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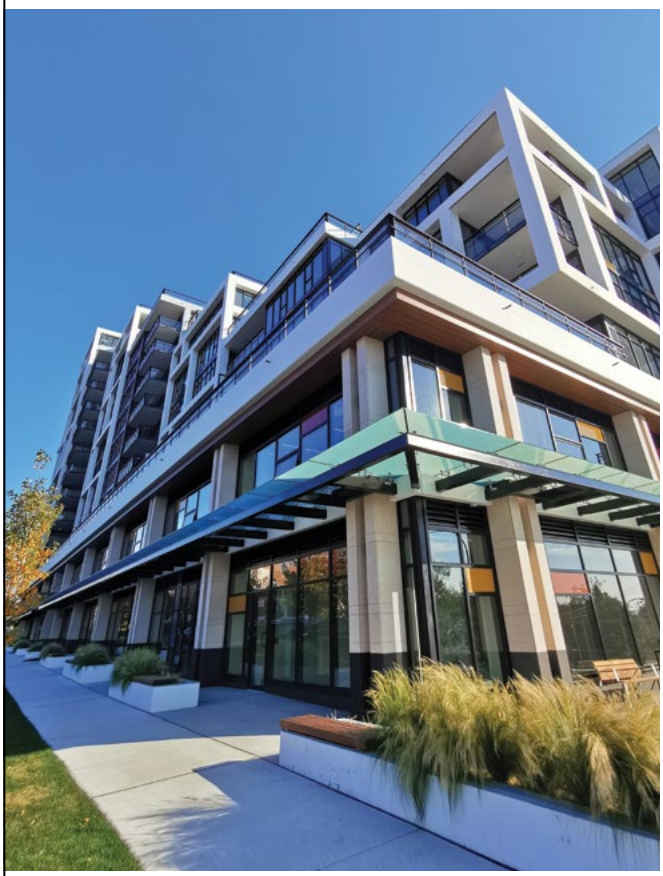

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Improving Wall Performance

Shelf Angles on Stand-offs

By Mark D. Hagel, PhD, P.Eng

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Thermal bridging is a very real phenomenon and can greatly reduce the thermal performance of a building envelope assembly. On a frosty day in Alberta, the dark areas located at the wood studs and floor rim boards on a wall in Figure 1 can be seen in stark contrast to the white frost between the studs, where the insulation is reducing heat loss on the home under construction. In these dark areas, the thermal bridging of the wood-framing has melted the frost, creating the look of dampness.

To become more thermally efficient, it is important to provide a break between thermal bridges. The use of continuous exterior insulation at above- and below-grade transitions of the wall and at floor and roof transitions has a significant impact on reducing thermal bridging in wall assemblies. For several years now, continuous insulation (c.i.) for masonry veneers has been achieved by placing shelf angles on insulation standoffs. A common method to create an insulation stand-off uses steel knife plates welded onto the shelf angle, which are then welded to concrete embed plates that are anchored to concrete foundations (or floors), as illustrated in Figures 2 and 3 (page 8). This knife plate stand-off allows for insulation to be installed behind the shelf angle, providing c.i. above and below grade with insulation that is in direct contact with the backup wall.

Alternatively, steel or fibre-reinforced polymer (FRP) hollow structural sections (HSS) stand-offs can be bolted to the structure to provide the space for the insulation to be installed behind the shelf angle, as illustrated in Figure 4 (page 8).

Lastly, proprietary pre-engineered stand-off systems can also be used, as illustrated in Figure 5 (page 10).

The advantage of the HSS sections or proprietary stand-offs is that they are bolted to the structure and can be installed by the mason. Bolting also avoids welding, which is advantageous when anchoring to wood structures.

Like shelf angles that are directly bolted to concrete or wood framing, the design of shelf angles on insulation stand-offs represents the intersection of masonry and steel design, and depending on the building's primary structural system, concrete, steel, or wood design. Often regarded as a "steel" design or a "concrete" design problem, rather than a "masonry design" problem, very little research or design guidance is available for the design of shelf angles on stand-offs. As with directly bolted shelf angles, this often leads to the oversizing of shelf angles, insulation stand-offs, bolts, and embed plates for shelf angles when c.i. is being used.

Recent testing and research of shelf angles on stand-offs anchored to concrete foundations and wood framing have provided insight into the behaviour and structural capacities that can be expected from these systems.

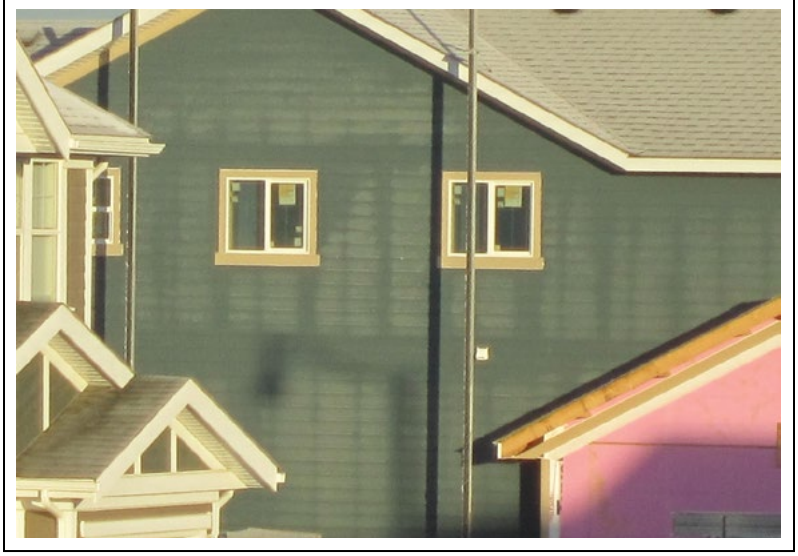
This article provides examples and discusses testing and research results of masonry veneers on knife plate, HSS, and proprietary stand-offs. It will also discuss the resulting strategies for a more efficient design of steel shelf angles on knife plate stand-offs.

Testing results of HSS and proprietary stand-offs anchored to wood-frame floors

Shelf angles bolted to 102 mm (4 in.) long FRP HSS 76 x 76 x 6 mm (3 x 3 x 0.25 in.) and anchored to three-ply 2x12 spruce-pine-fir (SPF) rim boards on a wood-framed floor system were tested to failure at the University of Windsor between 2021 and 2023. Figure 6 (page 10) illustrates the specimen being tested.

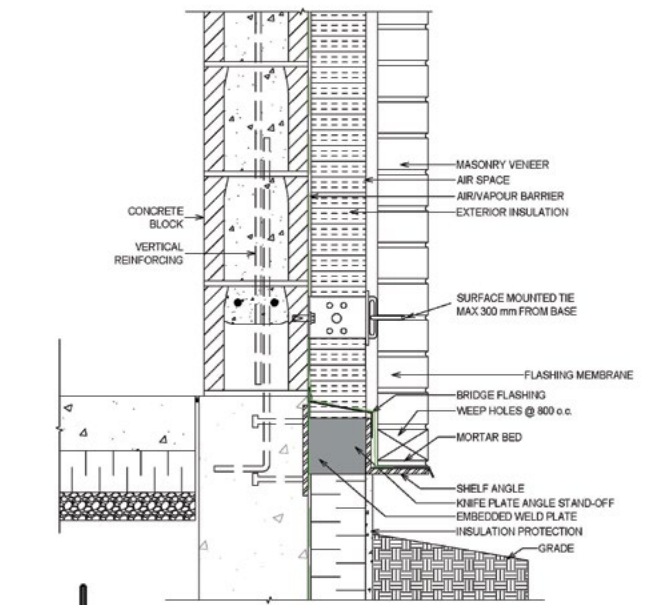
The mode of failure was either rotation or splintering of the SPF rim board, rather than lag

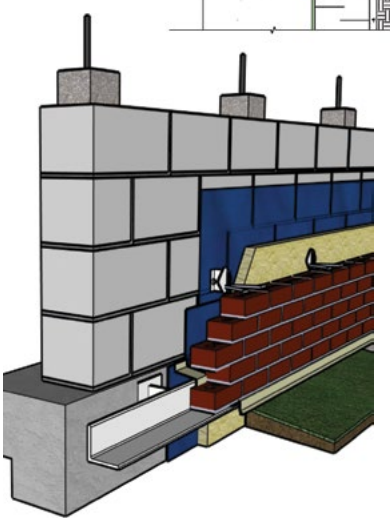
FIGURE 1



Thermal bridging of wood-framing on a home under construction in Alberta.

FIGURE 2





2D and 3D details of a knife plate standoff on a concrete block brick veneer wall assembly.

TABLE 1: TEST RESULTS OF SHELF ANGLE ON FRP HSS STANDOFF ON WOOD-FRAME FLOOR

Test specimen	Failure load kN (lb)	Deflection at failure (mm)	Factor of safety
Lag screw with 3 in. (76 mm) deep FRP HSS standoff -1	28 (6,292)	37.7	3.5
Thru-bolt with 3 in. (76 mm) deep FRP HSS standoff -1	28 (6,292)	30	3.5
Lag screw with 3 in. (76 mm) deep FRP HSS standoff -2	30 (6,742)	43.8	3.8
Thru-bolt with 3 in. (76 mm) deep FRP HSS standoff -2	49 (11,101)	69	6.1
Lag screw with 2 in. (51 mm) deep FRP HSS standoff -1	47 (10,562)	41	5.9
Thru-bolt with 2 in. (51 mm) deep FRP HSS standoff -2	72 (16,180)	72.7	9.0

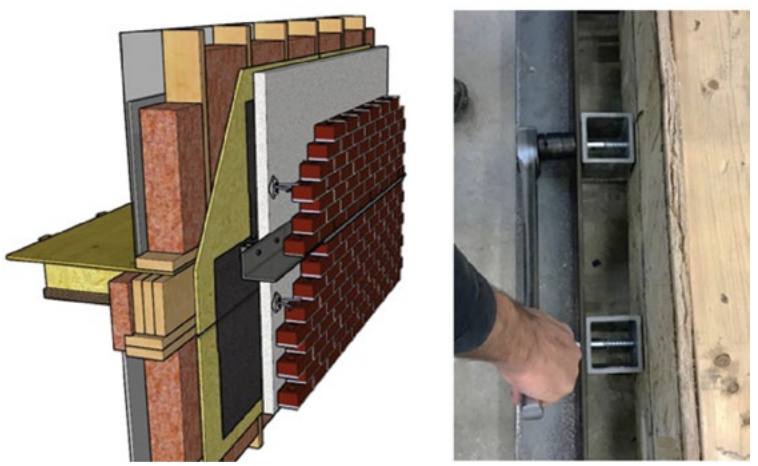
*Shivam Sharma/University of Windsor

FIGURE 3

Knife plate standoff on a concrete block brick veneer wall assembly in a school.

PHOTO COURTESY SHIVAM SHARMA/UNIVERSITY OF WINDSOR

FIGURE 4



Hollow structural sections (HSS) standoff detail to a wood-framed floor assembly and installation of fibre-reinforced polymer (FRP) HSS standoffs in a laboratory.

screw or thru-bolt withdrawal. The results of the testing are found in Table 1.

The results presented in Table 1 indicate a safety factor ranging from 3.5 to 3.8 was achieved for 76 mm (3 in.) insulation stand-offs. For 51 mm (2 in.) insulation stand-offs, a safety factor of between 5.9 and 9 was obtained. This analysis assumes the weight of 3 m (10 ft) of brick veneer, which is approximately 7.99 kN (1,796 lb), is acting on the shelf angle mounted on the stand-off. This indicates 3 m (10 ft) of brick veneer can be safely carried by the FRP HSS systems. It is important to note that the cantilevering of the through-bolt or lag screw through the HSS section reduces the structural capacity of the system as compared to proprietary systems that directly bolt to the SPF rim board.

The test was repeated using a proprietary shelf angle stand-off. Once again, the proprietary stand-off and shelf angle were anchored to three-ply 2x12 SPF rim boards on a wood-framed floor system and taken to failure, as can be seen in Figure 7 (page 11).

As with the FRP HSS stand-offs, the mode of failure was either rotation or splintering of the SPF rim board rather than lag screw or thru-bolt withdrawal. The results of the testing are found in Table 2 (page 10).

