INSIGHT™

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"Insight: to see into and understand; an item of knowledge gained by this power."

Effective rainwater control requires proper building envelope design, installation, and maintenance. The wall components and materials must have reliable behavior and performance properties and have suitable durability to provide lasting performance. This Issue's *Technology Update* discusses water penetration resistance of weather-resistive barriers (WRBs). Field investigation of poor in-situ performance related water intrusion problems in combination with in-house laboratory testing of weather-resistive barriers indicates that WRB performance varies from product to product. Our research and testing has found that some significant water penetration mechanisms are not addressed by current test methods and standards. The results of our testing will be presented in an upcoming issue of *RRJ Insight*. In the *Tech Tip* article we discuss strategies for designing exterior walls which minimize potential for water leakage and mold growth.

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Figure 1 – Is this a rational test for evaluating water penetration?

Technology Update

Performance Criteria for Weather-Resistive Barriers

During a recent field investigation of water intrusion problems with the exterior walls of a residential building, RRJ identified concerns with the water resistance capabilities of the polymeric weather-resistive barrier (WRB) installed over the wall sheathing behind the siding. On this project, water damage to the exterior wall wood sheathing and framing was found in numerous locations. While some water damaged areas corresponded with conditions often associated with common paths of water entry, such as poor flashing installation and lack of integration of the WRB with other wall components, other locations of water damage did not. In fact, our investigation identified locations of water damage behind the WRB material where it was installed continuously and free from any penetrations that would allow water to intrude behind it. The water damage appeared to be associated with water penetrating through the protective WRB membrane. This finding prompted us to examine pertinent building code provisions, current test methods and to perform laboratory testing to study WRB performance. The results of these laboratory tests, which are currently underway, will be presented in *RRJ Insight* Issue 20.

Figure 2 – Example of water damage due to water penetration through a polymeric WRB membrane.

WRBs are used behind exterior wall coverings or siding materials to provide moisture protection to the substrate, structural framing and other building materials. However, requirements for their use and performance requirements vary between building codes and material acceptance standards. For example, the 2000 International Building Code (IBC) requires the use of WRBs under all cladding materials, with the exception of cladding over concrete or masonry substrates, or other substrates that demonstrate resistance to wind-driven rain conditions when tested in accordance with ASTM E 331, *Standard Test Method for Water Penetration of Exterior Windows, Curtain Walls, and Doors by Uniform Static Air Pressure Difference.* Traditionally, residential codes, including the 2000 International Residential Code, only require the use of WRBs behind certain exterior wall coverings such as stucco, wood shakes, stone, and masonry veneers. In addition to prescribing when WRBs are to be used, the codes define WRBs using prescriptive criteria. The 2000 IBC requires "one layer of No. 15 asphalt felt, complying with ASTM D 226 for Type 1 felt" or an approved alternate. However, the scope of ASTM D 226, *Standard Specification for Organic Felt Used in Roofing and Waterproofing* is limited to dimensional and physical requirements and does not address water resistance performance. For other WRBs, the International Conference of Building Officials (ICBO) publishes ICBO AC38 — *Acceptance Criteria for Weather-Resistive Barriers* with the purpose to, "establish requirements for recognition of WRBs." ICBO AC38 includes three individual test standards that can be used to test alternate WRB materials. Any of the three test standards may be used to test the product, and the WRB candidate material need only pass one test criteria to be accepted.

One of the test methods prescribed by ICBO AC38 is ASTM D 779, *Standard Test Method for Water Resistance of Paper, Paperboard, and other Sheet Materials by the Dry Indicator Method.* This test standard involves bringing one side of the WRB in contact with water and measuring the elapsed time for liquid water penetration to occur. A common method of performing this test involves floating a small boat made from the product on water (see Figure 1). In order to meet the minimum standard for a Grade D barrier, the product must resist water penetration for ten minutes. The two other test standards cited by ICBO AC38 are AATCC 127, *Water Resistance: Hydrostatic Pressure Test* and CCMC 07021, *Water Ponding Test.* These test procedures subject the test specimen to a hydrostatic head of water for allotted time periods under different head pressures.

