The BETEC Symposium: Fenestration: A World of Change

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Introduction

A 40-year waltz through what hasn’t worked the way we would have liked, and where we need to go from here.

Topics:
• Certification vs. field performance – standards development, durability, and the road ahead
• What happens when chemistry battles gravity
• Window-to-wall integration and the lessons learned from the lack of proper integration
Certification vs. Field Performance
Evolution of Standards

• In the beginning... 
  – 1950’s - University of Miami began testing program to evaluate water penetration of jalousie windows.

• The beginning of consensus standards... (~1965-67)
  ASTM adopts the precedent-setting standards for window, door and curtain wall performance:
  • E330 – Structural
  • E331 – Water
  • E283 – Air
Certification vs. Field Performance

What is AAMA certification?

• Representative samples (also prototypes) submitted for battery of tests conforming to industry standard methods, to qualify for certification and to affix AAMA label.
• Testing done by independent “validator” or done by manufacturer and witnessed by validator.
• Single successful test of production or prototype sample qualifies product to carry AAMA label for 4 years.
• Products with changes that “are deemed not to adversely affect test results” need not be retested if Waiver granted by Administrator.
• Two unannounced plant inspections annually to confirm production products conform to tested samples.
Certification vs. Field Performance

What the AAMA Certification program is not:

- Not an on-going quality assurance program – job left to manufacturers.
- Not an assurance of field performance – conditions vary from laboratory – since 2002, manufacturers have recognized this for water leakage testing and stipulated that field tests should use only 2/3 of the air pressure differential that was used to certify the product in the lab.
- Not an attempt to replicate or reproduce that amount of water on a window or door that would occur in a given rainstorm.
Certification vs. Field Performance

Problems with the current standards for water penetration resistance testing:

1. Definition of Leakage
2. Consistent Performance
Certification vs. Field Performance

Definition of Water Leakage

- There is some variation in the definition b/t standards but generally: **No water shall penetrate the plane parallel to the glass, that intersects the innermost projection of the window. Also, no passage through frame corners into wall assembly.**
- Innermost plane concept considers water running down inside of glass and ponding on meeting rails and frame sills acceptable – not what consumers expect.
- Most field leaks occur well below certification pressures – but test standards and leakage definitions don’t address this.
Certification vs. Field Performance

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• Some products pass the high pressure certification tests and fail in the field at zero differential pressure.
Problem w/ $\Delta P$-only Testing – Out-Swing Windows

Water Test w/Positive Air Pressure

!![Diagram of operable sash head detail with wind forces operable sash inward causing interior and exterior gaskets to compress and provide a better seal to resist water penetration.]

Water Test w/o Air Pressure

!![Diagram of operable sash head detail with wind forces operable sash inward causing interior and exterior gaskets to compress and provide a better seal to resist water penetration.]
Subject to Mediation/Settlement Privilege
Certification vs. Field Performance

Definition of Water Leakage

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**Bottom Line:** Fenestration products should be tested and certified under a range of air pressure differences, and, for low pressure regimes (i.e. representative of frequent weather conditions), the criterion for acceptance should be no water flowing on normally exposed interior surfaces (except for surfaces that contain and drain the water).
Certification vs. Field Performance

Consistency of field performance vs. certification tests
(why do so many windows that have been handled and installed properly fail to meet the certification test levels?)

• **Pushing the Limits** - in the quest for higher performance/market advantage, manufacturers eke out the last measure of performance in testing, seeking the highest pressure achievable. But in the field, product may be slightly out of level, etc. (still within tolerance) and the product fails to meet certification test pressures (or 2/3 WTP). Design professionals need to take this into account when specifying.

• **Durability** –
  - **Not a perfect world** - weatherstripping effectiveness can be compromised by exposure; sill-to-jamb corner sealants can lose bond from prolonged contact with water
  - **Coming to grips** - fenestration manufacturers do not account for degradation or reasonable service life in their performance promises – the 6 month limit on applicability of performance standards promulgated by AAMA in 2008 is not a solution.
When Gravity Battles Chemistry

Greatest negative trend in the building enclosure field since WWII is the movement toward relying solely on sealants to do the job of waterproofing. Sealant improvements have been dramatic . . . but sealants still cannot do reliably what some architectural designs and some windows require of them.

For the window/door industry, a primary use of sealants is in creating seals at sill-to-jamb frame corners. But even the best sealants suffer adhesion loss when subjected to prolonged contact with water, or when used in such narrow joints that even the movement associated with transporting windows can fail the sealant.
When Gravity Battles Chemistry

Causes of window frame corner leaks in windows with corners made watertight with sealants:

• Narrow bond lines of mating thin-walled extrusions,
• Convoluted intersections challenging the best workmanship
• Weatherstripping that intersects corners and interrupts sealant continuity
• Flat sills that subject the sealant bond to prolonged water contact.