The results presented in Table 2 (page 10) demonstrate safety factors ranging from 9.2 to 12.8 for 51 mm (2 in.) insulation stand-offs without a shim. For the proprietary stand-offs with a shim providing 76 mm (3 in.) insulation, safety factors ranging from 9.6 to 10.4 were observed. These calculations were once again based upon the assumption that a weight of 3 m (10 ft) of brick

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TABLE 2: TEST RESULTS OF SHELF ANGLE ON FERO-FAST BRACKET STANDOFF ON WOOD-FRAME FLOOR

Test specimen	Failure load kN (lb)	Deflection at failure (mm)	Factor of safety
Lag screw specimen @ 12-in. (305-mm) o.c. Fero-Fast bracket-1 (without Fero shim)	73 (16,404)	28.1	9.2
Thru bolt specimen @ 12-in. (305-mm) o.c. Fero-Fast bracket-1 (without Fero shim)	102 (22,921)	54.8	12.8
Lag screw specimen @ 12-in. (305-mm) o.c. Fero-Fast bracket-2 (with Fero shim)	77 (17,303)	44.7	9.6
Thru bolt specimen @ 12-in. (305-mm) o.c. Fero-Fast bracket-2 (with Fero shim)	83 (18,652)	52.6	10.4
*Aarish Khan/University of Windsor			

FIGURE 5

PHOTO COURTESY JEFFREY HUNG/FEROCORP

Proprietary pre-engineered insulation standoff systems.

FIGURE 6

PHOTO COURTESY SHIVAM SHARMA/UNIVERSITY OF WINDSOR

Typical specimen for shelf angles on 102 x 76 x 6.4 mm (3 x 3 x 0.25 in.) fibre-reinforced polymer (FRP) hollow structural sections (HSS) standoffs.

veneer, approximately 7.99 kN (1,796 lb), was acting on the shelf angle on a proprietary stand-off. This indicates that the proprietary systems can also safely support 3 m (10 ft) of brick veneer. Further, the ability to directly bolt to the SPF rim board using the proprietary system significantly enhances its structural capacity when compared to the cantilevered lag screws and through bolts used with the HSS stand-offs. The proprietary system more than doubles the capacity of the 76 mm (3 in.) specimen, achieving an ultimate load of 77 kN (18,652 lb), compared to the HSS system's 30 kN (6,752 lb).

The conclusion is that either standoff system can be used with wood-frame floor systems to provide c.i. for shelf angles at floor transition locations in wood-frame buildings.

Testing results of steel knife plate stand-offs anchored to concrete foundations

A 102 x 102 x 6 mm (4 x 4 x 0.25 in.) shelf angle welded onto 127 x 102 x 19 mm (5 x 4 x 0.74 in.) steel knife plate stand-offs that were anchored to embed plates on concrete foundations were tested to failure at the University of Alberta in 2025. In addition to using steel knife plates, stand-offs, and concrete structures, these tests also differed from the wood-floor tests in that the effects of the masonry ties and brick veneer on the deflection of the shelf angle were also explored as part of the research. The shelf angle on knife plates with masonry ties and brick veneer can be seen in Figure 8. An axial load of 15.17 kN (3,410 lb) was applied to the top of the 813 mm (32 in.) tall brick veneer (Figure 8), which delivered a total axial load equivalent to the weight of 7 m (24 ft) of clay brick veneer on the specimen. The deflection of the shelf angle

TABLE 3: TEST RESULTS OF SHELF ANGLE ON KNIFE PLATE STAND-OFFS

Load point	Shelf angle with brick and ties		Shelf angle only	
	Axial load (kN)	Shelf angle deflection (mm)	Axial load (kN)	Shelf angle deflection (mm)
Weight of 7 m (24 ft) of brick	15.17	0.6872	17.08	2.979
Failure load	96.84	23.99	126.6	34.3
Factor of safety	5.7		7.4	
*Cory Scott/University of Alberta				

on knife plates was then measured at this load. The results are found in Table 3.

The specimen was then taken to failure. Failure occurred at a load of 96.8 kN (21,708 lb), providing a factory of safety of 5.6. The ultimate failure resulted from tearing out of the embed plate, as can be seen in Figure 9 (page 12).

The effect of the masonry ties and brick veneer on shelf angle defection was investigated by conducting comparison tests that ignored the effects of the masonry ties. In these tests, the masonry tie and brick veneer effects were eliminated by applying a load of 17.08 kN (3,839 lb) to the bare shelf angle specimen, as can be seen in Figure 10 (page 12). The test method was identical to those conducted on the wood-frame floors, which also ignored the effects of masonry ties and brick veneer by applying the load directly to the shelf angle.

Failure of the specimen occurred at a load of 126.6 kN (28,449 lb). As with the shelf angle on knife plates with masonry ties and brick veneer, the ultimate failure resulted from the tear out of the embed plate, as can be seen in Figure 11 (page 14). The results from the testing can be found in Table 3 for easy comparison.

The testing demonstrated that with a service load (weight of 7 m [24 ft] of veneer) applied to the shelf angle on knife plate specimens with masonry ties and brick veneer, a deflection of 0.6872 mm (0.0271 in.) occurred. In contrast, the testing of the shelf angle on the bare knife plate experienced a significantly larger deflection at the service load of 2.979 mm (0.1173 in.) or about 433 per cent more deflection. These results demonstrate that the effects of the masonry ties and brick veneer are clearly reducing the deflection of the shelf angle and should not be

FIGURE 7

PHOTO COURTESY AARISH KHAN/UNIVERSITY OF WINDSOR

Typical specimen being tested with shelf angle on a proprietary standoff.

FIGURE 8

Shelf angle on knife plate standoff with masonry ties and brick veneer specimen and test setup.

FIGURE 9

Shelf angle on knife plate standoff with masonry ties and brick veneer at failure—tear out of embed plate.

FIGURE 10

Shelf angle on knife plate standoff specimen.

ignored. However, the testing also demonstrated that a full moment connection between the shelf angle and the brick veneer when structurally analyzing the system may be too generous, as the deflection from testing is about 50 per cent more than the deflection predicted using a full moment connection. It appears the brick veneer shelf angle system would be better represented using a rotational spring at the brick veneer/shelf angle interface so that the deflection-reducing effects of the masonry ties on the shelf angle are better captured.

Design of knife plate stand-offs using the force method and virtual work

A new design approach that more accurately considers the interaction between the tied masonry veneer and the shelf angle is necessary to better capture the deflection-reducing effects of masonry ties and brick veneer on shelf angles with knife plate stand-offs that support masonry veneers. The proposed design method uses the force method in combination with virtual work to address the one-degree statically indeterminate system created by the introduction of the tie restraining force (R_{TIE}) at the first course of ties, as illustrated in the free body diagram shown in Figure 12 (page 14).

From Figure 12, the following parameters are required to use the force method and virtual work supporting 7 m (24 ft) of brick veneer:

- b = Knife plate spacing = 813 mm (32 in.)
- P = Unfactored (service load) of masonry veneer and shelf angle (N) = 11,506 N (2,586 lb)
- P_f = Factored load of masonry veneer and shelf angle (N) = 16,108 N (3,620 lb)
- R_{TIE} = Reaction force in the brick ties at the first course of ties (kN)
- V_f = Reaction force in the brick ties at the first course of ties (kN)
- T_f = Reaction force in the brick ties at the first course of ties (kN)
- C_f = Reaction force in the brick ties at the first course of ties (kN)
- t_angle = Thickness of the horizontal leg of the angle = 7.9 mm (0.3 in.)
- L_knife = 127 mm (5 in.)
- b_knife = 19 mm (0.75 in.)
- h_knife = 102 mm (4 in.)
- t_veneer = Thickness of the masonry veneer = 92 mm (3.6 in.)
- t_airspace = 25 mm (1 in.)
- V-tie_radius = 2.4 mm (0.09 in.)
- L1 = Vertical leg length = 103 mm (4 in.)
- L2 = Horizontal leg length = 103 mm (4 in.)
- L3 = Vertical distance to the centre of the knife plate = 51 mm (2 in.)

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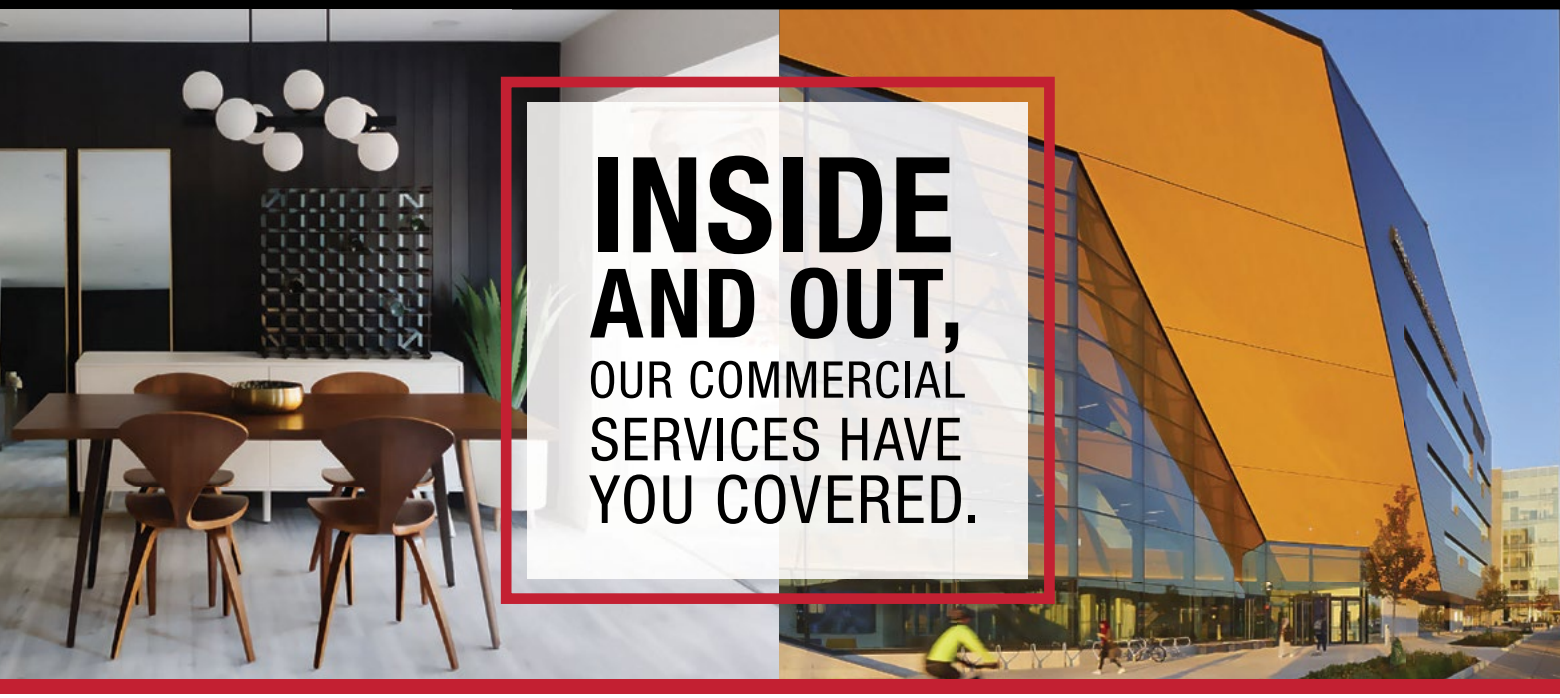

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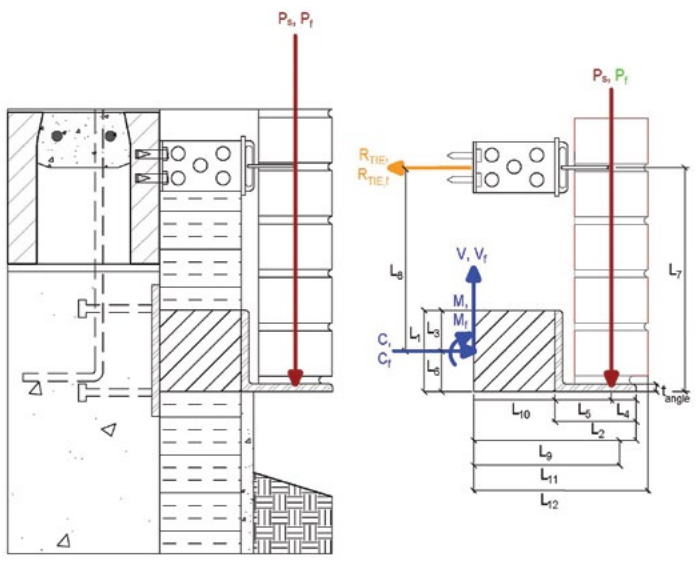
- L4 = L2 – L5 = 30 mm (1.19 in.) for imperial modular brick
- L5 = Eccentricity of veneer load = Air space + veneer thickness/2 = 72 mm (0.28 in.)
- L6 = L1/2 = 51 mm (2 in.)

