REMEDIATION OF A LOCK-STRIP GASKET WINDOW ASSEMBLY

MATTHEW C. FARMER
WISS, JANNEY, ELSTNER ASSOCIATES, INC.
FAIRFAX, VIRGINIA
ABSTRACT

Many façades built since the 1950s employ a two-piece rubber structural gasket system to support glazing. This system is designed to replace a more rigid metal frame. These gaskets are often integrated into a supporting steel or aluminum structure, used as mullions between multiple glazing panels or to tie the glazing into a precast concrete panel wall system. While the system offers many benefits, if poorly installed, severely aged, or damaged during glazing replacement, the system offers no redundancy and minimal protection against uncontrolled water leakage. Repair or remediation of the system is often difficult, due to the inability to reliably adhere sealant to the rubber compounds. This problem, as well as the problems associated with working on occupied buildings, can pose significant repair challenges to buildings.

Wiss, Janney, Elstner Associates, Inc.’s recent involvement with one such project illustrates a unique and innovative way to remediate a lock-strip gasket system installed in precast concrete wall panels that suffered from chronic uncontrolled water penetration. Our solution did not require removal of glazing or modifications to the lock-strip gaskets themselves, though it did maintain the integrity of the barrier wall assembly. This paper presents the history of this assembly and its common advantages and disadvantages. It also describes this particular project and the process by which our repair strategy was developed and implemented.

SPEAKER

MATTHEW C. FARMER — WISS, JANNEY, ELSTNER ASSOCIATES, INC. - FAIRFAX, VIRGINIA

MATTHEW C. FARMER joined Wiss Janney Elstner’s New Jersey office in 1985. Since then, he has been involved with numerous evaluations of concrete, steel, and timber structures, as well as failures of clay and concrete masonry, stone, and cast stone. Mr. Farmer has concentrated on the area of design, investigation, and repair of new and existing building envelope systems, including engagements as an expert witness for construction-related litigation. He was appointed manager of the Washington, D.C. office in 1994. He is a graduate of the University of Colorado and Cornell University and is a licensed professional engineer in the District of Columbia, Virginia, and Maryland.
REMEDICATION OF A LOCK-STRIP GASKET WINDOW ASSEMBLY

INTRODUCTION

Many façades built since the 1950s employ an innovative two-piece rubber structural gasket system to support window and curtain wall glazing. Referred to as a locking-strip gasket system, the gaskets are designed to replace a more rigid metal frame. The gaskets are often integrated with a supporting steel or aluminum structure and used as mullions between glazing panels or to tie glazing into precast concrete wall panels.

While the system offers many benefits, it is highly reliant on installation practices. If improperly installed, severely weathered, or damaged during glazing replacement, the system offers no redundancy and minimal protection against uncontrolled water leakage. Repair or remediation of the system is often difficult, due to the inability to repair the gaskets or reliably bond elastomeric sealants to the rubber compounds comprising the gasket system. These difficulties, along with the problems normally associated with working on occupied buildings, can pose a significant repair challenge to locking-strip gasket systems that experience uncontrolled water leakage.

THE LOCKING-STRIP GASKET GLAZING SYSTEM

HISTORY

Locking-strip glazing gasket systems were first introduced for building façades in the 1950s by the General Motors Corporation. Manufactured by its Inland Manufacturing division, the gaskets were an adaptation of GMC’s automotive windshield system. In 1961, Standard Products purchased GMC’s glazing gasket technology and manufactured the gaskets under the brand name StanLock. Griffith Rubber Mills purchased the StanLock Division of Standard Products in 1989 and continues to manufacture and market the two-piece gaskets under the StanLock brand.

Although there have been a few other competing systems introduced over the years, StanLock continues to be an industry leader and the most common system in use today.

DESCRIPTION

The locking-strip gasket system is a two-piece, preformed, elastomeric mechanical seal used to surround and attach a building panel or glass unit to a supporting structure made, typically, of metal or concrete. The gasket system consists of the gasket itself, which captures the edges of the panel or insulating glass (IG) unit, and a separate locking strip with a higher durometer (Shore A) rating that, when forced into a groove provided in the gasket, puts sufficient compression on the panel to secure it to the supporting structure and create an intended “watertight” seal. The locking-strip gasket system is also often referred to as a “zipper gasket,” due to its resemblance to a zipper as the locking strip is installed or removed.