The solutions:

• Slope sills to drain – keep the sealant bond line dry
• Accept the inevitability of eventual water entry and provide perimeter flashing to protect the building.

Gravity always trumps chemistry
When Windows and Walls Don’t Talk
When Windows and Walls Don’t Talk

• “No window is an island, entire of itself.”
• Root cause of most building enclosure malfunctions:
  Lack of effective integration of component parts
• No better example than the history of barrier EIFS experience
  – Barrier EIFS develops in post-WWII Europe as a method to economically cover damaged masonry facades
  – Introduced to U.S. in 1969 and gains wide use in the residential building booms of the 80’s and 90’s – but no masonry back-up walls
• Problem - Barrier walls and nail fin windows set flush with cladding don’t mix
  – EIFS manufacturers did not anticipate the mis-match of barrier EIFS and traditional window geometry and function (e.g. windows are not tested for watertightness outboard of nail fin)
Wood siding

Brick Veneer

EIFS

1" Overlap
Vapor retarder
Wood Clapboard

Building paper
(Plane of waterproofing of cladding)
Face nails
Insulated wood stud wall

Window leakage Controlled

Building paper
(Plane of waterproofing of cladding)

Window leakage
Entapped

EIFS lamina
(Plane of waterproofing of cladding)

Wood stud wall
Vapor retarder
Insulation board
(adhesively attached)
When Windows and Walls Don’t Talk

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- Root cause of most building enclosure malfunctions: Lack of integration of component parts.
- No better example than the history of barrier EIFS experience
  - Barrier EIFS develops in post-WWII Europe as a method to economically cover damaged masonry facades.
  - Introduced to U.S. in 1969 and gain wide use in the residential building booms of the 80’s and 90’s.
  - Barrier walls and nail fin windows set flush with cladding don’t mix
  - Wall manufacturers did not anticipate the mis-match of barrier EIFS and traditional window geometry and function (e.g. windows are not tested for watertightness outboard of nail fin)
  - Window manufacturers were slow to respond and consequently got dragged into the legal mess that followed

- Lessons learned:
  - Our building enclosures often fail to perform as intended when we design them as assemblies of component parts and not as an integrated singular whole
When Windows and Walls Don’t Talk

- Not just water leakage – thermal – air – energy requirements suffer when we neglect window-to-wall integration.
  - e.g. - thermally broken window frames with highly energy efficient IG units fail to deliver the anticipated performance if the thermal barrier of the surrounding wall is not aligned with the thermal barrier of the window.
Impact of Window Placement – as Tested/Isolation

$T_{\text{ext}} = 0^\circ\text{F}$

$T_{\text{int}} = 70^\circ\text{F}$

$58^\circ\text{F}$

$59^\circ\text{F}$

$59^\circ\text{F}$
Impact of Window Placement – in Masonry, aligned with Cavity Insulation

$T_{\text{ext}} = 0^\circ F$

$T_{\text{int}} = 70^\circ F$

49 ºF

51 ºF

51 ºF
Impact of Window Placement – in Masonry, not aligned with Cavity Insulation

$T_{ext} = 0^\circ F$

$40^\circ F$

$42^\circ F$

$41^\circ F$

$T_{int} = 70^\circ F$
Impact of Window Placement – Window Set Over Steel Shelf Angle

Curtain wall in “tested” configuration

Curtain wall as installed, directly over solid steel angle

Color Legend

- 0.0° - 0.0°F
- 5.0° - 7.0°F
- 10.0° - 13.0°F
- 15.0° - 18.0°F
- 20.0° - 23.0°F
- 25.0° - 28.0°F
- 30.0° - 33.0°F
- 35.0° - 38.0°F
- 40.0° - 43.0°F
- 45.0° - 48.0°F
- 50.0° - 53.0°F
- 55.0° - 58.0°F
- 60.0° - 63.0°F
- 65.0° - 68.0°F
- 70.0° - 73.0°F

52°F

22°F
Impact of Non-thermally Broken Starter Sill

“Tested” configuration

With thermally broken starter sill

With all-aluminum starter sill

38°F

33°F

23°F
Conclusion

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• The challenges that lie ahead are significant, including the need to achieve increased reliability and durability to meet customer expectations and sustainability requirements.
• The path to improved performance of fenestration products is, in large part, dependent on our collective willingness to:
  – improve the test and certification processes to achieve predictable, consistent, and acceptable field performance,
  – establish realistic durability expectations for windows and doors, and
  – address the integration of all the component parts of the wall to realize efficient and effective building enclosures.