FIGURE 11

Shelf angle on knife plate stand-off specimen

FIGURE 12



Free body diagram of shelf angle at foundation—statically indeterminate.

- L7 = Max 300 mm (12 in.) from base support = 278 mm (11 in.)
- L8 = Vertical distance between the ties and the centre of the knife plate = 228 mm (9 in.)
- L9 = Distance from vertical shelf angle to centroid of brick
- L10 = Length of the knife plate = 127 mm (5 in.)
- L11 = Distance from start of knife plate to centroid of brick = 199 (8 in.)
- L12 = Total horizontal distance = L_knife + t_airspace + t_veneer = 245 mm (10 in.)
- f'm = The compressive strength of the masonry veneer = 12 MPa (1,740 psi)
- Em = Modulus of elasticity of the masonry veneer = 850 f'm = 10,200 MPa (1.4 million psi)
- Es = Modulus of elasticity of structural steel = 200,000 MPa (29 million psi)
- I_angle = b · t_angle^3 / 12 = 21,337 mm^4 (0.013 $in.^4$)
- I_knife = b_knife · h_knife^3 / 12 = 1.6 million mm^4 (1.01 $in.^4$)
- I_veneer = b · t_veneer^3 / 12 = 65 million mm^4 (39.74 $in.^4$)
- I_tie = 4 · [π·V-tie_radius^4 / 4] = 104 mm^4 (0.00064 $in.^4$)

To use the force method, the statically indeterminate structure was made determinate by the introduction of a release. In this case, the release chosen was at the tie and labelled co-ordinate 1 in Figure 13. The service load, P, and a unit load at co-ordinate 1, were then applied to the released (determinate) structure.

A partial moment connection mimicking the introduction of a rotational spring at the brick veneer steel/shelf angle interface was simulated by reducing E_m to $E_{m,\,effective}$ to account for the reduced rotational stiffness at this interface. This partial moment connection reduces the tension load in the ties and increases the shelf angle deflection when calculated using the force method and virtual work. $E_{m,\,effective}$ was determined to be $^1/_{100}{}^{th}$ of E_m. This value for $E_{m,\,effective}$, was calibrated based on the testing results from the University of Alberta, providing the same deflection of 0.6872 mm (0.0271 in.) at the 17.08 kN (weight of 7 m [24 ft] of brick veneer) on the shelf angle.

The proof of the following equations is beyond the scope of this paper but can be determined by applying the force method and virtual work to the free body diagram in Figure 13.

$$R_{TIE} = \frac{\frac{(L_5 \cdot L_6^2 - 2 \cdot L_5 \cdot L_6 \cdot L_7 - L_5^2 \cdot L_7) \cdot P}{2 \cdot E_s \cdot I_{angle}} + \frac{(L_8 \cdot L_{10}^2 - 2 \cdot L_8 \cdot L_{10} \cdot L_{11}) \cdot P}{2 \cdot E_s \cdot I_{knife}}}{\frac{L_6^3 + 3 \cdot (L_6 \cdot L_7^2 - L_6^2 \cdot L_7 + L_5 \cdot L_7^2)}{3 \cdot E_s \cdot I_{angle}} + \frac{L_7^3}{3 \cdot E_{m,effective} \cdot I_{veneer}} + \frac{L_6 \cdot L_8}{E_s \cdot I_{knife}}}$$

$$\Delta_C = \frac{L_5 \cdot \left[T_u \cdot (2 \cdot L_6^2 \cdot T_s - L_6 \cdot L_7 \cdot R_{TIE}) + \left(2 \cdot L_7^2 \cdot R_{TIE} \cdot R_{TIE\ u} - L_6 \cdot L_7 \cdot R_{TIE_u} \cdot T_s\right)\right] + 2 \cdot L_6^3 \cdot T_s \cdot T_u}{6 \cdot E_s \cdot I_{angle}} + \left(\frac{L_7^3 \cdot R_{TIE} \cdot R_{TIE\_u}}{3 \cdot E_{m,effective} \cdot I\_veneer}\right)$$

$$\Delta_D = \left(\frac{-R_{TIE} \cdot L_7}{2 \cdot E_s \cdot I\_angle}\right) \cdot L_4 + \Delta_C$$

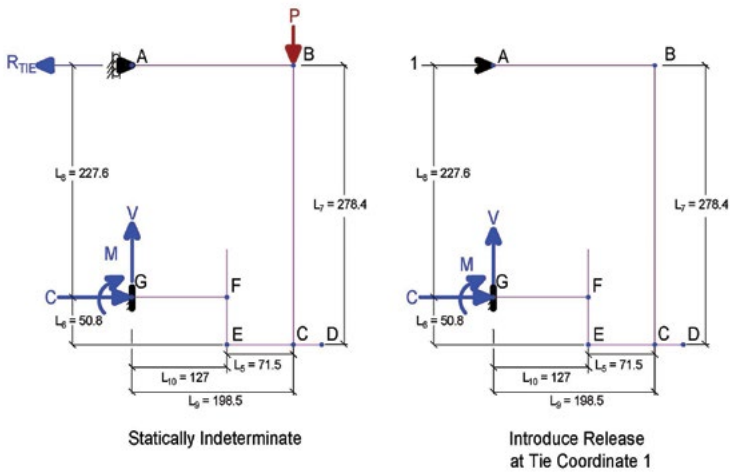
Once R_{TIE} has been determined, virtual work is applied again to obtain the deflection at the tip of the shelf angle on the knife plate stand-off at Point D in Figure 13. Without proof, the equation is as follows:

Entering the numbers into these equations demonstrates a deflection of 0.46 mm (0.018 in.), which is less than the L/480 limit of 0.51 mm (0.02 in.).

The testing results and design method proposed results in more efficient designs for both the shelf angle and the knife plates used as stand-offs to provide c.i. for full bed brick veneer installations and in this particular case permit installations of up to 7 m (24 ft) of brick veneer using a 102 x 102 x 7.9 mm (4 x 4 x 0.31 in.) shelf angle welded to 127 x 102 x 19 (5 x 4 x 0.75 in.) steel knife plate stand-offs, which are then welded to embed plates anchored in concrete foundations or floors. Past observations of this type of construction on a school used the same size knife plates, same knife plate spacing, and same shelf angle size to support 4 m (14 ft) of masonry veneer 3 m (11 ft). Applying the new design method suggests that with the same knife plate spacing of 813 mm (32 in.) o.c., the knife plate thickness could be reduced from 19 mm (0.75 in.) to 15.9 mm (0.63 in.), and the shelf angle size thickness could be reduced from 102 x 102 x 7.9 mm (4 x 4 x 0.31 in.) to 10 2x 102 x 6.4 mm (4 x 4 x 0.25 in.) and still be sufficient to support 4 m (13 ft) of veneer.

Optimizing the shelf angle design leads to smaller shelf angles and knife plates, which not only reduces costs but also enhances thermal performance and decreases the system's carbon footprint.

FIGURE 13



Indeterminate structure and reactions on the released structure.

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Key Considerations When Field Testing Fenestration Systems

By Amy Roberts

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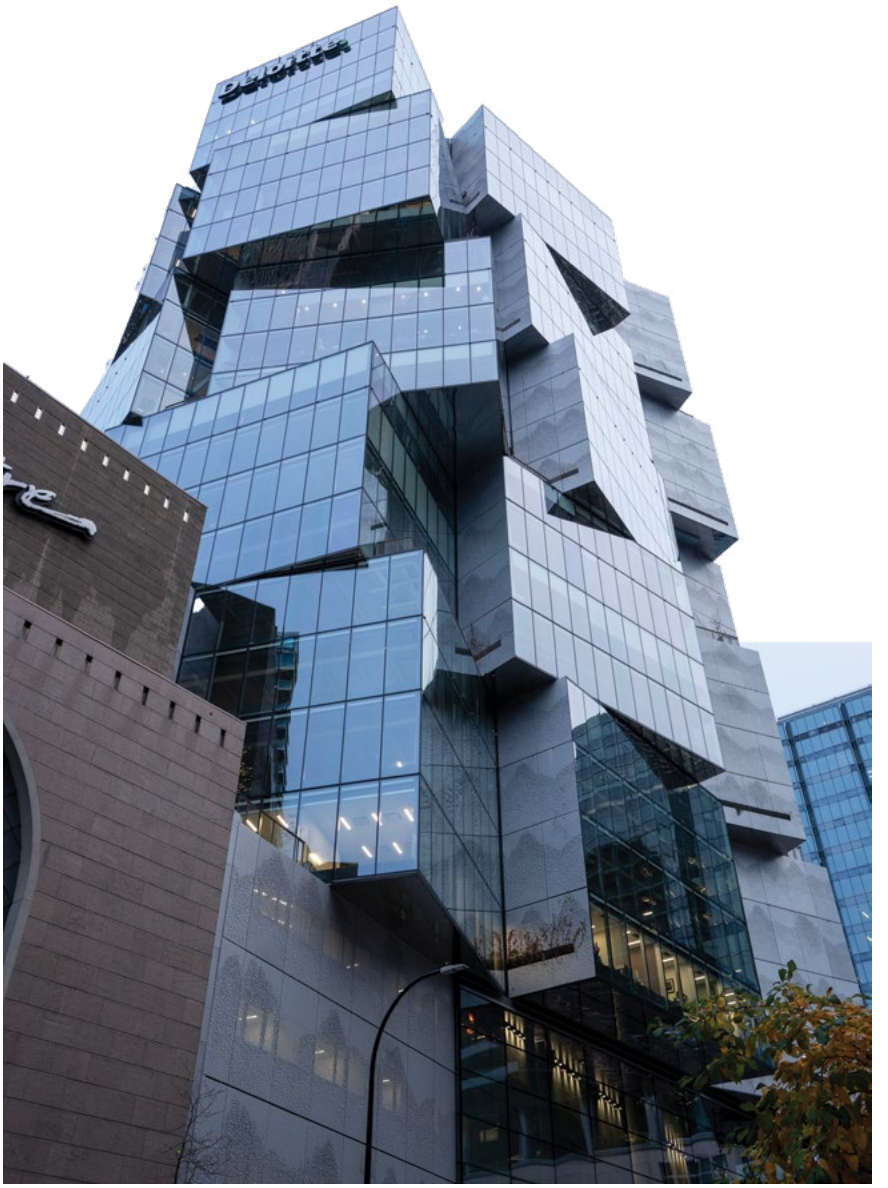
When installing storefronts, curtain walls, and sloped glazing systems, it is beneficial to test the systems' air infiltration and water penetration resistance performance at regular intervals, as it can help detect manufacturing, installation, and/or perimeter sealing problems before a substantial portion of the project is completed. If the tests are performed early enough, necessary corrections can be made with less financial impact and limit other deleterious effects on the project. It is advisable to test products at intervals of five per cent, 50 per cent, and 90 per cent completion of the installation on large projects.

A document from the Fenestration & Glazing Alliance (FGIA) called AAMA 503, *Voluntary Specification for Field Testing of Newly Installed Storefronts, Curtain Walls and Sloped Glazing Systems*, establishes the requirements to evaluate the air infiltration resistance and/or water penetration resistance performances of newly installed storefronts, curtain walls, sloped glazing systems, and their installation during initial construction. This test should be



conducted before building occupancy permit is issued, and no later than six months after. AAMA 511, *Voluntary Guideline for Forensic Water Penetration Testing of Fenestration Products*, must be used if field testing is required more than six months after the building occupancy permit has been issued.

