EVOLUTION OF EIFS

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ADDRESSING THE BUILDING ENVELOPE
ABSTRACT

First introduced in the U.S. over 40 years ago, exterior insulation and finish system (EIFS) claddings have evolved, with code and industry standard modifications, to effectively manage moisture. Following its initial use on commercial construction projects, costs declined, and EIFS installation became viable in the residential market. Increased construction errors fueled application and design changes to require compliant use of code-recognized systems.

Barrier EIFS do not incorporate moisture-management components and rely fully on the exterior surface—including all sealant joints—to be completely weatherproof. Damage resulting from water infiltrating behind barrier EIFS arose in the 1990s due to improper detailing and construction, lack of oversight, and absence of a moisture-managed system. Code and industry standards evolved to prevent the damage associated with barrier system failures over water-sensitive materials with the introduction of moisture-managed EIFS, which incorporate a weather-resistive barrier and weep mechanisms to promote drainage.

A case study of the largest postlitigation construction repair project in Denver’s history will illustrate common errors in EIFS application, effects on related systems, and challenges encountered in transitioning from barrier systems to a moisture-managed façade. Firsthand experience of forensic investigations, testing performed, repair design, and on-site quality assurance will be provided.

SPEAKER

RYAN J. BARNES, EI — SBSA, INC. - GOLDEN, CO

Experienced in building design and construction, RYAN J. BARNES is particularly knowledgeable in the area of building envelope systems. He provides forensic investigations to evaluate existing residential and commercial buildings, determine the existence of non-compliant construction that is in violation of applicable building code requirements and industry standards, identify resultant damages, and provide repair recommendations for property owners. Barnes is a certified third-party EIFS inspector (EI), and his areas of expertise include exterior cladding materials, plaza deck and balcony waterproofing, window assemblies, sealants, and related moisture-management materials. Ryan also provides rehabilitation and new building design and consultation services, including development of construction documents, design review, on-site quality assurance, and construction administration services.
MOISTURE-MANAGEMENT HISTORY

Back when castles were built using masonry mass-wall construction, the performance of larger buildings was not much of an issue. However, in today’s construction, water penetration resistance, air resistance, and thermal performance are important issues.

Castles utilized stone as the primary building material. The physical characteristics of stone were ideal for water management, allowing the materials to behave as a mass reservoir for the walls, preventing damage to interior finishes. Stone inherently has a high moisture storage capacity; these walls are able to store moisture from precipitation and then naturally dry out without damage. One drawback was that stone construction took significant time and manpower, and it became costly to procure and cut the stone, train masons, and construct and maintain the buildings without scaffolding.

The Industrial Revolution of the late 19th century produced technical advancements that pushed the envelope of construction, changing the face of architecture forever. Previously understood only by the trade master, the design of structural systems advanced as civil engineering provided means of conducting precise calculations to predict how a structure would react under specific loads. A dramatic increase of materials produced in mass quantity, including reinforced concrete iron, steel, aluminum, and glass, allowed for standardized components to be manufactured and assembled offsite. This led to a dramatic increase in materials that could be procured in mass quantity or industrialized for mass production, including Portland cement to create reinforced concrete. Material uniformity and elemental repetition became common in designs of large, light, open structures that could be rapidly constructed, overcoming the burdens associated with the labor needed to process the natural resources used in earlier times.

The late 19th century saw an increase in populations, particularly in urban areas. With more people, there was an increased demand for buildings that cost less and could be built quickly. Framed wall assemblies were designed and built because they could go up faster than traditional construction methods and were cheaper than the previously utilized materials. Early methods of framed residential construction utilized more consistent and durable materials, such as sawn lumber and plywood. Minimal insulation was placed within the walls, and excess air infiltration and drafts were not uncommon or unexpected. Unlike the buildings commonly constructed today, these types of buildings had an increased moisture storage capacity and drying ability, which resulted in high energy use at a time when energy costs were relatively low.

