zone that poses potential health risks.

As this phenomenon affects millions of Canadians scattered across various urban cities such as Toronto and Vancouver, urban planners have turned to green public spaces as a major solution to reduce the impact on temperature and simultaneously provide a welcome respite from the hustle and bustle of the fast-paced city life.

The importance of surveillance on green public spaces

The accessibility of green public spaces and their significance in people's daily lives make it crucial for city planners to implement measures to keep these areas safe and secure for visitors.

A bullet camera in a city square.

Surveillance cameras fulfil their fundamental purpose of providing law enforcement with real-time and offline footage for crime prevention and forensic investigation; however, beyond that, cameras can provide comfort and peace of mind to visitors while assisting facility personnel in managing operations. Further, audio capabilities can significantly boost and expand a system's capabilities, giving it the power to communicate emergency and non-emergency messages and even cultivate a more relaxing and inviting environment through ambient music.

Crime prevention and forensic investigation

Safety and security are two non-negotiable priorities that urban planners must consider when designing and developing green public spaces. Surveillance systems have undergone great technological advancements that have expanded their capabilities. Today's surveillance cameras offer improved monitoring features, including low light and thermal imaging, for effective operation in dark and challenging conditions. Pan, tilt, and zoom functions provide broader and more detailed coverage, while specialty cameras can be customized to meet specific needs and scenarios.

In addition to advancements in surveillance camera capture capabilities, new technologies have emerged to enhance their functions. These innovations work together to create a comprehensive system that detects, analyzes, and prevents crime. Urban planners can deploy this system in green public spaces, such as parks, playgrounds, and hiking and biking trails, to ensure safety and security.

A horn speaker in a parking lot.

Suspect behaviour analysis.

For example, deterring potential offenders is paramount in playgrounds and splash pads, where children frequently wander away from their parents while interacting with others and using equipment. Conspicuous box cameras can serve as a deterrent, making bad actors think twice about their actions. When equipped with audio speaker capabilities, these cameras allow security personnel to issue real-time warnings or deterrent messages, adding an extra layer of safety and reassuring parents and guardians that the area is being closely monitored. These speakers may also be used for music playback during low-alert situations, adding to the child-friendly mood of the space.