None of the three test standards prescribed by ICBO AC38 addresses water transport mechanisms other than liquid flow due to gravity and hydrostatic pressure. RRJ's field investigation of water intrusion problems has identified other factors such as capillary suction and surface tension properties that can also affect moisture resistance performance. Because the test methods do not address these behaviors, they neglect critical real world moisture transport mechanisms. As a result, some WRB products which meet ICBO AC38 may not perform satisfactorily in the built environment. Development of standard test methods which respond to realistic building conditions and are based on rational performance criteria is needed for ensuring adequate performance of exterior wall systems. Testing performed at RRJ provides insight into the behavior of certain WRBs and will serve as an important step towards meeting these objectives. Look for our follow-up article in the next issue of *RRJ Insight* which will report these results.

– Garth Hall, AIA

Tech Tip

Design of Durable Wall Systems by Eliminating Food and Water

Excessive moisture within exterior building walls can create a variety of problems for building owners and occupants, including deterioration of structural building components, loss of thermal performance, and increased insect infestation, as well as the potential for mold growth. For molds to form in an exterior building wall there need to be mold spores, an environment of moisture and moderate temperatures, and a source of organic food material. Because all three of these elements must be present for mold to grow and flourish, in the process of design and the selection of materials there is a real opportunity to lessen the likelihood of biological growth. Although we cannot eliminate mold spores from the air, one can attempt to reduce or eliminate one or both of the vital components essential to mold propagation: food and water.

An approach to exterior wall design which includes wall details to prevent moisture accumulation and uses building materials that do not contain organic food sources is the first step in delivering a building that is less susceptible to mold growth. The reduction or elimination of water leakage necessitates a wall design which contains good waterproofing detailing, and the proper integration of the various materials and components. Our experience investigating water intrusion problems in buildings has shown that leakage problems often occur at the interface of the different building components. This boundary or interstitial space between adjoining building materials is commonly relegated to a separate trade for design and installation and must accommodate anticipated thermal, moisture, and building movements as well as provide for product sizing tolerances. To guard against water leakage, a means of waterproofing redundancy or secondary line of defense may be considered. Including weather-resistant membranes, cavity spaces, flashing and weeps below or behind vulnerable materials or building components can be effective methods for providing added protection from water infiltration. Concealed weather-resistant membrane installations can include peel-and-stick membranes, stainless steel closures and flashings, preformed vinyl flashing products, and gunnable sealants, as well as new troweled and sprayed on materials. Equally important is consideration for the accumulation of moisture in the form of moisture vapor and condensation. An analysis should be made to assure the exterior wall design will perform for the anticipated interior and exterior environmental conditions. Air barriers, air seals, vapor retarders, and other vapor control means need to be considered.

To reduce potential food sources for molds to grow it is important to consider the composition of materials used in the wall construction as well as the potential for contamination prior to, during, or after construction. Many construction components have inorganic substitutes which reduce the available food sources necessary for mold growth. Consider these examples: metal studs or concrete masonry in lieu of wood studs; fiberglass faced sheathing products in place of paper-faced gypsum sheathing; latex paint in lieu of paper or vinyl wall covering; and Portland cement plaster instead of gypsum wall board. Besides cellulose materials such as paper, wood and fiberboard, it is also important to consider whether or not a building material is absorptive and can retain water for long periods of time or is made with organic adhesives or additives. Our investigations of leaking buildings have commonly identified the presence of biological growth on the paper facing of gypsum sheathing or wood-based materials. Because paper and wood contain cellulose and are absorptive of moisture, these materials provide good conditions for mold to develop.

Figure 3 – Deterioration of sheathing and framing from water leakage at window openings.

Figure 4 – Mold growth on gypsum wall

Since mold spores are prevalent throughout the interior and exterior building environment, mold growth can best be reduced by eliminating moisture through thoughtful design and following good construction practices, as well as selecting wall materials that do not provide food sources. Managing moisture migration or water penetration requires project specific detailing of the wall construction interfaces, recognizing areas that are vulnerable to water leakage, and providing waterproofing redundancy where it is appropriate. Removing organic materials from the wall design as much as practical mitigates mold development by taking away the food needed for biological growth. Thoughtful design consideration to reduce and eliminate moisture and organic materials in exterior walls can go a long way toward the prevention of mold.

– Dennis K. Johnson
– Garth Hall, AIA

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