

WATER LEAKAGE IN GLAZED CURTAIN WALL SYSTEMS:

CAUSE, EFFECT, and CURE

BY WILLIAM D. SMITH

Figure 1—Four Corporate Center, Franklin, TN. Architect: Little & Associates, Charlotte, NC. Gen. Contractor: Ray Bell Const. Co., Nashville, TN. Glazing Contractor: Alexander Metals, Nashville, TN. Curtain Wall Framing: United States Aluminum 4250. © United States Aluminum Corp.

Introduction

Water infiltration related to glazed curtain wall systems is an all-too-frequent occurrence. Such leaks can result in significant damage to interior finishes, and if left unresolved for extended periods, can cause structural damage as well. Unfortunately, the assembly methods used to construct many of these systems can make discovering the cause of leakage a difficult challenge. Complicating this challenge is the fact that the appearance of water on the building interior may be far removed from the point of exterior entry, which often leads to incorrect assumptions about the cause of the leak.

This paper will describe the various water control methods incorporated in the design of glazed curtain wall systems, the defects most commonly found, and the recognized testing methods that can detect these problems.

Glazed Curtain Wall System Designs

Monumental glazed curtain wall systems are normally factory-fabricated assemblies that can be shipped to the job-site—either as pre-assembled panels or in knocked-down form for field assembly.

Aluminum is one of the most popular framing material choices because of its versatility, ease of fabrication, and light weight. But other materials, such as stainless steel or bronze, are sometimes used. Glazing choices include a myriad of glass products as well as stone panels such as granite or marble and a variety of composite panels.

Although there are a number of variations, glazed curtain wall systems can be generally grouped into two categories: internally-drained or face-barrier methods.

In spite of the exceptions, conventional, internally-drained curtain wall systems can often be identified by the framing that is visible on the exterior around each glazing panel (*Figure 1*).

Most commonly, these systems are designed so that the glass is retained within the frame using extruded EPDM gaskets. This is often referred to as "dry glazing." The gaskets are inserted between the face of the glass and the frame. Although a pressure fit is achieved, the gaskets are generally not intended to be watertight. Instead, knowing that the glass is not perfectly flat and the gaskets also have variations, it is anticipated that water will enter around the glass as well as at exterior metal joints. Thus, an internally drained system is constructed in a manner



Figure 2—Applied Industrial Technologies, Cleveland, OH. Architect: GSI Architects, Cleveland, OH. Contractor: Turner Const. Co., Cleveland, OH. Glazing Contractor: Architectural Product Sales Co., Brooklyn, OH. Curtain Wall Framing: Vistawall CW-600 and W-250. ©Vistawall Corp.

that collects this water within the frame, diverts it to strategically located drainage points, then weeps the water back to the building exterior.

Since the framing is made of individual metal components that are mechanically joined together, every joint must be made watertight. To achieve this, sealant must be used during the assembly process.

Unlike the conventional dry glazed systems, face barrier curtain wall systems operate under the theory that the outermost face of the curtain wall system will be watertight, and thus water collection and drainage provisions are not necessary.

Normally, this is made possible by installing silicone sealant at the entire perimeter of each glass or

panel insert. Instead of inserting the glass or panel into the frame, its inside surface is adhered or "glued" to the frame using structural silicone.

Then the joints between the individual panels are also sealed with silicone, ultimately resulting in a fully sealed panel-to-panel water barrier. These systems can often be recognized by the lack of exposed framing on the exterior surfaces. This method of installing the glazing material is sometimes called "structural glazing," referring to the silicone sealant that adheres the glass to the frame.

Some curtain wall systems combine the dry glazed and face barrier systems together to provide additional design flexibility (Figure 2). Variations of these systems omit the exterior exposed metal from either the vertical members or the horizontal members.