Although a number of configurations exist, the most common locking strip gasket profile is an “H” shape (see Figure 1). This profile is designed to bridge between a building panel and the flange of a supporting structure, and it is often used for individual window openings. The gaskets are vulcanized into a single square shape by a combination of extrusion and injection molding. An example of this gasket in service is shown in Figure 2.

A second common configuration of the locking strip gasket system utilizes the “H” shape to receive two building panels and also incorporates a spline to mechanically engage the supporting structure (see Figure 3). These can be completely vulcanized systems or can consist of extruded lengths

Figure 1 – Schematic of H-shaped locking-strip gasket.

Figure 2 – Example of H-shaped locking-strip gasket securing an IG window unit to a precast concrete panel in service.

Figure 3 – Schematic of spline-type locking-strip gasket.
joined in the field to molded corners and tees. Figures 4 and 5 illustrate an example of an installation using a spline-type gasket.

All of the gasket profile systems rely on the installation of the locking strip into the gasket to secure the glazing or building panels. Special tools and techniques are required to properly install and replace building panels or glazing; improper installation/removal of the locking strip or the gasket can lead to damage of the system and water leakage.

**Material**

The most common material used for the locking-strip gasket system is neoprene. It is highly durable as well as flame-, oil-, and chemical-resistant. It functions well under temperature extremes and remains elastic with low compression set over its service life. Neoprene is typically only available in black. Though the material is stable under exposure to ultraviolet light, the material surface exposed to the environment undergoes oxidation and forms a friable "dust" on that surface as it degrades. This characteristic makes adhesion of elastomeric sealants unreliable, since the bonding surface is difficult to clean and continues to break down over time.

The flexibility inherent with the locking-strip gasket system accommodates variations in alignment between the opening substrate and the building panel, thereby reducing stresses induced by racking and glass-to-metal contact. It also can be effective in dampening noise and vibration. The gasket is also a natural thermal break, minimizing thermal conductance between the interior and exterior of the wall assembly. It also can easily be designed to allow glass removal from either the interior or exterior.

**Water Penetration Resistance**

The locking strip gasket systems are considered barrier systems from a water-resistance standpoint, since they do not offer redundancy against water penetration and do not typically incorporate drainage provisions for water reaching the interior of the assembly.

Water is resisted at the interface of the gasket and the building panel by compression of the gasket created by the locking strip. If the gasket compression is compromised by debris, damage, or improper installation, water can collect in the gasket and eventually leak to the interior. Field sealing of splices between extruded sections and molded intersections is also extremely sensitive to installation techniques, as these extend the full depth of the extrusion and represent a direct path by which water can reach the interior of the structure.

**Remediation of a Locking-Strip Gasket Assembly**

As previously mentioned, locking-strip gasket systems rely heavily on knowledgeable technicians for proper installation and maintenance. Over time, these systems can be irreparably damaged during routine glass replacement by glaziers not familiar with the locking-strip technology or not equipped with the tools necessary to correctly replace failed glazing. Improper maintenance can result in uncontrolled water penetration, damage to interior finishes, and discomfort to building occupants.

The author's recent involvement with one such project illustrates the potential damage from a lack of proper maintenance and incorrect glazing-replacement procedures. It also offers a unique and innovative way to remediate the damaged locking-strip assembly in a cost-effective manner and with minimal disruption to building operations.

**Project Description**

The subject project is a 13-story, mid-rise office building located in the mid-
Atlantic region and originally constructed in the 1970s. The structure consists of conventionally reinforced concrete flat-plate floor slabs supported by conventionally reinforced columns. The exterior façade consists of precast concrete panels that incorporate rectangular openings recessed between horizontal spandrels and vertical “fins” to accept individual, insulating-glass (IG) units to form the windows (see Figures 6 and 7). The upper floors vary slightly from the typical precast/window configuration in that glazing units, and spandrel panels are stacked to form an uninterrupted “column” of glazing between the precast concrete fins (see Figure 8). An H-shaped locking-strip glazing gasket system is used to engage the IG units and secure them to flanges on the precast concrete panels at the opening perimeters.