Standard scope

As mentioned, AAMA 503 establishes the requirements for test specimens, apparatus, sampling, test procedures, and test reports to be used in evaluating the performance of newly installed storefronts, curtain walls, and sloped glazing systems as well as their installation during construction. It provides a structured, controllable, and reproducible method for testing.

AAMA 503 recommends including in the project specifications an exact description of the area(s) to be tested. Failure to do so can increase the cost of field testing. Here's a sample specification that specifiers can use.

- The newly installed (Insert storefront, curtain wall and/or sloped glazing system) shall be field tested, as contractually agreed upon by the interested parties, by an AAMA-accredited independent laboratory, as engaged by (_____), in accordance with AAMA 503, *Voluntary Specification for Field Testing of Newly Installed Storefronts, Curtain Walls and Sloped Glazing Systems*.
- The area(s) to be tested is (are) as follows: (Insert an exact description of the area(s) to be tested)
- Air leakage resistance tests shall be conducted at a uniform static test pressure of _____ Pa (____ psf). The maximum allowable rate of air leakage shall not exceed ____ L/s•m^2 (____ cfm/sf).
- Water penetration tests shall be conducted at a static test pressure of _____ Pa (____ psf).

Left: The test chamber must be applied to the interior or exterior of the wall, curb, or roof construction in such a manner as to create a pressure differential across the specimen assembly, including perimeter frame intersections and perimeter seals, subframes, receptors, and flashing.

PHOTOS COURTESY INTERTEK

Right: If tests are performed early enough, necessary corrections can be made with less financial impact and limit other deleterious effects on the project. It is advisable to test products at intervals of five per cent, 50 per cent, and 90 per cent completion of the installation on large projects.

PHOTO ©TADA IMAGES/ COURTESY SHUTTERSTOCK.COM

The test specimen must be representative of typical installations and construction for the project. The specimen(s) must have no outstanding punch list items, visible damages, or irregularities, and not be singled out due to obvious performance problems.

Specification considerations

Per AAMA 503, the test specimen(s) should be determined after carefully considering the project size. It is not cost effective to test large area(s) on a small project (less than 93 m^2 [1,000 sf] of glazing). A glazing specimen of 9.3 m^2 (100 sf) may provide the required information. On all projects, regardless of size, the specifier should also determine how many specimens and/or their desired surface area are required to establish a reasonable measure of quality for the entire project. ASTM E122, *Standard Practice for Calculating Sample Size to Estimate, With Specified Precision, the Average for a Characteristic of a Lot or Process*, provides more information on determining the number of test specimens.

Further, the specifier should balance the cost of the specimen or specimen preparation, as well as the cost of testing and restoration of surrounding components and finishes to their original condition, before determining the number, location, and size (surface area) of test specimens. On larger projects, a formal cost-benefit analysis is appropriate. On smaller projects, the specifier should ensure that the cost of testing and building restoration is less than the cost of the glazing system(s).

Field air leakage resistance tests are only recommended for discrete "punched opening" curtain walls, storefronts, and sloped glazing elevations. It is not recommended for a portion of a continuous system due to the problems associated with compartmentalization and identification of extraneous air leakage (tare).

The specified static water test pressure differential should not exceed two-thirds of the tested or rated laboratory performance. If any test specimen fails to meet the requirements, refer to Section 7.3.7 of AAMA 503.

If water penetration testing reveals leakage that cannot be solely attributed to the glazing system, forensic testing must be initiated by using AAMA 511 and ASTM E2128, *Standard Guide for Evaluating Water Leakage of Building Walls*.

The project specifications and/or the contract documents must clearly identify the responsible party who is liable for the costs associated with the initial field testing, retesting and, if necessary, forensic testing.

Testing must be performed by an AAMA-accredited laboratory or field-testing agency. This assures the specifier the agency has the staff, training, experience, and calibrated equipment to properly perform field testing.

Test methods

AAMA 503 recommends testing resistance to air infiltration using static air pressure difference, as described in ASTM E783, *Standard Test Method for Field Measurement of Air Leakage through Installed Exterior Windows and Doors*, and testing resistance to water penetration using static air pressure difference, according to ASTM E1105, *Standard Test Method for Field Determination of Water Penetration of Installed Exterior Windows, Skylights, Doors, and Curtain Walls, by Uniform or Cyclic Static Air Pressure Difference*.

Test chamber arrangement

The test chamber must be applied to the interior or exterior of the wall, curb, or roof construction to create a pressure differential across the specimen assembly, including perimeter frame intersections and perimeter seals, subframes, receptors, and flashing.

Joints between the specimen and the adjacent wall, curb, or roof can be included in the test specimen unless otherwise noted in project specifications. However, it is not practical to install a chamber on a segment of a continuous horizontal or vertical member. Therefore, air leakage testing of these systems is not recommended.

The test must be performed soon after the specimen is installed, sealants are cured, and before the installation of gypsum wallboard, insulation, or other finish materials. If interior wall materials have been installed, they must be removed to visually check for water leakage.

Wind and other environmental conditions (barometric pressure, rain, and temperature changes) can adversely impact field testing performance. Therefore, the specimen should be isolated from adverse ambient surroundings with a barrier, and conditioned, if necessary, to protect it from environmental settings that may affect test results.

Site preparation

The test specimen must be representative of typical installations and construction for the project. The specimen(s) must have no outstanding punch list items, visible damages or irregularities, and not be singled out due to obvious performance problems.

A single 9.3-m^2 (100-sf) test specimen is typically recommended when contained within a larger wall area. This recommendation does not apply to punched openings less than 9.3-m^2 (100-sf).

The specimen must include perimeter seals, typical splices, frame intersections, and, if applicable, at least two entire vision lites and two spandrel lites containing an intermediate vertical and an intermediate horizontal.

If the specimen contains an integral ventilating system/device, it must be tested twice for both water penetration resistance and air leakage resistance: once with the venting portion of the ventilating system/device in the closed position and again, if necessary, with the venting portion closed and taped or sealed.

After the specimen(s) locations have been selected and the chamber is prepared for testing, it is important to conduct a pretest inspection to check:

- plumb, level, and square of the specimen
- operation of the specimen (if applicable)
- pre-test condition of all surfaces to confirm they were in a condition where a judgment can be made as to whether water penetration is a result of this testing

Whenever possible, the specifier must define the field-testing requirements in the project specifications, including the number of tests and their location. This will provide some assurance that consideration has been given to the complexity of field testing prior to bidding and communicate the requirements to those who will be responsible for or involved in it.

Test procedures

Air leakage and/or water penetration resistance tests must be performed at pressures specified in Sections 7.2.3-7.3.1 of AAMA 503.

If both tests are to be conducted in sequence, the air leakage resistance test must be conducted before the water penetration resistance test.

If there is reason to believe that residual water from rain or other sources could be in the specimen, a negative (outward) pressure test followed by a positive (inward) pressure test must be conducted at the same pressure differential used for the performance test to purge the specimen of any residual water. The specimen gaskets or weatherstrips must be examined and dried before proceeding with the air leakage resistance test.

AAMA 503 also recommends testing resistance to water penetration using static air pressure difference, according to ASTM E1105, *Standard Test Method for Field Determination of Water Penetration of Installed Exterior Windows, Skylights, Doors, and Curtain Walls, by Uniform or Cyclic Static Air Pressure Difference.*

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Air leakage rate

An air leakage resistance test must be conducted at a minimum uniform static test pressure of 75 Pa (1.6 psf) or as specified for the project. However, this must not exceed 300 Pa (6.2 psf). Air leakage resistance (when required) shall be determined and adjusted to standard conditions per ASTM E783.

If changes in outdoor wind speed and/or indoor air pressure cause static air pressure difference readings to fluctuate more than ± 10 per cent from the specified test pressure, one of the following methods must be used:

- Method A: The specimen and/or test chamber must be shielded or temporarily enclosed to minimize these fluctuations.
- Method B: Record 10 readings of airflow, evenly distributed over a 30-minute period for each of the total and extraneous air leakage (tare) measurements. Report both the average of the 10 readings and standard deviation in the test report.
- Method C: Equipment used to maintain the pressure differential during testing must continuously monitor test pressure and self-adjust to maintain the appropriate test conditions.

Extraneous air test

Measurement of extraneous air leakage (tare) readings require special consideration on many on-site installations. It is recommended to review the installation details to identify sources of tare leakage before testing. Precautions must be taken to minimize tare. If tare exceeds the limits specified in ASTM E783, then the chamber can be attached to the perimeter frame of the test specimen to obtain an accurate tare reading.

The intent of the air leakage test is to measure only exterior air leakage through the joints, fixed glazing, hardware, etc., and within the area enclosed by the specimen frame. The air is assumed to be coming from the exterior of the building directly through the specimen. Other sources of air infiltration (*i.e.* through fastener holes, interior trim and mullion covers, exterior panning systems, receptors, flashing, and through leakage in the testing equipment or air chamber attachment to the specimen) are referred to as extraneous air leakage and must be accounted for.

Since it is not practical to account for all sources of air leakage when testing a portion of a continuous curtain wall or sloped glazing, it is not recommended to perform field air leakage tests on these systems.

The maximum allowable rates of air leakage for field testing must not exceed 1.5 times the project specification rate, or 0.5 L/s•m^2 (0.09 cfm/sf), whichever is greater. The specifier may require project-specific air leakage, but this must be stipulated in the project specifications.

The purpose of in-field air leakage testing is to provide reasonable assurances the fenestration product will perform to its specified or rated level with allowances for field reductions, primarily related to ambient environmental conditions and installation.

As expected, field installation conditions will influence product performance. Products tested in the laboratory are perfectly plumb, level, and square in a precision opening. Field test specimens, although installed within acceptable industry tolerances, are rarely

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When installing storefronts, curtain walls, and sloped glazing systems, it is beneficial to test the systems' air infiltration and water penetration resistance performance at regular intervals, as it can help detect manufacturing, installation, and/or perimeter sealing problems before a substantial portion of the project is completed.

perfectly plumb, level, and square. Shipping, handling, acts of subsequent trades, ageing, and other environmental conditions will impact the performance of the installed specimen. A 50 per cent increase in the allowable air leakage for field testing is specified as a reasonable adjustment for the differences between a laboratory test environment and a field test environment.

Water penetration resistance

Water penetration resistance performance shall be determined per ASTM E1105 using Procedure A, "Uniform Static Air Pressure Difference." The field water penetration resistance tests shall be conducted at a static test pressure of two-thirds of the specified project water penetration test pressure, but not less than 200 Pa (4.18 psf). The specifier may increase the field water test pressure to the value specified for the project, but this should be stipulated in the project specifications.

If the project does not have a specified water penetration resistance test pressure, the value should be equal to the manufacturer's published laboratory test pressure or 20 per cent of the positive allowable stress design (ASD) wind load, whichever is greater, times 0.667.

The default pressures used for onsite water penetration resistance tests are not the same as the laboratory test pressure to accommodate for ambient environmental conditions and installation. Therefore, a one-third reduction of the test pressure for field testing is specified as a reasonable adjustment for the differences between a laboratory test environment and a field test environment.

With all operable portions of the specimen closed and locked, the specimen will be subjected to a water penetration test in accordance with ASTM E 1105 with continuous pressure and water application. One must observe and note all points of water penetration, if any, occurring during the test. If the origin of the water leakage cannot be definitively determined, a forensic evaluation must be performed using the procedures outlined in AAMA 511, while maintaining the test pressures defined in AAMA 503.

Unless expressed otherwise in project specifications, water penetration shall be defined as:
a) Water penetration attributable to the surrounding wall conditions—The presence of water not contained within drained flashing, gutters, and sills, which did not originate from the fenestration product or the joint between the fenestration product specimen and the wall/roof.
b) Water penetration attributable to the fenestration product specimen—Per ASTM E1105 with the modification that the collection of up to 15 ml (0.5 oz) of water on an interior horizontal framing member surface in the 15-minute test period will not be deemed a failure.

c) Water penetration attributable to the perimeter joint—Water not controlled by a water management system that indisputably originates at the perimeter joint.

If leakage through frames, frame corners, exterior perimeter seals, or adjacent materials is not visible from the interior and leakage appears on the floor below the test specimen, the lower floor should be inspected for signs of leakage. A means to view, observe, or identify test-related water penetration beyond the planes of water penetration should be accommodated, if desired by any responsible party, provided the appropriate parties know repairs must be made.