As technology advanced and the construction industry gained knowledge of how buildings performed in response to the weather, the industry realized that the energy efficiency of buildings could be dramatically improved by utilizing different construction and materials. The use of these materials resulted in lower construction material and labor costs and lower energy consumption. Some of the advancements included using manufactured materials such as engineered lumber, oriented strand board (OSB) and gypsum sheathing, asphalt-impregnated building papers and felts, premanufactured house wraps, and plastics such as vapor retarders. Protecting these materials is particularly important because many of them are cellulose-based. Cellulose will lose structural properties when exposed to increased moisture. Additionally, increased moisture causes biological growth; fungal attack causes additional loss of structural integrity.

Construction utilizing these materials, which are common today, resulted in a reduced moisture storage capacity and, thus, a lower drying ability in comparison with previous practices. While this improved energy efficiency and lowered construction costs, an entire new set of concerns arose in regard to proper management of moisture in order to protect the new increasingly water-sensitive building components. The building materials changed radically; the industry’s approach to water control also had to change. The new materials did not have the same properties as stone and did not allow the systems to wet and dry without an effect on their performance. Because the buildings had to resist moisture differently than the masonry mass walls did, buildings were designed to accept moisture, capture, and drain it. Otherwise, without this means of capturing and draining the moisture, the walls have to act as a barrier and prevent water intrusion.

A common downfall of these new materials occurred when the façade failed to act as a barrier. When the moisture management components are properly installed, water is prevented from entering the wall assemblies and it works well; however, if the systems are installed incorrectly and if water does enter the system, it’s less able to get out and can seriously degrade the building components. Designers, builders, and manufacturers have all worked on improving moisture management to address system failures of modern buildings. To address failures that were found in the building façade, they implemented new designs and devised ways to construct systems that divert water toward the exterior, protecting the moisture-sensitive building components underneath the façade, as well as the interior finishes.

Preventing water entry requires a system of moisture management components to be designed and constructed in a manner that protects the water-sensitive building materials for the life of the building. When the moisture management components are not installed correctly, water is able to enter or form within these structures and cause severe damage that requires repair.

Furthermore, controlling moisture within buildings is also important for the building’s energy efficiency. The exterior environment varies greatly, depending upon the climate and location of the building. These exterior conditions can cause vapor drive to the interior of buildings. Also, sources of moisture that originate from the interior must be considered. Everyday activities—
such as cooking, showering, and washing—produce moisture that increases the indoor relative humidity. Depending on the environment, this interior moisture can be driven to the exterior. Ventilation and vapor retarders became more prevalent as a way to control vapor drive and prevent moisture from condensing within the wall assembly.

Many contractors installing systems incorporating the new moisture management components did not initially have the training or knowledge of the systems, including exterior insulation finish systems (EIFS), to properly install all the required components so as to prevent moisture intrusion and damage to the buildings as a result of that intrusion. The performance of the building was no longer just shelter; it was to be aesthetic, comfortable, structurally sound, and provide protection from the elements through all four seasons.

**EVOlUTION OF EIFS**

First installed in Europe in the 1940s, EIFS were installed directly over existing masonry structures that had high moisture-storage capacities; water infiltration behind the EIFS was of little or no consequence. EIFS are composed of insulation board—generally expanded polystyrene (EPS)—attached to the underlying sheathing, a cementitious base coat that is applied to the insulation boards with embedded fiberglass reinforcing mesh. An acrylic finish coat provides the finish surface. The thermal insulating characteristics of EIFS result in a highly effective means of controlling the transfer of heat through the exterior walls.

Following its use on commercial properties in the U.S. in the 1970s and 1980s, EIFS costs declined, and barrier systems became a prevalent cladding alternative in the residential market in the early 1990s due to the lower cost and thermal-resistance benefits. Problems soon began to arise as barrier EIFS were applied to wood-framed structures classified under Type V construction, which allows buildings to be constructed of any materials allowed by the code.

