ZbD: Notes from the Field

Insights in High-Performance Construction

IS0014 // April, 2017

When Is the Right Time? Testing Fenestration Systems for Water Penetration

By: Mike LaCrosse

With each new year, it seems we are seeing an increase in the number of project specifications which require air- and water-tightness testing of windows, storefronts, and curtain walls in commercial construction. Given the amount of fenestration any given new construction building might have, it's easy to see why. If the fenestration system is going to leak water, wouldn't you want to know about it and take corrective action *before* the building is finished, occupied, and the contractor has moved on? I think most can agree that there are less headaches and more money saved in the long run by doing it this way. But what isn't as cut and dry is *when* during the construction phase these fenestration systems really ought to be tested.

In our experience, when a project requires a spray rack and pressure chamber type water test (ASTM E1105/AAMA 502 or 503), the specifications typically require this testing on at least 3 or more window/storefront/curtain wall areas. This is good, because it is hard to conclude the success of a product and its installation method across an entire building based on just one test result.

Regardless of what period in construction we are ultimately asked to perform an ASTM E1105/AAMA 502 test, if all of the tested units pass, then everyone breathes a sigh of relief, moves on, and never gives a thought about the "when" of testing. Not even us, really. We've proven the installation works. It's when things start failing, and failing repeatedly, that the conversation of "when" inevitably comes up on one project or another.

When a system leaks water repeatedly after several visits, the installer's argument typically evolves into something like, "Well, this window unit is failing because this isn't a complete system. The cladding isn't installed yet and my outside weather-seal isn't in." To be truthful, it's a totally fair argument. By not having the exterior weather-seal and cladding in, as well as possibly other materials, the product and rough opening are being subjected to more water than they would actually see when the building is completely finished. To bring it down to a single point, the argument is that testing anything other than a full and complete installation, is a misrepresentation. Again, a fair argument, but it has potentially problematic implications.

If we tested when all of the cladding was installed and the weather-seals made, how many other windows will already be installed at this point in the same manner? Probably the majority of them, and if there is a major systemic issue discovered with the product or installation, then there are probably dozens, if not hundreds, of products/installations that need repair. You can imagine the impact on cost and schedule this would have. With finishes installed around some of the products, and drywall getting installed inside, accessing the rough opening from either side to improve it or replace the product, becomes very difficult at this stage. This is also troublesome during testing, because if water *is* observed at the rough opening, we have a difficult time pin-pointing the issue to the builder.

The major point to extract from this is that the real benefits of testing a product and its installation go out the window (no pun intended) at this point. We want to catch any product or installation issues early on, *before* several installations have occurred and *before* they are inaccessible. This same logic

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can easily be applied to ASTM E783 air tightness tests and AAMA 501.2 hose tests (water test without pressure) for fenestration systems.

You still might question the fact that a product is being subjected to more water without finished systems installed. Based on my experience, this is my take. The real driver to water leakage is the simulated wind pressure, not the amount of water. I've seen dozens of products/installations pass a basic AAMA 501.2 hose test (water without pressure) which probably introduces more water to a single area than the spray rack tests do, but fail the moment you switch gears and apply negative pressure to the unit. On the flip side, I've seen dozens of products and installations pass spray rack tests with simulated winds of 60 mph with nothing but a single air seal installed at the rough opening. If the product itself has a system pattern of leakage, there are often only minor adjustments that can be made to it before the manufacturer must get involved. The installation at the rough opening is a different story; I think the key is establishing total air barrier continuity from wall air barrier to the product being tested around its entire perimeter. With a true air separation from indoors to out, the exterior side of the air seal should be neutral to the effects of the negative pressure induced on the inside during the test. In other words, a good air seal creates a barrier preventing outside water from being acted upon. A long-winded explanation, but finally getting to the main question of, "When *is* the best time to be testing fenestration systems?"