If any of the specimen(s) do not conform to the prescribed air leakage or water penetration resistance requirements, or both, the manufacturer and/or the installer must have the opportunity to perform a site inspection and determine the reason for noncompliance. Noncompliant specimen(s) must be repaired as required and retested as soon as practical. The remedial work must be recorded and approved by the specifying authority, architect, and/or owner. Upon satisfactorily passing a retest, the remedial work performed should be considered for similar conditions on the remainder of the project.

Should problems be identified with the specimen installation, they shall be promptly communicated to the responsible contractor and/or manufacturer's representative.

The observations to be recorded must include, but not be limited, to:

- Deterioration of building elements resulting from water penetration
- Deviations of the installation from the drawings of record
- Staining or discolouration of building components
- Evidence of damage to either the installed product or the surrounding building elements
- Unusual or unexpected evidence of water penetration or air leakage requiring remediation
- Any observed performance or installation details that might be deemed of importance to a subsequent forensic investigation

AAMA 503 also provides guidance on calibration of all measuring apparatuses as well as validation of equipment used for onsite testing. Detailed guidelines on the data to be included in test reports are also provided in the standard. This way, AAMA 503 provides a detailed framework for ensuring newly installed storefronts, curtain walls, and sloped glazing systems perform as they are intended to, thereby preventing costly remedial work.

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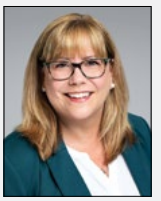
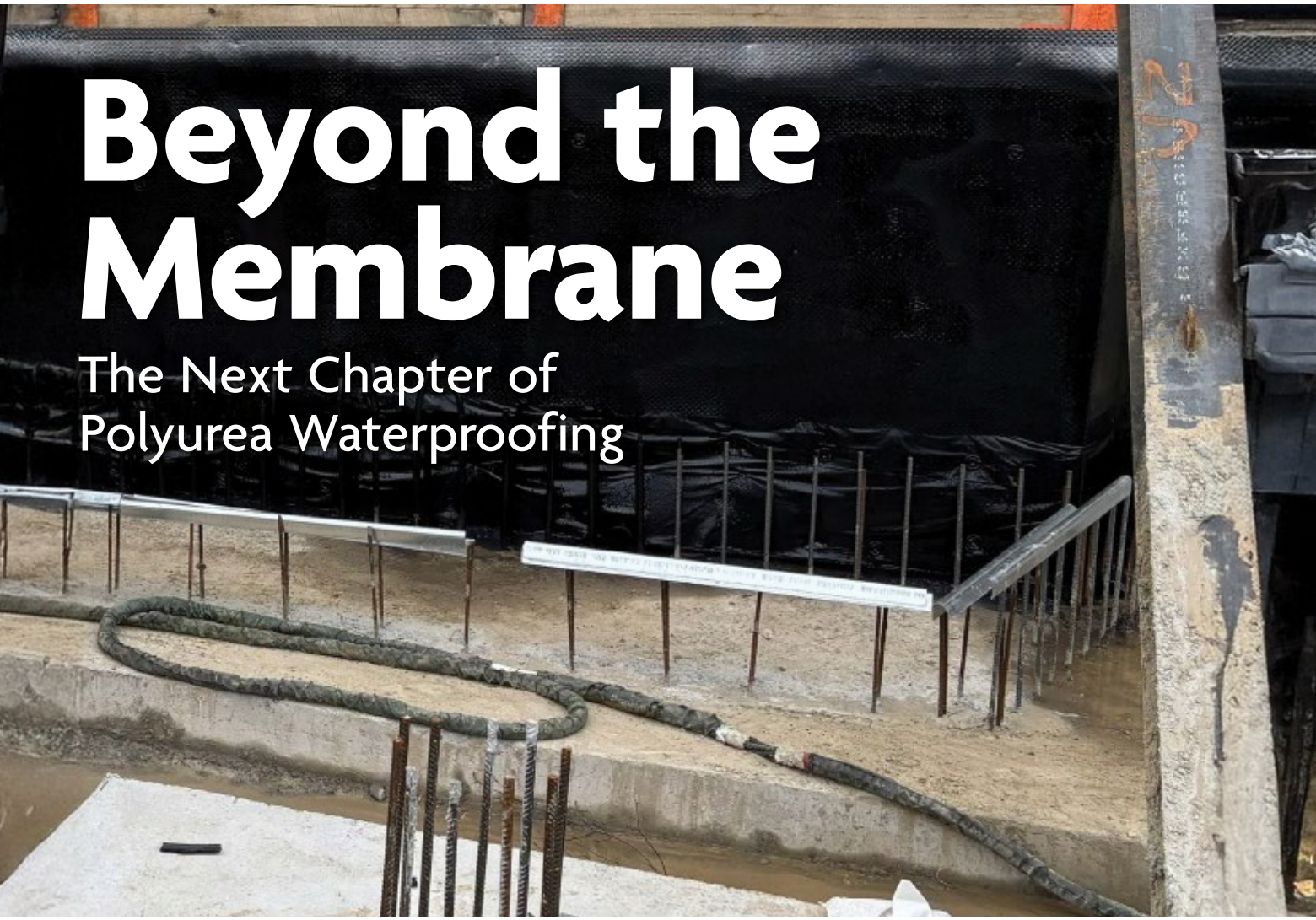


Amy Roberts is the Canadian code and advocacy director for the Fenestration and Glazing Industry Alliance (FGIA). She leads FGIA's Canadian codes and regulatory initiatives with a focus on building and energy codes, standards development, and industry advocacy. In her role, she also supports the FGIA FENBC Region, working closely with stakeholders to represent industry interests at both regional and national levels. With more than 25 years of experience in glass and insulating glass (IG) manufacturing, as well as residential and commercial window production, Roberts brings deep technical expertise and strategic insight to advancing the Canadian fenestration and glazing industry. She can be reached at aroberts@fgiaonline.org.



Beyond the Membrane

The Next Chapter of Polyurea Waterproofing

By Rockford Boyer

PHOTOS COURTESY ELASTOCHEM

Here is a universal truth in construction: water always wins. The industry can try and fight it, detail around it, pray the torch guys do not miss a seam, but in the end, water finds the weak link. This is why waterproofing is one of those construction trades that typically do not make headlines until there is a failure, and then suddenly everyone on the project knows exactly what went wrong and the fingers start pointing.

When this author wrote their first piece on polyurea in *Construction Canada* last year, it was about introducing the polyurea system, a fast cure, seamless application, chemical resistance with all the shiny technical bullet points. However, after spending more time in the field, talking with installers, and digging into project case studies, they realized there is a second chapter of polyurea to tell. This is not just about "what is polyurea." It is about how it is changing the waterproofing practice in Canada, where it shines, where it stumbles, and what is the next generation.

So, grab a strong coffee or a Red Bull and let's get started with the second chapter.

More than just waterproofing

In building science community, everyone loves their control layers: air, vapour, thermal, and moisture control. They are supposed to work in tandem, not against each other. The tricky part is that real buildings/sites are not architecturally scaled details; they are messy intersections of materials, trades, and schedules.

Polyurea has mostly been sold as "a waterproofing layer," but in practice, it is more than that. Due to its seamless, tough, and flexible characteristics, it often ends up having multiple functions:

- Acting as an air barrier on below-grade walls
- Serving as a secondary vapour retarder under plaza decks
- Protecting thermal insulation in roof assemblies

The big advantage of polyurea is system integration. Instead of relying on various layers of dissimilar products taped, glued, or welded together, there is one continuous, resilient membrane that provides secondary security. However, this is key; it only works if the design team understands what they are asking the membrane to do. There cannot just be a material substitution from a sheet membrane for polyurea membrane without rethinking the whole assembly.

Honestly speaking, polyurea is not a miracle coating without adequate design, preparation, and application. It can turn a project around when done correctly, but it can just as easily fall short if the basics were not adhered to. In this author's experience, success is derived by three site factors: good surface preparation, a skilled installer, and solid quality control. Nail those factors, and the polyurea performs beautifully and as intended. Miss one of the three, and it causes trouble (just like any other product). On one Toronto podium deck project, polyurea was chosen because the building owner could not afford to shut down the retail space below for more than a weekend. The crew blasted the concrete, applied primer, laid down polyurea on Saturday, and by Monday morning delivery trucks were back on the deck.

Now, being the devil's advocate; a below-grade application in Calgary saw the general contractor try to "save time" by skipping the application of primer on damp concrete. The polyurea went down fine, looked great, in fact. But within months, water pressure (second law of thermodynamics) started forcing it right off the wall. By the time the repairs were done, the cost savings were long, long gone.

Lesson learned? Polyurea can deliver outstanding performance, but it can be less forgiving than sheet membranes when corners are cut. When one gets it wrong, the membrane makes it known fast.

Freeze-thaw, floods, and resiliency

Here is where polyurea membrane really starts to shine: Resilience. It is known that the climate is not getting easier. In Canada, that means more freeze-thaw cycles, more rain/snow events, and more flooding. Traditional waterproofing membranes are not always designed for that kind of punishment or durability. Polyurea waterproofing, with its flexibility, resilience and chemical resistance, is starting to be used not just as waterproofing, but as flood protection and containment.

An elevated shaft.

Looking at underground parking garages in Montreal or Ottawa, where road salt and hydrostatic pressure and temperatures are relentless. Or those podium slabs in Vancouver that double as green roofs. In these scenarios, polyurea is not just keeping water out of the system; it is acting as a long-term durability strategy, and municipalities are catching on. The author spoke with a facilities manager in St. John's, N.L., who has been specifying polyurea

Podium deck application.

waterproofing in stormwater tanks and culverts. Why? They need infrastructure that has the potential to survive saltwater and abrasion resistance without shutting down for repairs every five years. Polyurea waterproofing has similar upfront costs, but lifecycle cost is where it wins.

The failures nobody talks about

When understanding a building component or system, reading the marketing and technical documents help, but much information can be gained from looking at past failures. Polyurea failures usually fall into three categories:

Adhesion loss

This one is the classic polyurea waterproofing heartbreak. One can have the best product in the world, but if the surface is not prepared correctly, it is game over. Dust, laitance, or a bit of hidden moisture in the concrete will come back to remind one of the negligence. Caution should be given to damp substrates as they look dry, feel dry, then pop blisters once the coating cures, which is usually in minutes. The majority of the time, the problem is not the polyurea waterproofing itself—it is what it is applied to.

Thickness variation

Polyurea does not forgive thin spots of application. A pinhole here or a light pass there might not seem like an issue until the first pressure test, when suddenly, there is a leak path and a long day ahead. It is a fast-moving system, so it takes a steady hand and a good eye to keep coverage even. Wet film gauges, overlap checks, electric thickness gauges, and a bit of pride in one's spray pattern go a long way.

Installer error

The material is only as good as the applicator holding the spray gun. Wrong pressure, cold substrate, or bad mix ratio can turn a perfect specification into a repair job. Polyurea moves quick, so experienced installers know their equipment, their surface, and their rhythm. The inexperienced usually learn the hard and expensive way.

These issues are not the result of the waterproofing material itself; they are failures of process. Polyurea waterproofing is reliable, solid; it is the shortcuts, the guesswork, and the "good enough" mentality that cause the headaches for the site and design team. As polyurea waterproofing shows up in more specs and more job sites, the industry must improve its preparation and installation practices. This means real contractor training, not a five-minute demo in a parking lot over a Timmies. It means QA/QC mockups and programs that catch mistakes before they are buried under concrete or backfill. The chemistry and chemists have done their part; now it is about consistency, accountability, and elevating standards to ensure polyurea performs as intended.

Right now, polyurea is in a funny place with Canadian standards. It is not a fringe product anymore, Canadian Construction Materials Centre (CCMC) has approved systems, ASTM has test methods, but it is not fully embedded in codes the way sheet waterproofing membranes are. This creates a chicken-and-egg problem: some specifiers hesitate because "it is not in the book," while manufacturers argue the product cannot get into the book without more specs and jobs.

However, the momentum around polyurea is starting to shift in Canada. As embodied carbon reporting starts hitting specs, long-life resilient membranes such as polyurea gain traction. As climate resilience becomes part of building codes, systems that withstand flooding and freeze-thaw cycles without replacement will move from "nice to have" to "required."

