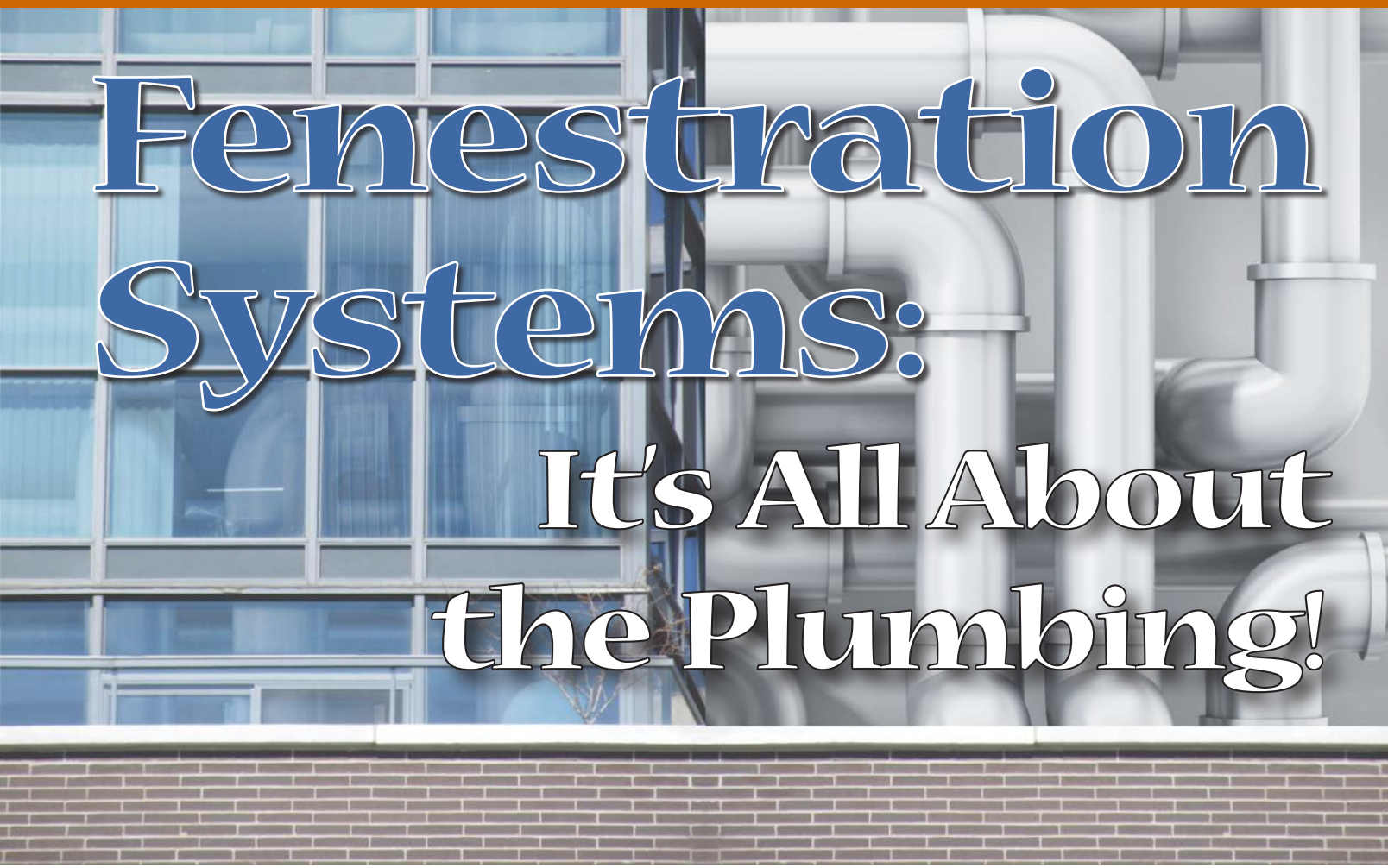

Fenestration Systems: It's All About the Plumbing!

This glazing system on the condominium above can be represented by the slightly more chaotic plumbing on the right. Ok, not quite—but you get the idea.

By Peter Adams, P.Eng., Principal & Senior Building Envelope Engineer, Morrison Hershfield

A few years ago, the Toronto office of our engineering firm experienced what we termed "the year of the crappy curtain wall." In reality, it was more like 18 months, and during that period, we investigated persistent water penetration in several low- to mid-rise commercial office buildings ranging in age from five to 20 years old.

The failures discovered were not unique to curtain wall systems and were entirely avoidable if those responsible had even a basic understanding of how these systems are supposed to function. For some of the buildings we investigated, the failures were in conventional, fully captured curtain wall systems that were not installed correctly from the get-go. There are many excellent, qualified curtain wall installers out there, but apparently, they were off benefitting other jobs when these buildings were constructed.

Any fenestration systems can be adversely affected by inexperienced or unqualified installers. A new high-rise condominium, specified to be rainscreen, had the misfortune of being fitted with a modified window wall system that started off being face-sealed and ended up being a reluctantly draining rainscreen system. The developer passed off a cheaper solution to the owners, and the manufacturer sold the developer their modified system with empty promises of performance equality. This "lipstick on a pig" project saw multiple hacks into the window wall system that loosely complied with the project specifications but ended up leaving the building with a systemic water penetration problem. The performance of even the best quality systems can be jeopardized if basic rules of engagement are not followed.