Both dry glazing and wet glazing methods have certain advantages. For example, dry glazed systems can sometimes be more versatile than wet glazed systems. But installation and shipping constraints require that dry glazed systems be assembled and glazed in the field, while a wet-glazed system can often be pre-glazed in the factory and shipped to the job in fully-assembled panels. This erection method can dramatically reduce overall installation time.



RCI, Inc.
800-828-1902
www.rci-online.org

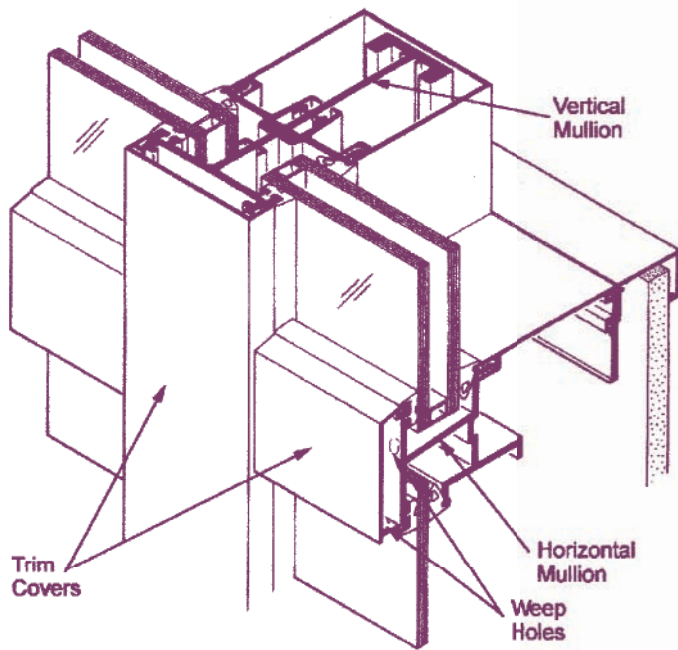


Figure 3—US Aluminum Series 3600 Curtain Wall System. ©U.S. Aluminum

Common Causes of Water Intrusion

As noted earlier, most dry-glazed curtain wall systems are designed to accept water. But proper performance demands that the water remain contained within the system until it is diverted to a drainage point. Thus, if water appears on any interior surfaces, a failure may have occurred within the system. Likewise, the observation of water on the interior surfaces of a wet-glazed curtain wall system also indicates failure, but the cause is usually different from that of the dry-glazed system.

Performance of the dry-glazed curtain wall system relies on sealant at the internal portions of each horizontal-to-vertical frame joint and at each expansion joint of the main frame components. An exploded view of one manufacturer's design is shown in Figure 3. Note specifically how this system is designed to control water. Each vertical mullion runs continuously, with expansion joints intermittently spaced, usually at every other floor. The horizontal mullions are cut to fit between and are attached to the vertical mullions. Sealant is installed at each of these metal-to-metal joints (detail at Figure 4) so that water flowing down the vertical mullion will be diverted into the horizontal. Holes in the outer face of the horizontal mullion allow this water to drain into the horizontal trim covers, and holes in the bottom of the trim cover allow this water to weep out to the building exterior.

Since wind loads and thermal changes cause movement of the curtain wall system, the type of

sealant selected and its application to metal joints are critical to system performance. Sealant selection must consider, among other things, movement capabilities and resistance to elevated temperatures. In addition, the installation of the sealant must take into consideration all aspects of proper application. This requires that the sealant bead be of the proper shape and size, that the surfaces on which it is installed are properly cleaned, that primer is installed if necessary, and that the sealant is properly tooled after application. It's been said that because of its critical role in system performance, the importance of proper sealant selection cannot be over-emphasized, and initial sealant cost should not be a determining factor in product selection.¹

If the sealant located at the horizontal-to-vertical metal joints fails, water flowing down the vertical mullion will escape the joint. When this occurs, the water is no longer controlled by the drainage mechanism of the system. Instead, the water can flow inside the glazing material, whereupon it eventually appears on the building interior.