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Sewer lining with polyurea using robotic arm.

Infrastructure: Where the action is

To see polyurea flex its membrane muscles, look at infrastructure industry. This is where it earns its stripes.

- Bridges—Polyurea is used as a waterproofing and anti-corrosion layer under asphalt overlays, protecting concrete decks from salt, freeze-thaw, and decades of abuse. It is fast to apply, cures in minutes, and does not hold up traffic for a week, and municipal crews love that.
- Wastewater plants—Polyurea's chemical resistance and durability is key here. Tanks, clarifiers, containment pits, and places where concrete and epoxy systems would normally degrade, stay intact because polyurea is resilient against acids, salts, and whatever else ends up in the mix. It is referred to as the coating's equivalent of a raincoat for industrial sludge.
- Transit tunnels and subways—These are perfect examples of where seamless application matters. Polyurea creates a continuous waterproof membrane that keeps groundwater on the outside. No seams, no joints, no weak spots, just a monolithic waterproofing barrier between the tunnel occupiers and the mess behind the wall.

These are not quick residential touch-ups. These are high-stakes, high-budget, public-facing projects such as bridges, tunnels, and treatment plants where failure is not an option and everyone from the engineer to the mayor wants peace of mind. Municipalities are willing to spend more upfront for something that will not peel, crack, or leak five years later.

Polyurea may have successfully entered the Canadian market through the building enclosure side, roofs, parkades, below grade, and podiums, but it also has a future on infrastructure projects. The bigger and harsher the job, the better it has the potential to perform. It is fast, durable, and proven in environments that would degrade a lesser coating. This is not a niche product anymore—it can provide national-scale waterproofing protection, one spray pass at a time.

Here is where it gets interesting: Polyurea is already a high-performance coating, fast-curing, flexible, and built to last, but research and development are where the chemistry can really be dialled in. What used to be a niche waterproofing system is now a full-on chemistry-derived product for the Canadian market.

- Polyurea and polyaspartic blends—This combination brings the best of both worlds together: polyurea's toughness with polyaspartic's UV resistance and gloss retention. The result is coatings that can take direct sunlight and heavy traffic and still look sharp years down the road. They are great for exposed decks, parkades, or anywhere that used to yellow or chalk after a few summers. It is the evolution from "industrial tough" to "architecturally clean."
- Polyurea and geotextiles—Embedding geotextiles into polyurea membranes adds tensile strength and gives crack-bridging ability. Think of it like

rebar for coatings; it helps absorb movement without tearing or delaminating. This is more widely used on podiums, buried decks, and aging infrastructure that needs a little flexibility to stay watertight.

- Bio-based resins—Sustainability is creeping into the chemistry lab, too. Researchers are working on partially renewable feedstock bio-based polyols and isocyanate alternatives that reduce embodied carbon without giving up performance. While it is still early, the industry is watching closely the idea of a low-carbon, fast-cure polyurea.

Then there is the automation angle robotic spray rigs designed for tunnels, bridges, and massive flatwork. These systems promise laser-controlled spray paths, consistent film thickness, and no coffee breaks. If that takes some of the "installer skill" variable out of the mix, it could be a real game-changer. Imagine perfectly applied, uniform polyurea on a 2-km (1.2-mile) tunnel wall no overspray, no misses, no rework.

In short, polyurea's future is not just about better products; it is about smarter application and more sustainable chemistry. Technology is catching up to performance, and that is when materials stop being "coatings" and start being high-performing systems.

Training, safety, and understanding the contractor's perspective

Let's not forget: polyurea is a high-skill install product. It requires heated hoses, plural-component spray rigs, and proper PPE. Crews need training, not just in application, but in troubleshooting because when the gun clogs or pressures drift, it needs to be known before 200 L (44 gal) of resin is wasted.

Contractors the author has worked with appreciate the productivity—one crew can cover thousands of square feet in a day—but they also know there is a learning curve. Polyurea is not a "pick it up on Monday, install by Friday" trade; it is an investment for the contractor, designer, and building owner. The good crews keep daily work records to track product parameters, weather conditions, and preparation, and they follow the manufacturer's installation guide like the gospel, because it ensures that what is sprayed in the field actually matches what is written on paper.

Bathtub waterproofing application.

When it comes to warranty programs, polyurea is not a "set it and forget it" kind of system; it is a "prove it and document it" one. Always ask the manufacturer about their specific warranty length and coverage details because not all programs are created equal. The good ones back both the material and the installation, but only when the work follows the manufacturer's written instructions. This is where third-party insurance inspectors come in; they are not just clipboard carriers, they are the warranty's best friend. Having them onsite to review prep, mixing, and application steps keeps everyone honest and ensures the installation stands up to scrutiny years down the road, not just until the next rainstorm.

Water tank application.

What is next: From waterproofing to resiliency strategy

So where does this leave the industry? Polyurea has already proven itself in fast-track construction and heavy-duty infrastructure. The next phase is integration into resiliency strategies.

- Flood-resistant basements in residential high-rises
- Transit systems protected from water ingress
- Podium decks designed not just for waterproofing, but for long-term durability under green roofs and public spaces

As Canada continues grappling with climate change, municipalities, insurers, and asset managers will be asking harder questions: not just "how can water be kept out?" but "how to keep this asset running for 50-100 years without any major intervention?" Polyurea waterproofing is positioned to be part of that answer.

Conclusion: Past the buzzwords

At this point, there are enough waterproofing failures to know one thing: water has a sense of humour and it is usually at the industry's expense. It does not care about spec numbers, fancy power points, or how many pre-construction meetings were held. It just finds the first weak point and pours itself a coffee.

Polyurea does not stop water from being water, but it sure gives it a run for its money. When it is done right with proper prep, skilled hands, and solid QA/QC, it is like putting body armour on the concrete. When it is rushed, though, it might as well be waterproofing with optimism and duct tape.

The good news? The industry is catching on. It is seeing better training, smarter rigs, and chemists creating better resins that are tougher, greener, and and completely free of volatile organic compounds (VOCs) so they are safer for crews and the planet. From bridges to basements, to water parks, polyurea has evolved from an "interesting alternative" to "why was this waterproofing not used years ago?"

Therefore, next time someone calls it "just another coating," take a sip of bad coffee, smile, and remind them this: polyurea does not just waterproof—it changes the game. And unlike some of those hotel brews, it holds up under pressure.

Reference

- Read initial article on polyurea at constructioncanada.net/uncovering-the-unseen-blindside-waterproofing/

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.

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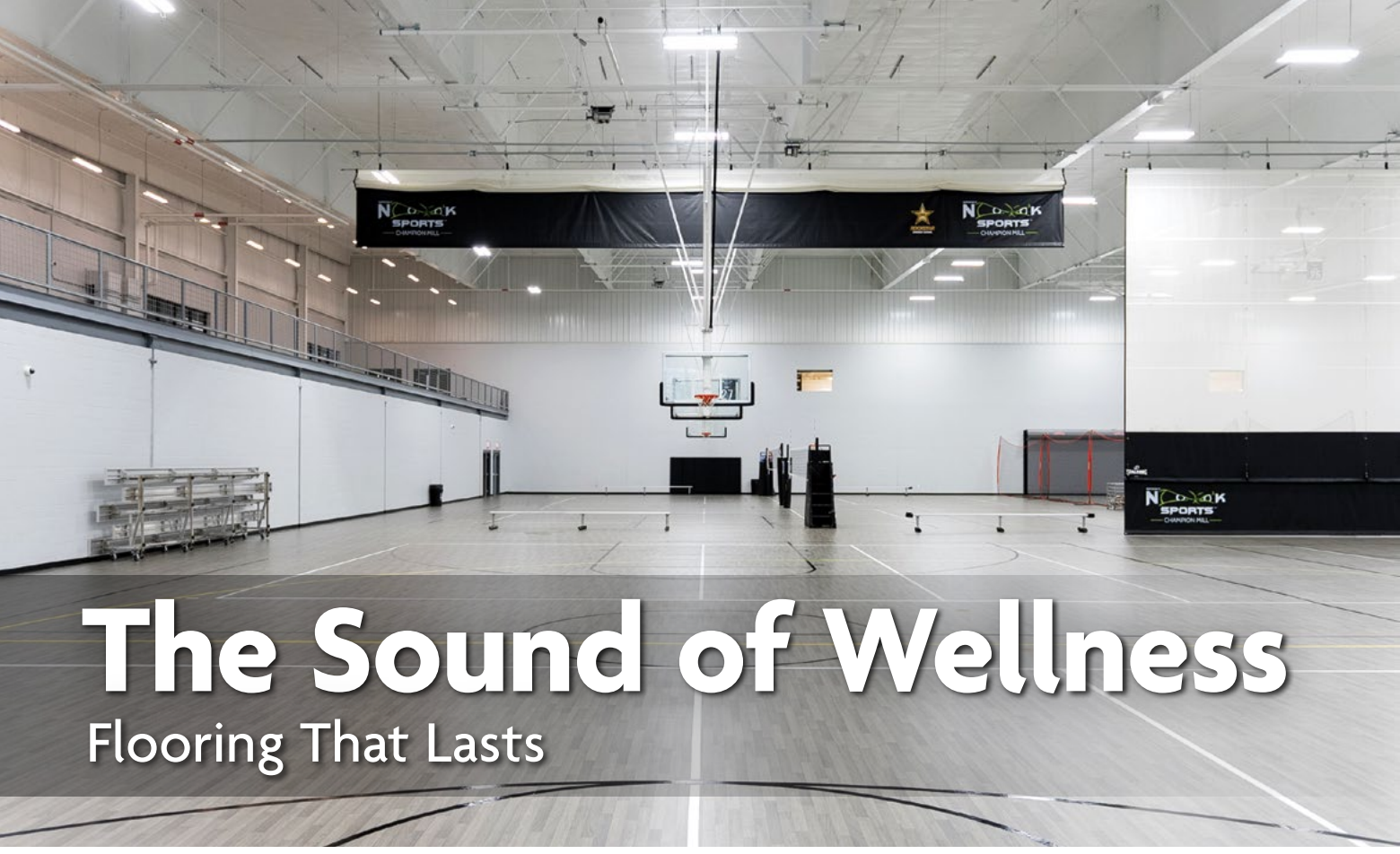


The Sound of Wellness

Flooring That Lasts

By Justin Reidling

PHOTOS COURTEST ECORE

As occupant health and wellness remain vitally important aspects of the built environment, acoustics have emerged as a key factor in creating spaces that foster productivity, rest and positive experiences. Whether in health-care facilities, offices, hotels, multifamily residences, educational institutions or fitness centres, managing noise is essential to supporting both mental and physical well-being. One often overlooked element in the acoustic equation is flooring—a material choice that directly influences impact noise from footsteps, dropped objects, rolling carts, and even weight drops in gyms. The right flooring solution can play a transformative role in reducing noise levels and enhancing overall occupant satisfaction.

The challenge of noise across building types

Noise can be a disruptive factor in nearly every type of building. In health-care settings, elevated and unexpected sounds can affect patient recovery by disrupting sleep, increasing the need for medication, and ultimately extending hospital stays. For staff such as nurses, excessive noise can lower speech intelligibility, impair decision-making, and contribute to fatigue.[1]

In commercial office environments, background noise from footsteps, conversations, and moving furniture can reduce concentration and productivity. Hotels and multifamily residences face challenges maintaining restful spaces for guests and residents, especially when gyms, conference areas, or restaurants are located near sleeping areas.[2]

Educational settings require low noise levels for optimal learning, while fitness facilities must manage impact noise from heavy weights, cardio machines, and high-intensity workouts.

Managing impact energy to reduce noise

When an object—whether it is a shoe, a chair leg, or a dropped weight—makes contact with the floor, the object's kinetic energy is redirected. That energy is distributed in several ways: some is returned to the object (bounce), some is transformed by the floor (heat), and some is transmitted as noise into the same room or adjacent spaces. Since the relative amounts of heat and transmitted noise are proportional to the mass and damping of the floor-ceiling assembly, the building materials therein are of critical importance.[3] In other words, the floor can help manage how and where the energy goes.

A health-care worker walks across resilient flooring designed to minimize impact noise and support a quieter healing environment.

