The Science of Fluid-Applied Flashing Systems

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ABSTRACT

Experts predict fluid-applied flashing will replace peel-and-stick which is under scrutiny now. The fluid-applied technology was invented by a large whole-building repair contractor working with cutting-edge sealant-coating STPE material from Europe and Asia. Hurricane test chambers built for product development and testing show a window mock-up using peel-and-stick and building wrap tested at 7.01 ACH. The fluid-applied STPE system tested at 0.17 – far below the ultra-stringent Passive House standard of 0.6 ACH.

KEYWORDS

Peel-and-stick, fluid-applied, flashing.

1. INTRODUCTION

The background of this paper is the remarkable initiative taken by a building repair contractor to develop products to meet an unmet construction need. The objective is to introduce the reader to an important development in construction waterproofing and air-barrier technology.

"Five years from now, what will we look back on as an important development in building envelope construction?" The answer: **"The replacement of peel-and-stick flashing membranes with fluid-applied flashing products."** This from panel member Alex Lukachko of a leading waterproofing and air-barrier consulting company (Joe Lstiburek's Building Science Corporation) responding to an audience question at the National Institute of Building Sciences, Building Enclosure Technology and Environment Council (BETEC), December, 2011 building envelope symposium in Washington, DC.

2. TECHNOLOGY DEVELOPMENT

Age: 3 Years. Repair cladding, structural repair, repair windows, new sliding glass doors.project Repair project cost: $13 Million.

A contractor specializing in whole-building water-damage repair of multi-story structures continuously saw the failings of peel-and-stick membranes and building wraps – and testified as expert witnesses on behalf of building owners in over 85 lawsuits concerning these structures. Fearing themselves at risk because of their use of peel-and-stick, and using a Systems Engineering approach, they developed and commercialized a fluid-applied STPE system[1] that not only prevents water intrusion issues but also dramatically reduces air leakage and associated condensation.

Lockheed Martin's highly innovative stealth aircraft resulted from that company's dedication to Systems Engineering – basing design on required functionality.

Systems Engineering is not being in the business of manufacturing peel-and-stick roofing or foundation waterproofing products or spun polyolefin packaging goods and deciding to market that material as window flashing.

Rather, the approach taken for the fluid-applied STPE system was to create a "Contractor's Wish List" of features and functions to optimize constructability and building performance:

- Bonds to damp surfaces
- Immediately waterproof – withstands rain
- Fluid applied
- Adheres without a primer
- 100% solids to avoid shrinkage
- VOC Compliant – minimal odor
- Opaque when target thickness is achieved
- Can be exposed for up to 6 months
- Paintable / compatible
- Vapor permeable
- Reduces steps / saves time
- Easily repaired
- Self seals around fasteners

Then, without any preconceived technologies in mind, they scoured the globe to find the very best way to implement the functional requirements. A silicone sealant manufacturer, realizing silicone technology was not suitable, guided them to a specialist in STPE sealant chemistry. Through a close collaboration, the technology was developed and has been in continuous use since 2004. This waterproofing technology is manufactured by a significant player in the commercial air- and water-resistive barrier market that maintains a close technology support and development relationship with the original development team. The Architectural Record recognized the technology in its list of top waterproofing products of 2010.

3. CHEMISTRY

STPE stands for Silyl Terminated Poly Ether. STPE is the leading construction sealant in Europe and in Asia – including Japan where it was developed and introduced to the market over 30 years ago.

Edward M. Petrie, author of McGraw-Hill's Handbook of Adhesives and Sealants, wrote a paper[3] on STPE technology for The Adhesives and Sealant Council. He compared STPE with urethane and silicone sealants, and he used a table to indicate the STPE out-performs the others across a wide range of factors.

[Here insert the table from a separate Word file comparing STPE, Urethane, and Silicone.]

Petrie also stated: "In addition to their high performance properties, these sealants are achieving popularity due to their formulation versatility that allows the customization of viscosity and early strength development for various applications." This is why this sealant technology has been formulated to spread like a coating for flashing and air / water barrier applications.

4. FIELD PERFORMANCE

An early multi-story project completed in 2004 was de-constructed in 2009 for the sole purpose of determining whether the materials were intact and functioning in the same way as when first installed. OAC forensic architectural and building enclosure experts of Seattle, Washington concluded the system was performing as intended, no adverse impact on any building components, all surfaces dry and in good condition, and no degradation of the products. A similar evaluation is planned for the ten-year anniversary of the installation in 2014.