Barrier EIFS do not incorporate an underlying weather-resistant barrier, nor are there any moisture management components that would allow water to be discharged from the systems. Instead, barrier systems need the exterior surface—including all sealant joints—to be 100% weatherproof 100% of the time. In order to maintain the integrity and intended performance of the barrier system, the sealant joints must be maintained or replaced prior to failure of the sealant. Sealants are a crucial piece of a moisture management system. When properly constructed, they keep water out of junctures of building materials or where fenestrations are installed. Despite advancements in the physical performance capabilities of sealants, all sealant joints will eventually experience adhesive or cohesive failure, leaving an opening for water to get into the building. To combat this inevitable failure, it is crucial that sealant joints be properly designed and constructed to last as long as possible and be able to be maintained. Once the sealant fails, water can enter the system where the underlying water-sensitive sheathing and wood framing are unprotected. Without a means for the water to exit the system, damage will occur to the water-sensitive building components as a result of being exposed to moisture for prolonged periods of time.

In the 1990s, it became apparent that barrier EIFS were failing to keep water out of buildings, and the trapped water was causing significant damage to the water-sensitive components. Few in the industry had experience installing EIFS, and this lack of experience was evident in the improper detailing and construction of these systems, a lack of supervision during installation, and the absence of a moisture-managed system offered by the manufacturers. As a result, building code and industry standards evolved to prevent the damage associated with the barrier system failures by introducing moisture-managed EIFS in the mid-’90s. Moisture-managed EIFS incorporate a weather-resistive barrier, weep mechanisms, and related components to address the problems found with barrier systems.

Moisture-managed EIFS, in conjunction with related flashing components, allow for inevitable, unintended water that infiltrates behind the exterior facade to be directed down the weather-resistive barrier and drained out of wall systems through weep mechanisms. Various types of moisture-managed EIFS are available today, some of which control the moisture more effectively than others. For example, some systems use preformed grooves on the backside of the insulation boards, which help to direct and drain water down the weather-resistive barrier. Another alternative allows the insulation board to be attached to a fluid-applied, weather-resistive barrier. The adhesive used to attach the insulation board is applied vertically with a grooved trowel to form voids that create channels behind the board to direct water down the weather-resistive barrier. Other systems utilize a drainage medium between the insulation board and underlying weather-resistive barrier to create a drainage plane capable of managing an increased amount of water infiltration. This medium is often an expanded metal lath fastened to the underlying framing. The insulation boards can be adhesively attached to the drainage medium in a manner similar to the second system discussed above. Given all the options of the underlying components, the end product always incorporates a base coat with embedded reinforcing mesh and a finish coat. Ultimately, the advancements made with regard to the moisture-managed EIFS have significantly improved system performance if properly applied.

Until the release of the 2009 International Building Code (IBC), EIFS were not specifically recognized by building codes as acceptable building materials. If a particular building product, component, method, or material—including EIFS prior the release of the 2009 IBC—is not recognized by the code, evaluation reports published by the International Code Council (ICC) provide supporting evidence and required testing that allow for alternates to be used so that they are in compliance with building code requirements. Prior to 2003, four different building-product evaluation services existed in the United States (NES, ICBO, BOCA, and SBCCI); in 2003, each combined its operations to form the ICC Evaluation Service. Acceptance Criteria (AC) reports issued by the ICC (or other product-evaluation service agency in the past) assist in the development of evaluation reports by defining performance and installation requirements that alternate materials must comply with in order for an evaluation report to be published.

Between 1992 and 1997, barrier EIFS were accepted by the ICBO Evaluation Service per AC 24, which set required installation and performance criteria for the systems to be installed on any building type at that time, if recognized by passing performance tests that would allow the system to be installed without a weather-resistive barrier. To obtain this recognition, the EIFS were to be subjected to a water-resistance test that tested a sample measuring 2 by 4
No terminations or sealant joints were required to be tested to pass the test. This simple test was not representative of the actual installation of a full EIFS, which would include proper detailing and construction at the system's terminations to dissimilar materials. These interfaces at windows, doors, and other cladding materials are, in fact, the most vulnerable areas of any cladding system, especially barrier EIFS and other claddings that do not have the ability to properly control water intrusion and protect the building’s water-sensitive components.