This is what's ideal:

1. To test just after the first few installations of a particular fenestration system, nothing more.
2. The rough opening would be fully accessible from the inside, meaning no drywall returns, and the primary air seal installed.
3. Materials not relevant to the installation of the product, such as insulation, in many cases, and cladding, are not yet installed.

It's rare for us to get in to test during this window of opportunity. In many cases, this perfect moment doesn't happen at all. That being said, we try our best to get in to test when the phase of construction, regarding fenestration, is as close to this as possible. This is why we hear the argument I described earlier, all the time. We don't like to test when everything is finished out because of the consequences that may come if there is a major systemic issue.

The scenario outlined above is really the best time to be testing as it can reveal a problem up front when there are few installations and while things are still accessible. If a systemic issue arises, the cost and impact on schedule to existing installations is minimal and the issue is further prevented by applying the determined solution moving forward on the rest of the installations. So, are there any other options? Ideally, we'd always be there to test in the moment of construction that is defined by those 3 parameters above. However, an excellent additional precaution is to test a product installation on a mock-up, ideally a stand-alone mock-up that is constructed well in advance of the building itself. The test can be performed during multiple stages of the mockup's construction for comparison, such as at "air barrier stage" and at "finish stage." If issues arise, the product can be retested until a solution is discovered and the solution can then be applied to the actual installations on the building itself. The images provided in supplement to this article illustrate a typical ASTM E1105/AAMA 502 test being performed on a stand-alone mock-up unit on a recent project of ours.

Zero by Degrees at Better Buildings by Design Conference

By: Jocelyn Warczak

Back in February our guys, along with Andy Shapiro over at Energy Balance, Inc. were invited to present at the Better Buildings by Design Conference held in Burlington, VT. We thought we'd give a run-down of their take on the conference, what they learned, and found interesting.

Quinn Treadgold: "All of The Above: High Design and High Performance in Single Family Home Design." This presentation addressed the air tightness of a single-family home located in Waitsfield, VT. The results from the air tightness tests ended up being .017CFM50/SF of enclosure. The walls were double studded with an R-value of 58.1, the roof had an R-value of 63.9, and the foundation slabs had an R-value of 37.3. The buildings annual heating cost is $300 with an air source heat pump. This was an expensive home to make. However, long-term, because the home is so tight, their up-front cost will eventually pay off.

Mike LaCrosse: Jake Marin's presentation on "Heat Pumps". I found this presentation to be really fascinating. In particular, his extrapolation and fantasizing of how technologies incorporated into other products today, could potentially be incorporated into heat pumps in the future. For instance, the use of thermo-electric inductors commonly found in plug-in coolers could be a technology incorporated into heat pumps to create a solid-state system, without the use of refrigerant. Thermo-elastic technology was another near-future idea he discussed. The idea of producing heat by stressing a material. Some prototypes are already in the works and could promise COPs of up to 11, which is huge.

Jon Haehnel: Martin Holladay "Reassessing Passive Solar Design Principles". Many of these concepts we still try to apply today even though our thinking about high performance buildings has changed a lot since those principals were first introduced. What was interesting about this topic, was thinking about these passive solar principles which derived from back in the '70s and actually looking at how they are (or aren't) relevant today, almost 50 years later, in new high performance construction. For instance, the idea of large spans of solar glass on a well-insulated home probably makes no sense. Well-insulated and air-tight homes today hold heat way better than the leaky and poorly insulated ones did back in the '70s. So, a lot of glass on the south face is going to cause today's home to overheat. This information wasn't shocking news by any means but really just refreshing. Makes you just go, "Yup, that makes total sense."

Reflecting on their own presentation, Jon and Mike both enjoyed the ability to share some of their knowledge and experience. Jon's regret was that he and Mike had a great deal of content and they weren't able to leave time for questions. While an understanding of Envelope Commissioning is growing in the construction industry, our guys appreciated the chance to share their knowledge with their colleagues. You can find the whole presentation on this quick code.

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- Breaking the Ice: Quinn Treadgold

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