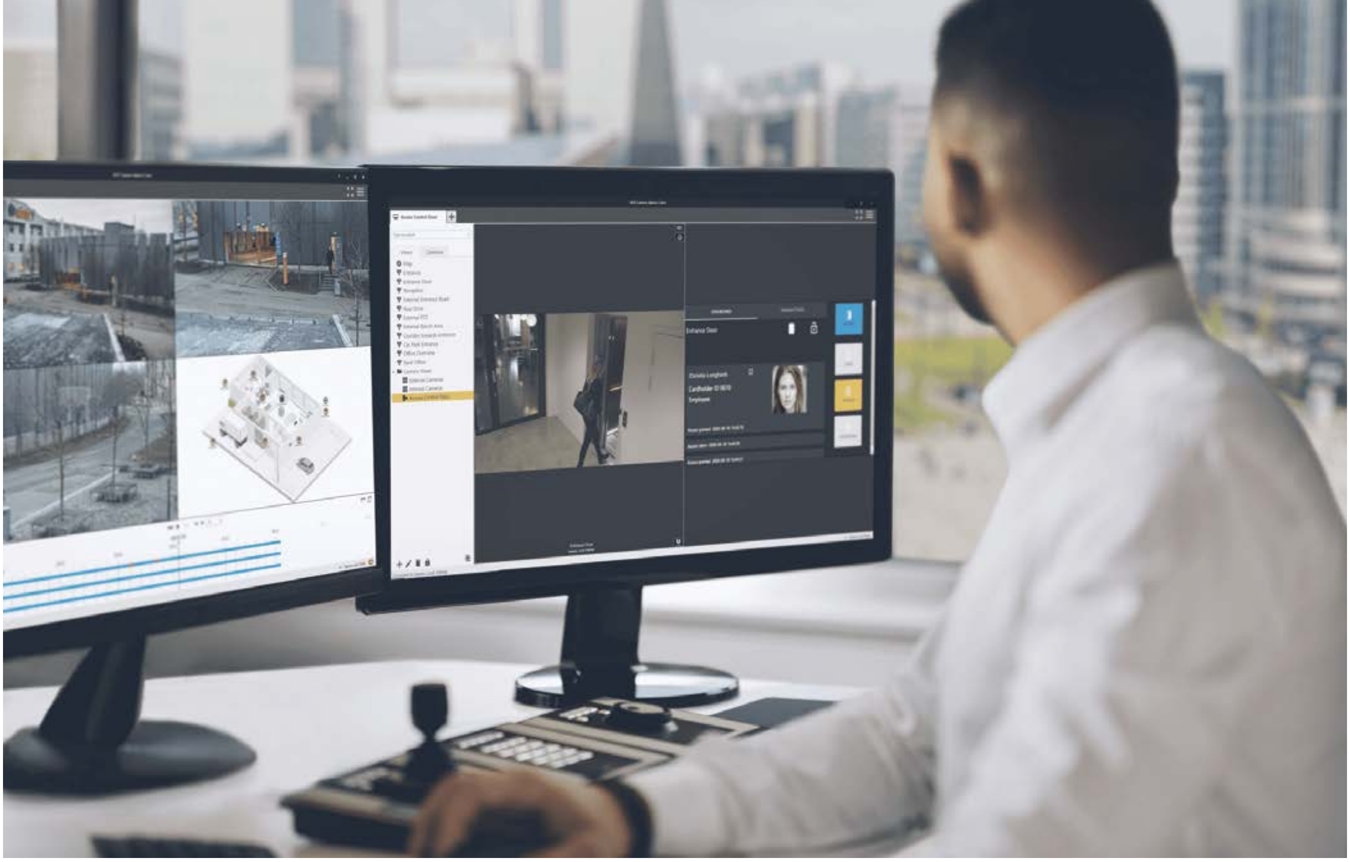
Meanwhile, artificial intelligence (AI) is an asset in supporting forensic investigations. By leveraging advanced analytics, surveillance systems can process hours of footage from various cameras, alleviating the need for manual video review. This speeds up post-incident investigations more efficiently and accurately, enabling operators to identify and pinpoint relevant footage and critical details swiftly.

In the event of an abduction at a playground, AI can analyze hours of footage from various cameras and vantage points to search for clothing details or notable facial features based on witness testimony. The speed and accuracy of AI allow for tracking the movements of the perpetrator(s) and potentially identifying escape vehicles. This data enables police to make more informed and efficient decisions, increasing the likelihood of a successful rescue. For audio-enabled surveillance systems, voices and conversations are recorded, providing more information and understanding of the footage captured.

Emergency response

Green public spaces are often bustling with activity, featuring energetic environments where athletes and amateurs engage in sports such as tennis, football, baseball, and others.

During the summer, these spaces are exposed to intense heat, potentially leading to dizziness, headaches, or dehydration. When designing or redesigning this dynamic environment, urban planners must carefully assemble a surveillance system that monitors movements within these spaces and environmental factors such as temperature, humidity, and other weather conditions. This optimizes the data quality that city officials and first responders can use to monitor and respond to emergencies. Internet of Things (IoT) sensors—small, internet-connected devices embedded in the environment to collect



A secure entry operator.

and transmit real-time data—may measure temperature and other environmental factors and alert personnel once a certain threshold is crossed. At this point, personnel may issue warnings or decide to close the grounds. With audio speaker capabilities, these updates may be communicated immediately.

Cameras on hiking trails can act as crucial safety monitors. For instance, if someone faints along the trail, smart surveillance systems can detect this unusual behaviour and alert security personnel to respond. These systems can even automatically notify first responders based on predefined parameters. With such advanced monitoring, runners and hikers can undertake their activities more confidently and with peace of mind.

City planners can integrate audio-enabled surveillance systems to equip first responders and personnel with the proper tools to attend to emergencies. With audio, personnel can remotely communicate with people in the area of concern, ensuring quick and timely action on issues. For example, in the case of lost children, these speakers can be used to instruct the child or the public to be on the lookout. Additionally, in events where inclement weather is expected, these speakers may also be used to inform and warn the public and, in extreme situations, instruct or facilitate evacuation.

