FENESTRATION SYSTEMS – IT IS ALL ABOUT THE PLUMBING!

Peter Adams, P.Eng, Yvon Chiasson, P.Eng, Morrison Hershfield Ltd.

EXTENDED ABSTRACT

A few years ago the Toronto office of our engineering firm experienced what we termed "the year of the crappy curtain wall". In actuality it was more like eighteen months, and during that period we investigated persistent water penetration in several low- to mid-rise commercial office buildings ranging in age from 5 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 several 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 rain screen 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 unfortunately is 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 towards 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 can you 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 that assume that only manageable volumes of water pass the outer moisture seals. Today, rainscreen fenestration systems are still the system of choice by building scientists because they provide redundancy, protection for 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? The vast majority of rain water 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 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 some dude 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 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 results in re-occurring 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 towards more dry\dry systems (in lieu of wet\wet or wet\dry systems) has meant that 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 decrease pressure onto glass surface, permitting increased water entry. Fastener torques re often not measured or, or even specified to achieve adequate water tightness. Are the manufacturer approved and specified products been installed, and is there a history of long term performance? The presentation will address all of these important issues, and provide guidance on how to identify problems before they are permitted to turn into costly liabilities.

So, how can we keep the fenestration systems air tight, water tight and draining free? The presentation will conclude with recommendations on how to maximize the performance potential of fenestration systems from concept to site:

1) Select fenestration systems that are "installer proof"; with quality material, "robust" internal seals and drainage mechanism that cannot be easily botched during installation. Always make sure quality system are in play from the start.

2) Ensure that specifications are clear to eliminate the inclusion of modified face sealed fenestration systems. Only grassroots and proven rainscreen systems from reputable manufacturers need apply.

3) Mock-ups are required to establish the standards of installation and work with the installers so they have an understanding of the intent. The use of stand-alone mock-ups and in-situ mocks have pros and cons that will be discussed.

4) 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 by all parties, the mock-up could be used as a benchmark for level of quality expected during construction.

5) Finally, and importantly, push hard to have qualified and frequent adult supervision during construction. Many problems we have observed could have been readily 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.

REFERENCES

1. Ontario Architects Association, OAA Window Wall Endorsement, July 28, 2009

2. Pro-Demnity Insurance, Pro-Deminity Non-Drained Exterior Wall Exclusion

3. Kesik, T., and Saleff, I. 2009. Tower Renewal Guidelines for the Comprehensive Retrofit of Multi-Unit Residential Buildings in Cold Climates, University of Toronto.

4. Hoffman, Stéphane P. 2001. Adaptation of Rain-Screen Principles to Window-Wall Design, Thermal Performance of the Exterior Envelopes of Whole Buildings VIII.