In September 1997, AC24 was revised to include “weather-resistive considerations” that did not allow barrier EIFS to be installed on Type V buildings. AC24 then required all EIFS installed on Type V buildings to comply with the requirements for EIFS wall-covering assemblies with drainage. A properly constructed moisture-managed EIFS must incorporate a weather-resistant barrier and related flashings, grooved insulation board, and weep mechanisms that allow moisture to exit the system. While this change to EIFS installation requirements within the industry had good intentions, poor detailing, improper construction, and ineffective coordination of trades to properly interface dissimilar cladding system materials can still occur, resulting in water intrusion.

The requirements set forth for EIFS in the 2009 IBC state that a “water-resistive barrier shall be applied between the EIFS and the wall sheathing.” Based on the code requirements, a successfully installed EIFS essentially relied upon the product applicators to install the product per the manufacturer’s installation instructions. While the contractors installing EIFS are generally more than capable of following the required installation instructions, unique conditions often exist that are not detailed by the manufacturer’s installation instructions. This requires the designer of record to provide appropriate details to ensure the system is properly interfaced with adjacent components in order to provide a weathertight assembly.

**BEAUVALLON CONDOMINIUMS**

Located in downtown Denver, CO, Beauvallon Condominiums is a mixed-use development with 214 units and dual 14-story towers that comprise the majority of the residential units. Commercial space is leased on the first and second floors, with a below-grade parking garage under the pool area plaza deck. The project was originally constructed between 2001 and 2003 and incorporated multiple building-envelope systems, including a low-slope EPDM roof; copper and steel wall panels at the upper two floors; polyurethane fluid-applied deck coatings on covered decks; concrete pavers on pedestals over EPDM waterproofing at exposed residential decks; hot-applied, built-up membrane over the community plaza deck and parking garage; and stucco and precast anchored stone on the first level. A barrier EIFS was installed over fiberglass-faced gypsum sheathing comprising the majority of the façade. The primary structure of the building is concrete slab and columns with steel stud infill to transfer lateral forces between the floors.

Following the completion of the initial construction, the development was indicative of past architectural principles from the Baroque period that began in Rome in the 1600s. The bilaterally symmetric building engaged observers with a sense of dynamic activity that stemmed from the perceptive forces of voids that define the shape of the adjacent solid elements. While the building evokes some sense of mass wall construction similar, from a casual observer’s perspective, to early architecture, the actual performance of this turn-of-the-millennium building was far from capable of controlling moisture by means of reservoir storage. Additionally, the building wasn’t constructed in a way to properly control the moisture from the outdoor environment in accordance with the building codes or industry standards. See Photo 1.

**BEAUVALLON INVESTIGATION**

In 2005, homeowners began to report evidence of water intrusion adjacent to sliding doors. This intrusion was causing damage to interior finishes. At that time, it was decided by the property management company, with input and consent from the homeowners association’s (HOA) board of directors, to engage in a preliminary investigation to determine the cause of the reported water intrusion. A forensic engineering firm was hired to perform an initial investigation of the building. Following this investigation, the firm reported a multitude of construction defects that could have been causing the damage, and there was a possibility that the problems with the system as installed could lead to further damage.

Based on preliminary recommendations provided to the HOA’s board of directors and its property management representati-
tive, the board engaged a law firm with extensive experience in construction defect law to pursue the claims related to defective construction. SBSA’s staff would act as the plaintiff’s primary expert. In the summer of 2006, SBSA’s staff performed a preliminary investigation, knowing the deficiencies previously reported by the initial forensic engineering company. It became immediately evident that water was intruding into the building’s exterior wall cavities because of the defective construction of the cladding and waterproofing systems. The barrier EIFS wasn’t properly interfaced with adjacent claddings, fenestrations, and other building components and was unable to control water that had infiltrated behind the cladding.