Our experience in the Greater Toronto market is, unfortunately, not unique, and we have seen similar unnecessary fenestration failures across North America. With the proliferation of fenestration systems in new construction and retrofit (often with increased level of sophistication to meet aesthetic requirements), the surge toward in-plant glazing, and the frequency of performance problems, it is important to understand some of the most significant causes of failure so they can be avoided. It is also important to know the tells that offer clues to where the failures are occurring, and how you can significantly reduce the chances that fenestration failures will damage your interior finishes and spoil comfort and the living experience.

Quality fenestration systems are engineered to manage water and, at least in Canada, have been designed as rainscreen systems for decades using either wet/wet or wet/dry configurations, which assume that only manageable volumes of water pass the outer moisture seals. Today, rainscreen fenestration systems are still the system of choice for building scientists because they provide redundancy, protection for

Retained water trickled from screw holes when backed-off. A little more love and attention to drainage would have prevented these tears.

sensitive elements from UV, and peace of mind. Building owners and operators should embrace them for the same reasons, although they are sometimes deterred and distracted by other, less costly fenestration systems. There are jurisdictions (such as in Ontario) where professional insurers require rainscreen for certain types of fenestration systems as a condition of coverage because of the past high volume of claims related to failures.

So why do fenestration systems cry? They need more love! The vast majority of rainwater that hits glazing is, in theory, supposed to be stopped by the exterior metal, seals, or glass surfaces and run harmlessly to grade. As with any rainscreen system, it is expected that the outer layer is not perfectly sealed and that a portion of the water will end up inside the glazing pocket of the framing system. What comes next is the make or break point for any fenestration system, no matter the level of sophistication.

Fenestration is like plumbing—trying to put more water in a piping system than it can handle leads to a back-up and an unhappy owner. Most rainscreen (also called drained and vented) fenestration systems are fully capable of managing an expected volume of water. Things quickly fall apart, however, when the volume of water entering the wall exceeds the volume of water that can be successfully drained. The system drainage capability is a combination of the quality of the original design and how the system is fabricated and installed.

Blocked internal drainage paths often walk hand-in-hand with leaky fenestration systems. An overzealous installer (or someone from "Others Contracting") with a caulking gun can quickly undo all the engineering, shop drawing review, and testing that went into what could otherwise have been a successful system installation. Much the same as a clogged pipe, blocked drainage paths in a glazing system will often result in conditions that are detrimental to internal seals and lead to water intrusion even under modest rain events. There is a balance at play here—the more restricted the drainage flow within the fenestration system, the longer it would take for the same volume of water to drain, causing back up and overflow conditions. This back up condition increases the length of time internal seals are exposed to water,

decreasing their longevity and resulting in reoccurring leaks.

Design changes over the years (sometimes implemented to reduce uncertainty on-site) have resulted in other potential problems. The elimination of soft seals and the movement toward more dry/dry systems (in lieu of wet/wet or wet/dry systems) has meant the water tightness of fenestration assemblies rely heavily on product tolerances and the pressure generated by gasketed pressure plates. All gaskets and tapes are not created equal—some of the gasket compounds are prone to compression set over time, hence decreased pressure onto glass surface, permitting increased water entry. Fastener torques are often not measured or even specified to achieve adequate water tightness. Have the manufacturer approved and specified products been installed, and is there a history of long-term performance? These important issues need to be identified, and the underlying problems must be solved before they are permitted to turn into costly liabilities.

So, how can we keep the fenestration systems airtight, watertight and draining free? The following is recommended to achieve the maximum performance potential of fenestration systems from concept to construction:

- Select fenestration systems that are "installer proof" with quality material, "robust" internal seals and drainage mechanisms that cannot be easily botched during installation. Always make sure quality systems are in play from the start.
- Visit the shop where wall components are being fabricated and check the frame's "birth certificate" for lineage.
- Ensure specifications are clear to eliminate the inclusion of modified face sealed fenestration systems. Only grassroots and proven rainscreen systems from reputable manufacturers need apply.
- Mock-ups are required to establish the standards of installation, and work with the installers so they have an understanding of intent. They provide the opportunity to review contractors' workmanship and identify potential transition issues. They also increase the comfort level of all parties involved for future installations. They can be

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Water retained within an insulating glass unit is a near-sure sign of drainage problems. Okay, the fish was added in Photoshop, but wouldn't that be cool?

built, examined and tested in a shop, as a standalone mock-up on-site, or as part of the work to remain.

- Pair the mock-up with a progressive site testing program to put the system through its paces, either before it gets on a building, or soon into the construction process (go or no-go). Once completed and agreed upon by all parties, the mock-up could be used as a benchmark for level of quality expected during construction.
- Finally, and importantly, push hard to have qualified and frequent adult supervision during construction. Many problems we observed could have been caught very early in a project with an experienced site presence, sharp eye for details, and a good understanding of the functions of the fenestration systems. ■

Peter Adams, P.Eng., is a principal and a senior building envelope engineer at Morrison Hershfield. He has been specializing in building science since 1992. Peter graduated as a mechanical engineer and spent the early part of his career at the National Research Council in Ottawa. He has conducted work on hundreds of properties, and his work has included forensic studies on building failures and building component design. He has extensive experience with indoor environment studies and mould risk assessments.

His work has included many buildings with challenging building envelopes and operating conditions, including libraries, water treatment plants, and sporting venues. Adams currently teaches building science and related topics at a university level. He is a past-president of OBEC and past-chair of ASHRAE Technical Committee 4.4 on Building Envelope and Materials.

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