Maintenance and improvement

City planners must continuously maintain and improve the design of green public spaces to align with visitors' evolving interests and priorities. Surveillance systems are crucial in researching visitor behaviour and analyzing traffic occupancy patterns. Insights from surveillance data can help city planners make fact-based assumptions and decisions regarding various priorities, such as design, security measures, and operations.

For instance, when redesigning or renovating parks and other recreational areas, AI and data analytics can be leveraged by urban planners to create "digital twins," which are replicas that mirror various aspects of their real-world counterparts based on data gathered by sensors and IoT devices. With digital twins, city planners can explore an array of simulations and assess which design or renovation will perform or serve the public needs the best.

Priorities and concerns in using smart surveillance in green public spaces

Smart surveillance systems rely on continuously gathering data to improve, secure, and enhance green public spaces. As such, city planners, surveillance operators, and other bodies with access should prioritize the secure storage, transmission, and safekeeping of these data. When mounting surveillance systems, care must

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Box camera in a city square.

be taken to ensure cybersecurity and other legal and ethical concerns are considered.

Cybersecurity

When installing and operating surveillance systems, particularly in high-traffic areas such as green public spaces, it is essential to implement safeguards against unauthorized access, tampering, and cyberattacks. This responsibility is shared between the surveillance system supplier, city planners, and operators. It must be upheld throughout the entire system's lifecycle—from the production, distribution, implementation, and in-service phases to decommissioning.

What does cybersecurity look like in each phase? The production and distribution phase involves city planners, who must carefully select suppliers and ensure they follow the same strict standards as their suppliers. The implementation phase entails resetting the device to its factory defaults and installing the most up-to-date operating system. This step ensures the system is free of unauthorized modifications and prepared to address the latest vulnerabilities.

During the in-service phase, it is critical to maintain system security by regularly updating the operating system. Signing up for notifications ensures operators receive timely security updates. Finally, suppliers should provide an end-of-support date to support during the decommissioning phase that operators must be aware of. Before support ends, it is vital to securely remove data and transition to new or updated systems to maintain cybersecurity.

Transparency

Since surveillance can create an unsettling feeling, transparency is a key ethical consideration. As with other areas with surveillance systems, city officials should prominently display signs and announcements in green public spaces. There should be display signs and announcements in the vicinity if surveillance is in operation. When audio speakers are installed, these announcements may also be regularly programmed. This transparency allows people to make informed decisions about their actions and conversations while in the space. Additionally, it serves as a deterrent to bad actors, signalling them to reconsider any harmful intentions.

Privacy

Green public spaces are oftentimes nestled in residential neighbourhoods and communities. When installing surveillance systems near entrances, exits, or areas with visibility of private properties, city planners must implement real-time privacy masking. This ensures that faces and license plates are automatically obscured, allowing security measures to be carried out while respecting individuals' privacy. By utilizing this feature, surveillance can be conducted in a manner that prioritizes safety and personal privacy protection.

Conclusion

As green public spaces become indispensable in many cityscapes for enhancing the quality of life, surveillance emerges as an ideal solution for crime prevention, forensic investigation, emergency response, and maintenance and improvement. By implementing surveillance systems with thoughtful practices that prioritize cybersecurity, uphold transparency, and respect privacy, city planners can significantly improve various facets of city living while fostering safer, well-maintained public areas.

Sophie Laplante is the business development manager of public safety at Axis Communications Inc. Her causes are civil rights and social action, education, the environment and health, and science and technology. She is the director of the Women in Security (WIS) committee and a member of the board of directors for the American Society for Industrial Security (ASIS) Quebec chapter.

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Kelly Sawatzky, CSP, RSW

Build better with specs

One of the architecture interns I'm in contact with said her entire understanding of specification writers was limited to: "Spec writers require a detail-oriented brain, and they can build a successful career writing them." At least she had heard the word "specifications"—I'm grateful to her professor.