Like dry-glazed systems, sealant also plays a critical roll in the performance of structural glazed systems. Due to the variations in framing designs, the critical points at which sealant must be applied will differ. However, the basic premise remains. That is, dissimilar materials—metal framing and glass or panels—must be married together in a manner that provides a waterproof skin. Achieving this goal with a structurally-glazed, face-barrier system requires the use of properly-applied sealant, as failure of the sealant will result in water intrusion.

Field Testing for Water Leaks

When they occur, water leaks often become a great source of irritation for building owners and occupants. Left unattended, the leaks can cause serious damage to interior finishes—and worse—to structural building components. Thus, field testing of curtain wall systems is common in forensic investigations. Testing is a diagnostic tool that is used to conclusively discover the source of water infiltration and thus the type of repair that is necessary.

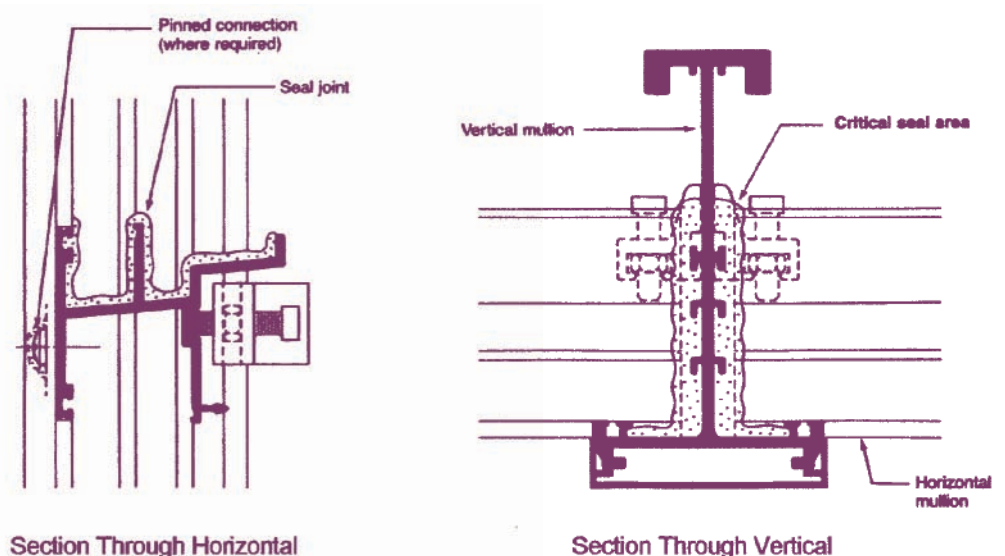


Figure 4—US Aluminum Series 3600 Curtain Wall System. ©U.S. Aluminum

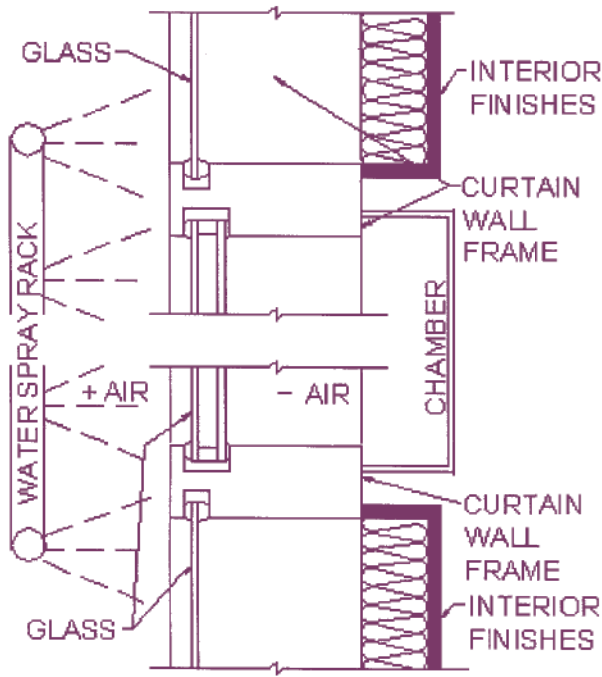
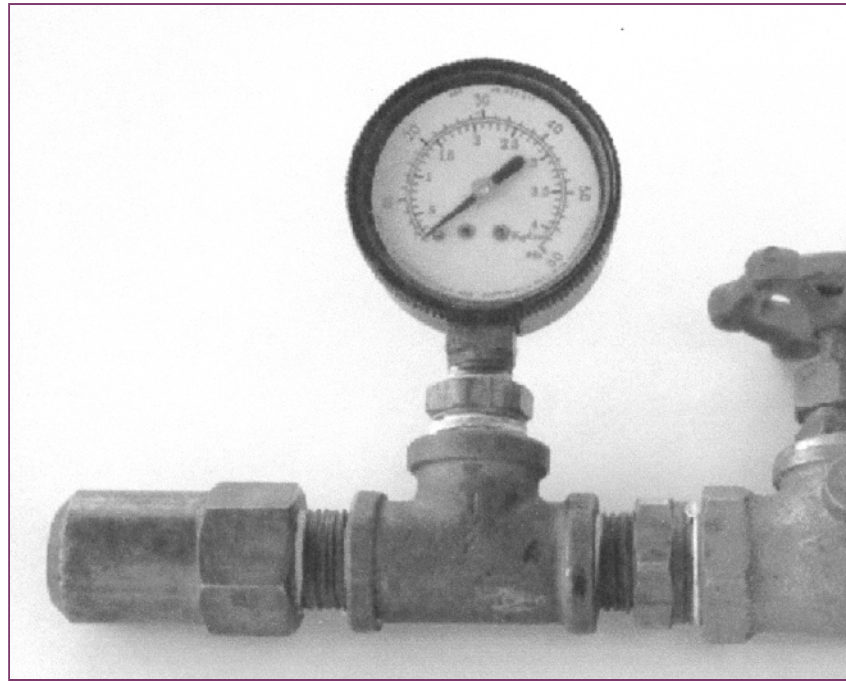


Figure 5, above left.

One method of testing is a procedure published by the American Society for Testing and Materials. ASTM E-1105 is a test method in which water is applied on the exterior surface of the glazing system while simultaneously creating a static air pressure differential between the exterior and interior surfaces.