5. EXCEEDS TESTING STANDARDS

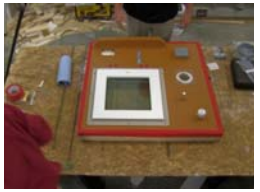
The technology has successfully passed all the tests required by the Air Barrier Association of America (ABAA Process for Approval of Air Barrier Materials, Components & Assemblies) and by the International Code Council Evaluation Service (Acceptance Criteria 212 for water-resistive barriers). The air-barrier test is run at 75 Pascals of pressure corresponding to a 25mph wind. The water-resistive test requires the coating to perform at least as well as asphalt-impregnated building paper.

The developers of the technology were not satisfied with the above-referenced national testing standards for such technology. They built the hurricane test chamber to confirm their suspicions about peel-and-stick --that even a perfectly executed assembly can leak.

They later used the chamber to demonstrate the STPE system can withstand water spray under 2,880 Pascals of pressure and racking movement corresponding to the 155mph wind-driven rain of a Category V hurricane for hours on end.

The technology is promoted as waterproofing material due to its ability to withstand a hydrostatic head. This is why the installation guidelines illustrations show them being used as sill-pan flashing and roofing underlayment – as well as for water-resistive barriers on vertical surfaces.

6. COMPARISON TESTING



Large sums of money are spent on high-performance windows with practically zero air leakage. However, traditional rough opening preparation and window installation methods and materials do not match the window performance. State-of-the-Art fluid-applied STPE materials and related techniques demonstrate a Passive House[4] level of performance: 0.6 Air Changes per Hour (ACH) compared to Energy Star's average 4.6 ACH. Of course, if you are stopping air leakage, you are also stopping water intrusion.

Below are results of tests performed using the portable test chamber (21.25cuft) shown in Photo 4 with window installation mock-ups using 1) sheetwrap with peel-and-stick and 2) the fluid-applied STPE materials. Testing is similar to ASTM E 2357 air barrier assembly testing using a smaller mock-up.

Air Changes per Hour @ 50 Pascals = 20mph wind

- Energy Star, 5 ACH (Climate Zones 3,4)
- Passive House 0.6 ACH
- Sheetwrap & Peel-and-stick 7.01 ACH
- Fluid-applied STPE 0.17 ACH

Fluid-applied STPE at 2,880 Pascals = 155mph wind Category V hurricane: 0.53 ACH

The results are supported by the recent Karuna[5] Passive House project testing where 0.42 ACH was achieved without the STPE air-barrier system fully installed.

7. ENERGY STAR PRESCRIPTIVE REQUIREMENTS

The ENERGY STAR for Homes Version 3 Guidelines require:

- Fully sealed continuous drainage plane behind exterior cladding
- Window and door openings fully flashed
- Air sealing
- Cracks in the building envelope fully sealed
- Rough opening around windows & exterior doors sealed with caulk or foam[6]

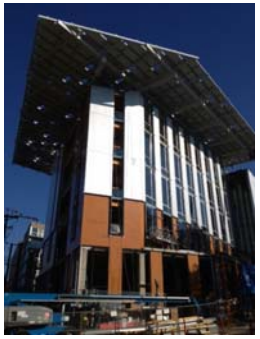
The fluid-applied STPE Technology meets these requirements.

8. ENVIRONMENTAL

The technology complies with the most stringent air quality volatile organic compound restrictions, and it is phthalate-free. This is one of the reasons it was specified and used on "The Greenest Commercial Building in the World" – The Bullitt Center in Seattle.[7]

9. METHOD OF USE

First, an STPE joint and seam filling product is gunned out of a cartridge and spread into the joints and seams of the rough opening and into the sheathing- wall seams. Then a fluid-applied STPE waterproofing material is gunned out of a cartridge and over the entire inside surface of the rough opening (including over the previously applied joint and seam filler), and 4 -6 inches out onto the sheathing or CMU wall around the rough opening. The window is then set in the rough opening, and backer rod with STPE in a conventional sealant formulation is used to form an air and water seal around the interior perimeter of the window (this is now recommended by AAMA[8] as well). For flanged windows, the STPE fluid-applied rough-opening waterproofing material is used to flash over the flanges of the window except for drainage weeps left in the sill area. A waterproof roller-grade STPE coating is then applied to the field of the wall to satisfy code requirements for a water-resistive barrier.