In acoustical engineering, this transmission is often measured through metrics such as Impact Insulation Class (IIC) and High-frequency Impact Insulation Class (HIIC). IIC quantifies how well a floor-ceiling system attenuates low-frequency impact sounds—such as footsteps or dropped objects—while HIIC is more sensitive to high-frequency sounds, such as the sharp click of high heels. Both ratings are influenced by factors such as surface hardness, underlayment composition, and structural mass. For example, denser materials may reduce low-frequency "thuds" but allow higher-frequency sounds to pass through, whereas resilient underlayments can absorb and dissipate energy across a broader spectrum.

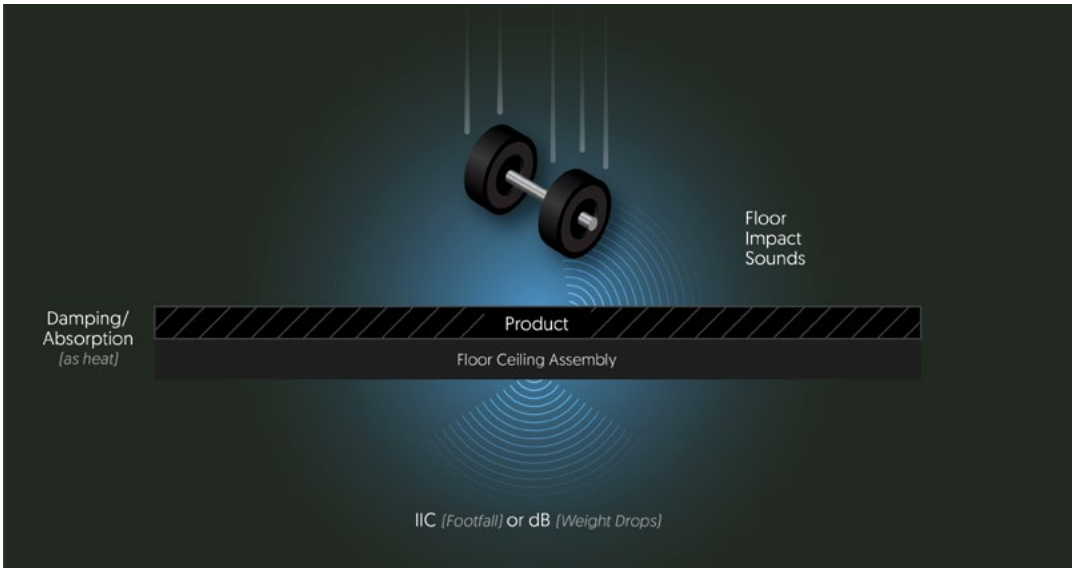
Historically, carpet was widely used in many building types because of its comfort and because its soft surface naturally reduces impact noise. However, modern design trends favour hard-surface flooring for light and temperature management, esthetics, durability, and maintenance, and these surfaces readily transmit impact noise. This is especially problematic in mixed-use and multistorey buildings where noise can travel between floors, via walls, and from tenant to tenant. By carefully selecting and combining flooring materials, designers can fine-tune acoustic performance to create environments better suited to health-care, educational, residential and commercial needs.

Flooring as a key acoustical solution

Performance flooring can significantly reduce sound from impacts and interactions with the floor, such as footfall, dropped objects, dragging furniture, or rolling carts. The effect can be orders of magnitude in terms of perceived noise. In hospitals, quieter flooring materials can reduce rolling and impact noise levels enough to encourage lower speaking volumes—a reverse of the "cocktail party effect," where everyone raises their voice to be heard. In fitness settings, specialized rubber flooring absorbs and isolates impact noise from dropped weights or fast-paced workouts, protecting noise-sensitive areas like offices, hotel rooms, or classrooms located nearby.

Evidence-based design and acoustical performance

Evidence-based design (EBD) is more than a philosophy—it is a disciplined approach that draws on scientific research and data to influence the built environment in ways that positively affect human health, behaviour, and experience. EBD considers numerous factors, including



Flooring assemblies help damp impact sounds from footfalls or weight drops, reducing transmitted noise, and improving acoustical performance as measured by Impact Insulation Class (IIC) or decibel levels.

In fitness settings, specialized rubber flooring absorbs and isolates impact noise from dropped weights or fast paced workouts.

visibility, circulation paths, ergonomics, and acoustics. It is especially relevant in facilities like hospitals, schools, and workplaces, where design decisions have measurable outcomes.

Environments inundated with unnecessary or uncontrolled noise can cause stress, hinder sleep and healing, and decrease concentration or productivity. The ability to proactively address acoustical issues rather than retrofit solutions after problems arise is a hallmark of thoughtful, occupant-centred design.

In multi-family housing, building codes require a minimum Impact Insulation Class (IIC) rating of 50 to reduce impact sound transmission between residential units. This minimum contributes to a baseline of acoustic comfort and privacy. Similar guidelines exist across other sectors, including hospitality, education, and health-care.

Studies comparing hard-surface materials, such as vinyl composition tile (VCT) and luxury vinyl tile (LVT), with acoustically engineered flooring systems have shown significant differences in both decibel levels and IIC ratings, which measure how well a floor assembly reduces impact sound transmission.[4] As mentioned, in health-care settings, quieter flooring can support healing by enabling rest and reducing stress on both patients and staff.[5] And in hospitality or multifamily buildings, it contributes to a more peaceful, premium experience for occupants.[6]

Building codes in multi-family housing require a minimum Impact Insulation Class (IIC) rating of 50 to reduce impact sound transmission between residential units. This minimum contributes to a baseline of acoustic comfort and privacy. Similar guidelines exist across other sectors, including hospitality, education, and health-care.

Well-designed flooring aligns with EBD principles to meet and exceed minimum requirements. For example, a 3 mm (0.12 in.) LVT on a 152-mm (6-in.) concrete slab structural floor might typically achieve IIC 40 or less, whereas an LVT with a rubber underlayment might typically achieve IIC 50 or more, and a vinyl plank with an integral rubber pad might typically achieve IIC 54.

Ultimately, EBD encourages architects, designers, and facility planners to assess the long-term impact of their decisions. Flooring that contributes to reduced noise transmission is a strategic investment in the health, satisfaction and productivity of every person who walks through the space.

Real-world applications and testing

Engineered floorings sometimes include dissimilar materials factory-laminated to achieve otherwise impossible performance. Such technology can enhance force reduction and energy restitution characteristics and change the way sound is generated and transmitted in order to help control both in-room and transmitted impact noise.

Independent testing has shown that some proprietary surfaces can achieve a notable reduction in perceived loudness compared to common hard-surface materials. For example, common VCT and LVT can generate an increase of well more than 100 per cent in perceived in-room loudness relative to certain factory-laminated floor surfaces.[7]

Designing for acoustics in any building type

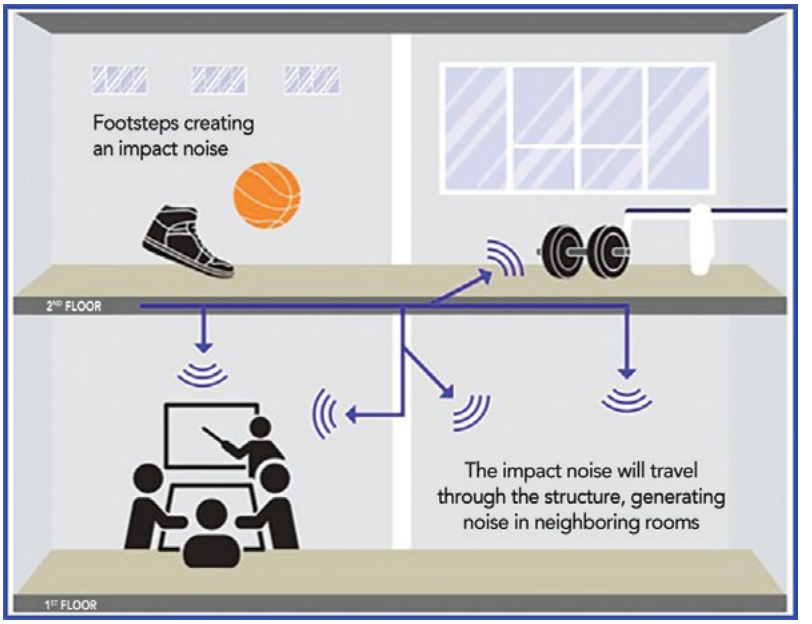
Selecting the right flooring for a space requires balancing multiple priorities: esthetics, durability, maintenance, hygiene, comfort and acoustics. In hospitals, this might mean choosing a surface that can withstand frequent cleaning while reducing noise from rolling equipment. In hotels, it might mean using sound-reducing flooring in hallways above guest rooms. In educational facilities, it could mean specifying impact-reducing materials in multipurpose rooms or gymnasiums to protect classrooms nearby.

Ultimately, good design is a balance of the project's many performance goals. Flooring is one of the few elements that directly affects impact noise in the room itself, transmitted noise to surrounding spaces, maintenance, and more—making it a critical piece of the acoustical design puzzle.

Conclusion

As the demand grows for healthier, more comfortable, and more productive indoor environments, acoustics continue to play a defining role in the built environment. From hospitals to hotels, offices to fitness centres, flooring choices can make a measurable difference in reducing noise, supporting wellness, and improving the overall experience for every occupant.

By incorporating evidence-based design principles and selecting materials engineered for acoustical performance, designers and facility managers create spaces that sound and feel better.



Impact noise from footsteps, dropped objects, or gym equipment on upper floors can travel through a building's structure, disrupting occupants in neighbouring spaces.

Notes

[1] See aamc.org/news/hospitals-are-noisy-they-don-t-have-be

[2] Refer to alertify.io/how-hotels-can-reduce-noise-complaints-and-improve-guest-satisfaction/

[3] Read "Structureborne Sound Isolation" in *Handbook of Acoustical Measurements and Noise Control.*

[4] Visit pubs.aip.org/asa/jasa/article/136/4_Supplement/2219/640594/Contribution-of-floor-treatment-characteristics-to

[5] Learn more at pubmed.ncbi.nlm.nih.gov/25929469/

[6] Refer to buildingbetterhealthcare.com/reducing-noise-to-support-stress-free-environments

[7] See ecoreathletic.com/news-press/updated-surface-generated-noise-test-data-available-ecore

Justin Reidling is an acoustic engineer at Ecore, bringing years of multifaceted experience as a product engineer and acoustical consultant. He holds a bachelor's degree in mechanical engineering with a minor in acoustics from Kettering University in Flint, Mich.

Mitigating Water Risks

Advanced Containment Solutions

By Steve Eyer

PHOTOS COURTESY DENIOS US

Safeguarding against floods, spills, and sprinkler discharge is critical across industries and facilities. Containment barriers are ideal for protecting facilities and their contents from these potential hazards, and many options are available. Barriers cater to a wide range of applications with both automatic and manual versions, ensuring businesses are equipped to handle various emergency scenarios without compromising operational efficiency. This article discusses the technology behind these barriers, their practical applications, and their benefits for different industries.

Industrial and commercial environments must always be on guard against floods, hazardous spills, and sprinkler discharge. Hazardous material spills with uncontained runoff can result in environmental contamination and expensive fines. Automatic sprinkler systems are lifesavers, but failure to contain their discharge water can be harmful to the environment and disastrously expensive to mitigate. Floodwater damage can be costly, even at lower levels of a foot or less. Existing drainage systems and minimal containment measures are insufficient, especially for facilities working with hazardous materials. The need for robust solutions is urgent, especially as environmental regulations grow stricter and industrial operations become more complex.

Flood risks continue to rise

Uncontrolled water entry is a threat to industries operating in low-lying areas. Industries that house sensitive materials are especially concerned about floods. More than 80 per cent of flood damage is caused by less than 381 mm (15 in.) of water, but just a few inches of water in a warehouse can cause stock loss and disrupted operations. Flooding is becoming harder to predict due to climate change. According to the World Resources Institute (WRI), the number of people affected by flooding will more than double by 2030. Floodplains are expected to shift and expand due to more frequent and intense storms. This growing instability increases the threat to businesses worldwide and makes reliable flood containment measures even more important. Unaddressed, these risks lead to escalating costs and greater liability.