Over the past several years, the building suffered from ongoing uncontrolled water infiltration and IG-unit failure, along with other deficiencies resulting from deferred maintenance of the exterior wall system. The project objective was to determine the cause of the water infiltration and develop appropriate repairs to address the deficient conditions observed. The following specific conditions were observed with respect to the locking strip gasket system:
• Many of the gaskets were distorted and misaligned due to a lack of compliance with construction tolerances. This condition resulted in distorted gasket position and poor glass/gasket seals that led to water infiltration (see Figures 9 and 10).
• Some gaskets did not completely engage the glazing. Sealant was typically applied to fill the gap between the glazing and the gasket (see Figure 11).
• Many of the locking strips were missing, leaving the gasket without adequate compression against the glass and allowing water to enter the gasket-glazing pocket (see Figure 12). The gaskets were also often cut at the corners to allow for glazing replacement without removal of the locking strips. This condition also led to reduced glass compression and allowed water in the glazing pocket to leak to the interior.
• Water collected in the glazing pockets. Because the IG units were not
shimmmed, their edge seals remained wet for prolonged periods, leading to eventual failure in the form of condensation between the glass bites and loss of insulating properties (see Figure 13).

- Elastomeric sealant was present between the locking-strip gasket and the precast concrete panels, as well as between the gasket and the glass. This sealant was deteriorated and lacked adhesion to the gasket system (see Figure 14).

Challenges

This project presented many challenges with respect to the remediation design. These are discussed below:

- The client required that the building remain fully occupied throughout the course of the work, with minimal disruption to the tenants. This necessitated that the majority of the repair work be conducted from the exterior and eliminated the potential for repairs requiring removal of glass on a large scale.
- It was critical to provide an adequate overlap between the IG units and the gasket, or glass bite, to avoid any reduction in resistance to wind loading.
- The inability to reliably bond elastomeric compounds to the neoprene gaskets made more traditional barrier system repair approaches impractical without substantial associated maintenance.
- Although there were relatively few opening sizes, there were multiple configurations of the glazing units (see prior Figure 8) and variability in the relationship between the gaskets and the edges of the precast concrete openings. It was preferable from a design and maintenance perspective to utilize a similar and consistent approach at as many window configurations as possible, regardless of the deviations.
- The client appreciated and wanted to maximize the clear glass area at each opening to preserve natural light and desirable views.

Proposed Solution

After reviewing the existing field conditions, it was decided to design an overlay barrier system for the existing locking-strip gasket system. The final solution consisted of a custom-fabricated, silicone-compatible rubber extrusion applied directly over the existing glazing gaskets that bridged from the glass to the adjacent precast concrete panels without relying on adhesion to the gasket itself.

The final design was an “L”-shaped extrusion formed to fit the external profile of the locking-strip gasket at the glass line. The edge in contact with the glass was...
thickened to allow it to be “bedded” in sealant against the glass surface, but without a visible external seal. The opposite leg length was trimmed to accommodate variable dimensions between the locking-strip gasket and the surrounding precast concrete. Once in place, a fillet bead of sealant was applied between the new overlay extrusion and the precast concrete panels, creating a watertight seal. Figures 15 through 18 illustrate the final profile concept and its relationship to the existing wall system at typical locations. This repair approach offered several key advantages with respect to the overall project:

- The bedding of the extrusion in sealant eliminated exposure of the sealant to the environment, prolonging its service life. It also offered a clean, narrow sight line in comparison to an exposed wet seal using elastomeric sealant.
- The installation of the overlay gasket did not require removal of the existing sealant between the existing locking strip gasket and the precast concrete, saving cost and eliminating a labor-intensive step in the repair process.
- The gaskets are made of silicone-compatible rubber (SCR), a highly durable, environmentally stable material. It has many of the qualities and the appearance of the original neoprene gaskets, but reliably accommodates the application of elastomeric sealants.
- The entire installation could be performed from the exterior without glass removal.
- Repairs to the original locking strip gaskets were not required.
- All of the various glazing configurations could be addressed using combinations of the custom overlay extrusion and widely available standard pre-formed SCR shapes.
- New sealant installed in joints between the precast concrete panels could be seamlessly integrated into the sealant joints around the window openings.