² The test method requires that water be uniformly applied on the exterior wall surface at a minimum rate of five gallons/square foot/hour by use of a calibrated spray rack. A chamber is built, most commonly on the interior side of the specimen, to create an air pressure differential. An example of the test set-up is shown in Figure 5. While the volume of water to be applied is specified by the standard, the amount of static air pressure differential is not stated. Instead, this must be deter-

mined by the testing agency, based upon specifications, the building code, or other reference documents.

Another procedure that is often performed in the field is published by the American Architectural Manufacturers Association. AAMA 501.2 is a method that applies water to the exterior in a sequential manner.³ This procedure, also commonly known as "hose testing," is often used during the construction process to check the integrity of joints that are intended to be watertight. In it, water is applied onto the exterior at a pressure of 30 to 35 psi using a special nozzle (Figure 6). Since this procedure does not use a static air pressure differential, it may not be effective in certain conditions.



If water intrusion occurs in a curtain wall system and an analysis is necessary, it is important that the proper testing procedures be selected and administered.

A study of the two test methods referenced above found that in some situations, AAMA 501.2 "hose testing" can provide "findings that are not consistent with the results of testing in accordance with ASTM E-1105 procedures."⁴ Consequently, the results of hose testing require careful interpretation.

Repairing Water Leaks in Glazed Curtain Wall

After the source of the leak is identified, an evaluation of the available repair methods can be made. As previously noted, performance of the curtain wall system is highly dependent on sealant. Thus, repairs most commonly will involve the repair or replacement of these sealants.