The threat of flooding does not stop at external factors, either. Internal sprinkler systems designed to protect against fire can cause water containment issues, as sprinkler water can mix with hazardous chemicals and contaminate areas it flows into. Even non-hazardous chemicals can be problematic from an environmental standpoint. Spill migration has the potential to be catastrophic. Even a small spill can cause contamination, forcing work delays and costing millions in cleanup and downtime. Without adequate containment systems to prevent contaminated water from leaving the room or facility, these events can result in regulatory violations and environmental damage. Facility managers know that these risks are not just limited to large-scale disasters. Even a minor incident can accumulate and cause expensive consequences. This underscores the need for proactive flood and spill containment strategies.

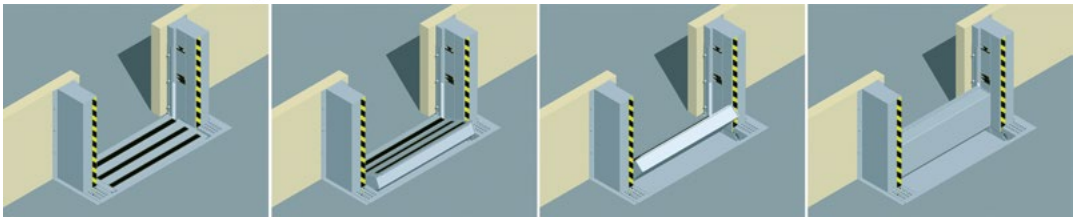
Floods, spills, and leaks can be costly and harmful

There are many financial, operational, and safety risks associated with uncontained water or chemical spills. Fines for environmental violations from regulatory bodies, such as the *Canadian Environmental Protection Act* (*CEPA*), can reach hundreds of thousands of dollars, not to mention the added cost of cleanup. A single uncontrolled spill in a chemical storage facility can mean fines for allowing contaminated runoff to enter local water supplies or sewage systems. Companies can also face insurance premium increases and a loss of business due to non-compliance with environmental safety standards. In addition, the bad press from an incident has long-lasting consequences. A damaged reputation undermines the trust of consumers and impacts business value.

Downtime caused by floodwaters or chemical spills can be devastating. Facilities that depend on continuous operation, such as food processing plants, pharmaceutical manufacturers, or logistics hubs, suffer from interrupted production lines

Automatic and manual barriers are available to suit a wide range of applications and industries, including deployment and removal of manual barriers for temporary protection during maintenance or for areas that do not face constant risk.

Barriers are constructed to 304 stainless steel and include a Teflon gasket to withstand harsh conditions.



Barriers are constructed to 304 stainless steel and include a Teflon gasket to withstand harsh conditions.

and delayed shipments. Employee safety is also a concern. Hazardous material spills can pose severe risks to worker health, and flooding can lead to structural damage, mould, and long-term safety hazards. Exposure to dangerous chemicals may require emergency response efforts and even facility evacuations. Uncontained floods, spills, and leaks can escalate costs and lead to greater liability. Solutions are needed, especially as environmental regulations grow stricter and industrial operations become more complex.

Automatic pop-up barriers control floods and spills

Advanced automatic pop-up barriers activate without needing electricity, compressed air, or human intervention. This innovative technology is beneficial in situations where a rapid response is critical. When a liquid flow reaches the barrier, it is collected in the sump that houses the barrier wall. As the volume of fluid increases, it displaces the wall from its horizontal position. The built-in mechanism then brings the barrier to its full locked and upright position, containing or holding back the impending liquid with a watertight seal. This fast response to a spill or flooding event can save time and money on cleanup operations. After the event, pop-up barriers can be easily reset and reused. The automatic pop-up feature ensures the facility remains protected even without personnel, preventing damage and lowering the risk of hefty fines.

Constructed from solid, welded Type 304 stainless steel with a Teflon gasket and built to withstand harsh conditions, pop-up barriers are suitable for many settings. Offering chemical resistance and long service life, they are made in a one-piece factory-adjusted design, lubricated, and easily installed in existing doorways. Designed to lie flat on the floor when not in use, there is no need for berms or ramps, and retention heights of 305 mm (12 in.), 457 mm (18 in.), and 610 mm (24 in.), respectively, are available. Available sealed widths range from 1,016 to 4,978 mm (40 to 196 in.). Their robust construction supports vehicular traffic up to 5,897 kg (13,000 lb) of axle weight when flat and not in use, making them no problem for busy facilities. Owners should follow manufacturer guidelines for periodic maintenance for peak performance.

Structurally, flood barriers and spill barriers are the same; the difference is how and where they are installed. As flood barriers, pop-up barriers are helpful in protecting infrastructure because they can safeguard low-lying areas, doorways, and other building access points from the influx of floodwaters. By rising automatically when water reaches the barrier's sump, they provide quick and reliable protection to

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Barriers on external doors protect against rising waters and flooding, while those installed on interior doors contain sprinkler discharge to avoid accidental discharge, expensive cleanup, and downtime.

minimize costly damage to equipment, stock, and even the structural integrity of a building. They are an excellent solution for facilities found near bodies of water and locations vulnerable to stormwater runoff from surrounding areas.

As spill barriers, pop-up barriers serve a valuable function for facilities concerned about sprinkler discharge water. Sprinkler systems are a common fire safety measure in industrial settings, and when the systems activate, water can mix with hazardous materials and lead to contamination. Pop-up spill barriers are NFPA compliant, prevent contaminated water from escaping the facility, and can help ensure that potentially harmful substances do not reach the sewer systems, soil, or waterways. Since they require no power, they are effective even when electric systems are compromised. Commonly found in chemical storage areas, manufacturing plants, logistics hubs, data centres, and food processing facilities, they are also effective across many industries, including pharmaceuticals, automotive, aerospace, and even large retail chains such as Amazon and Home Depot.

Manual barriers provide cost-effective protection

Manual containment barriers are a newer development that offer a practical and cost-effective way to retain polluting fluids. Their chemical-resistant gaskets maintain a tight seal in both hot and cold conditions, and the rigid steel and aluminum design withstands extreme temperatures during fire. A unique clamping mechanism secures the barrier in place between pre-set piers installed at the opening, which eliminates the need for ramps or berms. They work well for protection in areas with less frequent traffic and few pedestrian or vehicle doors to protect, such as warehouse storage zones or secondary access points. Indoors, without traffic, the barriers can remain horizontal and avoid possible leaks. Various styles and sizes of manual spill control barriers are available, including manual insertable, pivoting, loading dock barriers, and step-ramp style barriers. The barriers can be deployed and then removed, making them suitable for temporary use during maintenance operations or in areas that do not face constant risk, and are less intrusive because they do not require the extensive site preparation needed for automatic systems. Due to their manual nature, they require personnel to be on-site to activate them, which may not always be possible in emergency scenarios. They are a practical decision for facilities that need occasional spill or flood protection without the need for continuous readiness.

Containment barriers are widely used across many industries, and their effectiveness in preventing water damage and environmental contamination makes them a preferred choice. The wide range of selections allows companies to maintain facility safety and integrity with reliable and automatic protection against floods, spills, and sprinkler discharge. Technology advancements in automatic barriers and the ongoing development of manual alternatives mean more choices are available. The future of this industry will bring new maintenance programs and product enhancements as the barriers continue to safeguard industrial and commercial environments against unexpected water-related incidents.

Steve Eyer is manager, engineered solutions for DENIOS, which provides safety and environmental protection products for North American installations. For more information visit www.DENIOS.ca.

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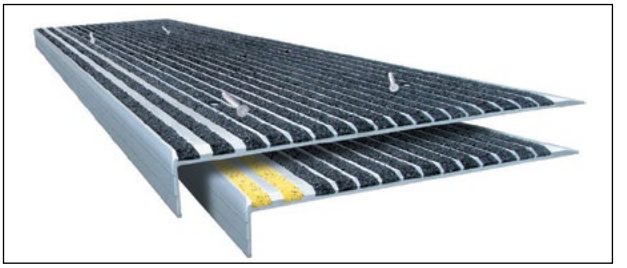

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Kelly Sawatzky, CSP, RSW

Practical lessons for growing as a leader

Over the past 20 years, I've often been asked a very familiar question, "Aren't you worried that 'X' technology is going to make your job as a specification writer obsolete?"

At the time of writing, I've just returned from the Construction Specifications Institute's (CSI) National Conference, where I attended several presentations and spoke with numerous people about artificial intelligence (AI) and its potential influence on the writing of specifications in the years ahead.

One point that was brought to my attention, which makes a lot of sense, is the comparison between AI and the introduction of master specifications in the 1960s. When they were introduced, they enabled people with limited experience in writing specifications to produce consistent specifications.

Much like the earlier shift, master specifications enabled novice practitioners to produce documentation that supported the project, even if they did not yet possess the expertise of seasoned specifiers. Those who chose to specialize developed the analytical and technical skills required for the role over time. In a similar way, I see AI helping teams reach a baseline of quality while still enabling experts to refine and elevate the work.

In my view, AI will automate some of the rote tasks (*e.g.* populating a project) involved in spec writing. Still, it cannot fully replace the people who know which questions to ask and the level of detail needed to communicate the design intent clearly. Currently, even researching materials still requires a person skilled at asking questions, guiding the search, and then verifying the accuracy of the results.

Providing the required regional modifications to our projects will be difficult for AI specification providers, although not impossible.

Lastly, AI cannot create something truly new; it can only generate variations based on existing, published information. However, there remains an opportunity to enhance consistency in wording and referencing.

It may give many teams the ability to produce strong work, much like how master specifications elevated project documentation when they were first adopted. I'm encouraged by the possibilities and optimistic about where we're headed.

I've never worried about being made obsolete. The work of specifiers has evolved over the years and will continue to do so, but will it be rendered completely obsolete by AI? Not likely.

Évoluer avec l'IA pour la rédaction des spécifications

Au cours des 20 dernières années, on m'a souvent posé la question : « N'êtes-vous pas inquiet que la technologie 'X' rende votre travail de rédacteur de spécifications obsolète? »

Au moment de la rédaction du présent document, je reviens tout juste de la conférence nationale de *Construction Specifications Institute* (CSI), où j'ai assisté à plusieurs présentations et parlé avec de nombreuses personnes sur l'intelligence artificielle (IA) et son influence potentielle sur la rédaction des spécifications dans les années à venir.

Un point qui a été porté à mon attention, et qui a beaucoup de sens, est la comparaison entre l'IA et l'introduction des spécifications maîtres dans les années 1960. Lorsqu'elles ont été introduites, elles ont permis à des personnes ayant une expérience limitée dans la rédaction de spécifications de produire des spécifications cohérentes.

Tout comme pour le précédent changement, les spécifications maîtres ont permis aux praticiens novices de produire une documentation qui soutenait le projet, même s'ils ne possédaient pas encore l'expertise des spécificateurs chevronnés. Ceux qui ont choisi de se spécialiser ont développé les compétences analytiques et techniques requises pour le poste au fil du temps. De la même manière, je vois l'IA aider les équipes à atteindre une base de qualité tout en permettant aux experts d'affiner et d'élever le travail.

À mon avis, l'IA automatisera certaines des tâches par cœur (par exemple, remplir un projet) impliquées dans la rédaction de spécifications. Pourtant, elle ne peut pas entièrement remplacer les personnes qui savent quelles questions poser et le niveau de détail nécessaire pour communiquer clairement l'intention de conception. Actuellement, même la recherche de matériaux nécessite encore une personne compétente pour poser des questions, guider la recherche, puis vérifier l'exactitude des résultats.

Fournir les modifications régionales requises à nos projets sera difficile pour les fournisseurs de spécifications d'IA, bien que ce ne soit pas impossible.

Enfin, l'IA ne peut pas créer quelque chose de vraiment nouveau; elle ne peut que générer des variations basées sur des informations existantes et publiées. Cependant, il reste une opportunité d'améliorer la cohérence dans le libellé et les références.

Cela peut donner à de nombreuses équipes la capacité de produire un travail solide, tout comme les spécifications maîtres ont élevé la documentation du projet lorsqu'elles ont été adoptées pour la première fois. Je suis encouragé par les possibilités et optimiste quant à la direction que nous prenons.

Je ne me suis jamais inquiété d'être rendu obsolète. Le travail des spécificateurs a évolué au fil des ans et continuera à le faire, mais sera-t-il complètement obsolète par l'IA? Peu probable.

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