Despite the many advantages of this remediation design, one major drawback to this solution is the need to access the exterior and remove/reinstall the overlay extrusions to replace failed IG units in the future. The owner was provided with attic stock for future repairs/replacement.

**IMPLEMENTATION**

The first steps toward the repair implementation began with design of the concept. This involved field measuring and documenting the various glazing conditions and components to assure that the design concept could address the multiple glazing configurations on the project.

Contract documents were developed for the design to provide sufficient detailing and information for the repair contractors to competitively bid the fabrication and installation of the overlay extrusions and associated work. Once the bids were received, each bid was carefully examined to assure that it recognized the intricacies of the repair process necessary to arrive at a final overlay extrusion product. Each contractor was asked to submit his preferred extrusion manufacturer as part of his bid.

After awarding the contract for the repairs to the successful bidder, the specified overlay extrusion manufacturer was contacted to perform field measurements and develop a prototype extrusion for trial installation (see Figure 19).

A trial installation proved critical to refine the final extrusion design and develop a method to minimize the repair process. With modifications to the extrusion profile, a successful installation could be achieved.

**Figure 17 – Overlay extrusion application where glazing meets at inside corners.**

**Figure 18 – Overlay extrusion application where glazing and spandrel panels meet vertically.**

**Figure 19 – An early schematic of the overlay extrusion profile proposed by the manufacturer.**

**Figure 20 – Final overlay extrusion profile. Note the modifications to vertical leg (area circled).**
In response, the installation methods were adjusted to assure a watertight bed-seal that could be visually verified from the building interior. The trial installation also allowed for the opportunity to experiment with different corner treatments to maximize watertightness while simplifying the installation (see Figures 21 and 22).

Once the overlay extrusion profile and the installation procedure were finalized, a mock-up installation was performed to establish the standards for the project and for the client’s aesthetic approval prior to implementing repairs building-wide. Water-penetration-resistance testing was conducted to verify that the overlay extrusion concept would be successful. As a result, it was discovered that the extrusion leg bearing on the glass was not being fully bedded, leading to water entrapment behind the overlay extrusion and uncontrolled water leakage (see Figure 23). In response, the installation methods were adjusted to assure a watertight bed-seal that could be visually verified from the building interior.

RESULTS

Once an effective installation procedure was established, the overlay extrusions were applied with surprising quickness. They maximize clear window area while substantially reducing water penetration. This method avoided expensive deglazing operations and reliable installation procedure. Minor modifications included a longer leg to accommodate greater deviations in distance between the original gasket and the precast concrete panels, as well as a shorter leg bearing on the glass to assure it did not displace outward when compressed (see Figure 20). The trial installation also allowed for the opportunity to experiment with different corner treatments to maximize water-tightness while simplifying the installation (see Figures 21 and 22).
and gasket-replacement options, while having a minimal impact on the overall wall assembly. Overlaying the damaged locking-strip glazing gasket system resulted in a crisp, clean line around the glass that is very similar in appearance to the original locking-strip gasket system installation (see Figures 24 through 27). The overlay extrusions integrated into the existing wall system should continue to serve well into the future as an effective barrier against uncontrolled water penetration with minimal maintenance requirement.

ACKNOWLEDGEMENTS

The author wishes to recognize the contributions to this project and paper from Griffith Rubber Mills, of Eugene, Oregon; Tremco Sealant/Weatherproofing Division, of Ashland, OH; Suzanne Thorpe, project associate (WJE); and Rita Sparacino, project associate (WJE).


EDITOR’S NOTE: A shortened version of this paper, titled, “Repairing a Gasket with a Gasket; Remediation of a Locking-Strip Window Gasket Assembly Provides Similar Appearance, Effective Water Barrier,” appeared in the Spring 2007 issue of Applicator magazine, published by the Sealant Waterproofing & Restoration Institute.