Bullitt Center, Living Building Challenge, Seattle, WA

10. PROBLEMS WITH PEEL-AND-STICK

Writing in the Winter 2011 issue of the National Institute of Building Sciences' Journal of Building Enclosure Design, Editor and Building Enclosure Technology & Environment Council Chairman Wagdy Anis of Wiss, Janney Elstner consultants stated:

"Another significant event that took place at the Buildings XI International Conference was the U.S. Department of Energy (DOE)'s road mapping session,
during which stakeholders reported their ideas about prioritizing research. BETEC reported its thoughts on this to
DOE, on behalf of more than 3,000 BEC members. Ideas included:

- Evaluate the performance of some common heat air and moisture control materials.

- The durability of flashing materials ….

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- Long-term adhesion of peel-and-stick membranes.

- Long-term performance of peel-and-stick membrane joints, vertical and horizontal, with and without term bars, shingled and reverse shingled.

Craig Wetmore, President of York Manufacturing (which sells both copper mesh through-wall flashing and peel-and-stick) provided the Flashings & Terminations Committee of the Air Barrier Association of America a paper in which he offered the following items in a critique of peel-and-stick:

- UV damage
- Flows at 140-180°F
- Spray foam heat causes flow and facer damage
- Masonry cleaners harm
- Full body weight rolling
- Must replace sheets instead of repairing fishmouths
- No moisture in substrate
- No dust, fines, or dirt
- Adhesion problems
- Use primer, but VOC problems
- Primer must be dry but not too dry
- Sealant adhesion problems
- Degrades air barriers
- Flame and smoke
- 10-20 year life expectancy

Conventional rough opening preparation and window installation follows ASTM E 2112 "Standard Practice for Installation of Exterior Windows, Doors and Skylights" which does not include methods for utilizing fluid-applied STPE materials. However, the Chair of the ASTM E 2112 technical committee and the ASTM management staff have invited this author to submit a revision that will add such systems to the ones listed in the standard.

Experts have recognized the shortcomings of materials and methods referenced in ASTM E 2112 that rely on sealing off the face of the rough opening:

"Notwithstanding the advances in the performance of sealants and membrane materials, reliance upon face sealed systems has a higher risk of water penetration because of the inherent aging of the materials and loads imposed, thus reducing the overall resistance to water penetration and consequent damage."

...the combination of wood- or steel-framed construction with windows that may leak at some point during their life cycle leads the authors to conclude that only the hot and dry hygrothermal zone may be tolerant of periodic wetting and secondary protection of the window opening is required in all other hygrothermal zones."[9]

Designers and builders are moving quickly away from conventional materials (to prepare the rough opening and install the window) to fluid-applied STPE technology. They are doing this to avoid water intrusion and air leakage from the items previously referenced by Craig Wetmore and these additional issues identified by the contractor that developed the original STPE formulations:

- Rotting of damp substrates behind vapor barrier coverings
- Reverse lapping
- Tenting
- Tunneling
- Difficult, laborious work
- Human error
- Adhesion failures

The conventional method requires 21 steps and creates 74 ***interfaces***. The title of RCI's technical journal is **INTERFACE** for a reason.

It's no wonder specifiers are looking for answers – given that U.S EPA's BASE study of 100 randomly selected U.S. office buildings found that 43% of the buildings had current water leaks, and 85% had experienced previous water leaks.[10]

11. INSTALLER EXPERIENCE, AVAILABILITY, DURABILITY

Physical actions required are pulling the handle on a caulk gun to lay down a bead of material, and spreading it with a piece of flat plastic. Inexperienced workers are successful in their first attempts. Speed and conservation of material increase with experience.

The material is available at hundreds of construction supply distributors across the country.

The service temperature of a leading peel-and-stick membrane is 158 degrees F with a maximum UV exposure of 30 days. This STPE technology has been tested to 300°F and may

be exposed for up to six months. It does not rip or tear, and any gashes into it can quickly be repaired by re-coating.

12. MARKET PENETRATION

The volume of material sold and applied has dramatically increased over this recessionary period and is expected to take a larger and larger share of the market as the economy improves. This has given rise to concerns that designers and consultants failing to specify and recommend the technology may find themselves charged with failing to meet the legal standard of care: "In performing professional services, [the professional] has a duty to use that degree of care and skill which would be used by a reasonably competent [professional] providing similar services and acting in similar circumstances."[11] The technology was recently made the subject of a continuing legal education program for construction defect attorneys entitled: "Standard of Care Problems for Architects & Builders: Changing Waterproofing and Air Leakage Technology."

1. CONCLUSIONS

A pressing need to replace peel-and-stick membranes gave rise to a significant technology development effort by contractors working on real-world problems.

2. ACKNOWLEDGE-MENTS

The principals and employees of PROSOCO, Inc., Building Envelope Innovations, and Tatley-Grund Building Repair Specialists, Inc.

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