Yvon Lachance, FCSC, CCCA, and CSC's 2nd vice-president, provided vital context for me. He explained that schools focus on teaching students to "think like an architect" rather than just training them to do the work. This method emphasizes developing critical thinking skills so experience isn't the only way to learn. I believe the same is true for engineers.

The widespread lack of familiarity with specification writing puts the environment, the built world, and our clients at risk. Not all architects and engineers want to be—or should be—specification writers, but they should understand the fundamentals: how specifications are organized, what information belongs in drawings versus specifications, the pitfalls of relying on generic information, and the level of detail needed for well-crafted specifications.

I believe professional schools should at least introduce each major method used to convey design intent, even if their primary focus remains on teaching problem-solving fundamentals. Perhaps these topics could be integrated tangentially through modeling courses or discussions on materiality and costing.

Fortunately, several colleges in Canada include specification writing in their curricula, and four schools go further by teaching "Principles of Construction Documentation." I commend these institutions for their commitment to effectively communicating design intent.

In addition to these academic efforts, CSC continues to promote specification education through its courses, curriculum outreach, and leadership in construction communication—supporting architects, engineers, project managers, and specifiers alike.

I'm calling on our professional schools and organizations to discuss specifications more often. I also encourage you to help students and interns learn the language and structure needed to transform their vision into reality. Urge them to take the time to understand why specifications and related programs are so vital. CSC offers courses to support this learning—take advantage of these opportunities for yourself and your firm. The benefits for future projects will be significant and lasting.

I am CSC.

Construire mieux avec des spécifications

L'un des stagiaires en architecture avec qui je suis en contact a déclaré que sa compréhension globale des rédacteurs de spécifications se limitait à : « Les rédacteurs de spec nécessitent un cerveau orienté sur les détails et ils peuvent construire une carrière réussie en les écrivant. » Au moins, elle avait entendu le mot « spécifications ». Je suis reconnaissant envers son professeur.

Yvon Lachance, FDCC, ACCC et 2e vice-président de DCC, m'a fourni un contexte vital. Il a expliqué que les écoles se concentrent sur l'enseignement aux élèves pour qu'ils « pensent comme un architecte » plutôt que de simplement les former à faire le travail. Cette méthode met l'accent sur le développement des compétences de pensée critique, donc l'expérience n'est pas la seule façon d'apprendre. Je crois que c'est vrai également pour les ingénieurs.

Le manque généralisé de familiarité avec la rédaction de spécifications met l'environnement, le monde construit et nos clients en danger. Tous les architectes et ingénieurs ne veulent pas être ou devraient être des rédacteurs de spécifications, mais ils devraient comprendre les principes fondamentaux : comment les spécifications sont organisées, quelles informations appartiennent aux dessins par rapport aux spécifications, les pièges de s'appuyer sur des informations génériques, et le niveau de détail nécessaire pour des spécifications bien conçues.

Je crois que les écoles professionnelles devraient au moins présenter chaque méthode majeure pour transmettre l'intention de conception, même si leur principal objectif reste d'enseigner les principes fondamentaux de la résolution de problèmes. Ces sujets pourraient être intégrés dans des cours de modélisation ou des discussions sur la matérialité et les coûts.

Heureusement, plusieurs collèges au Canada incluent la rédaction de spécifications dans leurs programmes d'études, et quatre écoles vont plus loin en enseignant les « Principes de documentation sur la construction ».

En plus de ces efforts académiques, DCC continue de promouvoir l'éducation sur les spécifications par ses cours, la sensibilisation au programme et le leadership dans la communication de la construction en soutenant les architectes, ingénieurs, gestionnaires de projet et spécificateurs.

Je demande à nos écoles et organisations professionnelles de discuter plus souvent des spécifications. Je vous encourage également à aider les étudiants et les stagiaires à apprendre le langage et la structure nécessaires pour transformer leur vision en réalité. Encouragez-les à prendre le temps de comprendre pourquoi les spécifications et les programmes connexes sont si essentiels. DCC propose des cours pour soutenir cet apprentissage — profitez de ces opportunités.

Je suis DCC.