Since the weather resistance barrier of face barrier systems relies on sealant at the exterior face of the wall, the sealant in this location is readily accessible, and repairs can be per-



RCI, Inc.
800-828-1902
www.rci-online.org

formed with no major difficulty. Conversely, the weather resistance of internally drained systems relies on sealant installed within the framing. Thus, a repair to the sealant in these areas is much more difficult to access.

Summary

As can be seen, there are a number of variations in glazed curtain wall construction methods, the extent of which is so vast that one article could not possibly describe them all. However, nearly all can be grouped into one of two basic categories (or a combination of the two categories) when discussing resistance to water infiltration. These are the internally-drained and the face barrier systems. Although the concepts handle water in a different way, both heavily rely on sealant installation at critical areas to make them watertight.

For internally-drained curtain wall systems, the integrity of sealant at expansion joints of the framing and at the internal portions of horizontal-to-vertical frame member joints is most critical for system performance.

For face barrier systems, the weather-resistant sealant is normally located at the exterior face of the system, such as at the perimeter of each glazing panel. Failure of sealant at any of these locations will allow water to enter the building interior.

Proven methods for verifying causes of water infiltration are available. One of these, ASTM E-1105,

is intended to replicate in-service conditions by applying water to the exterior while simultaneously creating a static air pressure differential between the building exterior and interior. Another method, AAMA 501.2, which is also referred to as "hose testing," applies water to the exterior without the use of air pressure, but as a result, may not provide conclusive results in all conditions.

Discovering the source of water infiltration will aid in establishing the method of repair. Sometimes the repair can be as simple as patching an isolated sealant failure or as extensive as replacing all the sealant. ■

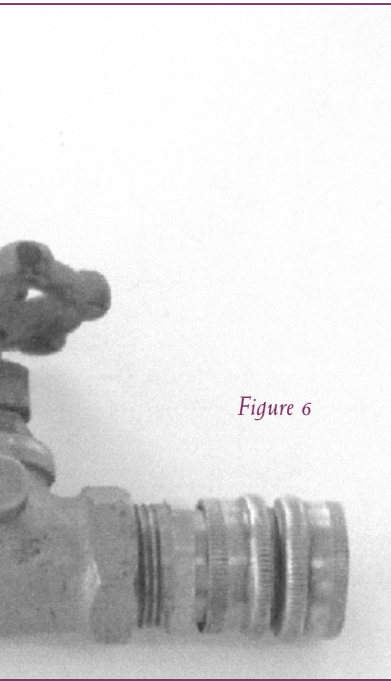


Figure 6

REFERENCES

1. "Installation of Aluminum Curtain Walls," *American Architectural Manufacturers Association*, 1989, p. 29.
2. "ASTM E-1105-96, Standard Test Method for Field Determination of Water Penetration of Installed Exterior Windows, Curtain Walls, and Doors by Uniform or Cyclic Static Air Pressure Difference," *American Society for Testing and Materials*.
3. "AAMA 501.2-94, Field Check of Metal Storefronts, Curtain Walls, and Sloped Glazing Systems for Water Leakage," *AAMA 501, Methods of Test For Exterior Walls*, American Architectural Manufacturers Association, 1994.
4. Smith, W.D., Peers, P.E., "Evaluation of Water Resistance Testing Problems for Installed Facade Systems," *Water Leakage Through Building Facades*, ASTM STP 1314, R.J. Kudder and J.L. Erdly, Eds., American Society for Testing and Materials, 1998, p. 242.

ABOUT THE AUTHOR

William D. Smith is President of Glazing Consultants, Inc. (GCI), a consulting firm specializing in the building envelope, including wall systems, waterproofing, roofing, glazing systems, and water leakage. GCI is headquartered in Palm Beach Gardens, FL, and provides services nationwide from seven offices.



RCI, Inc.
800-828-1902
www.rci-online.org



RCI, Inc.
800-828-1902
www.rci-online.org