A thorough investigation was initiated in August of 2007, beginning at the penthouse units located on the upper two floors of each tower. SBSA’s staff determined the low-slope EPDM roof was not causing problems; however, the steel and copper panels were not watertight, and significant amounts of water were penetrating at the perimeters of windows and slider doors. It was discovered that the weather-resistive barrier application was not provided underneath the panels or was installed incorrectly. Proper application of a weather-resistive barrier would include integration with window flashings. Flashings were either not applied properly or were missing entirely (Photo 2). This allowed water to get into the framed wall assembly through penetrations in the sheathing, particularly at the windows and doors, as well as through unsealed sheathing joints. The water caused corrosion of the steel-framed wall assemblies and was particularly severe along the sill track where water was able to collect and accumulate. The damage progressed to the interior finishes within the penthouse units, staining and deteriorating drywall, causing biological growth behind baseboards, and permanently deforming the wood flooring.

This water intrusion through the steel and copper panels was compounded by the improper integration of the EPDM mem-

Photo 2 – Copper panels removed. No weather-resistant barrier or flexible flashings installed at windowsill and slider door head, allowing water to enter the wall cavity.

Photo 3 – The EPDM membrane waterproofing at the penthouse deck is not shingle-lapped with a weather-resistant barrier, allowing water to enter behind the waterproofing.

Photo 4 – Inside metal-framed wall assembly below penthouse concrete deck. Water from under the deck waterproofing has entered the wall cavity at the edge of the concrete deck.
brane that was installed on the penthouse plaza decks; worse, the installation of the EPDM allowed water to infiltrate further into the building. The EPDM membrane was not shingle-lapped with a weather-resistant barrier behind the steel and copper panels (Photo 3), which allowed water to travel under the deck waterproofing and saturate the rigid insulation installed on the concrete deck. With water trapped below the impermeable EPDM membrane, after saturating the insulation boards, the only place for it to travel was to the edge of the concrete deck and into the steel-framed wall assembly below (Photo 4). Severe damage resulted within the soffits covered with the barrier EIFS, as water was able to travel a short distance from the deck edge above to where it accumulated in and around the steel channel at the bottom of the soffit framing (Photo 5).

Not only were the framed wall assemblies installed behind the barrier EIFS compromised by the intruding water from the penthouse units, but pan flashings, which were required, were not installed to prevent water intrusion at windows. Water was able to enter behind the barrier EIFS primarily through terminations of the system, including the perimeter of the hundreds of windows and slider doors installed in the system, causing further damage to the building (Photos 6 and 7).

In addition to documenting the damages that resulted from the failed barrier EIFS and other cladding materials, window assemblies were tested for both installation and window weathertightness. The performance testing was performed in general accordance with the protocols outlined in ASTM E1105, Standard Test Method for Field Determination of Water Penetration of Installed Exterior Windows, Skylights, Doors, and Curtain Walls by Uniform or Cyclic Static Air Pressure Difference. As stated in the ASTM E1105 protocol, the test is “intended primarily for determining the resistance to water penetration through such assemblies for compliance with specified performance criteria, but it may also be used to determine the resistance to penetration through joints between the assemblies and the adjacent construction.”

Water tests were made to determine (1) the exterior façade’s ability to manage water penetration and prevent infiltration to the interior and/or wall cavities, and (2) the window’s resistance to water penetration. Following the tests, the façade material in selected locations was removed to observe the installation methods and techniques used, and to determine the cause(s), if any, of failure during the tests. Failure is defined by ASTM E1105 protocol as “penetration of water beyond a plane parallel to the glazing (the vertical plane) intersecting the innermost...
projection of the test specimen, not including interior trim and hardware, under the specified conditions of air pressure difference across the specimen.... Failure also occurs whenever water penetrates through the perimeter frame of the test specimen. Water contained within drained flashing, gutters, and sills is not considered a failure.” It was determined through a series of tests that the residential vinyl windows were not causing water infiltration, but rather the installation and seals around the window were the mode of failure.

The joints around the vinyl windows utilized an open-cell backer rod behind the sealant. Open-cell backer rods absorb moisture within the cells of the material; the wet backer rods were in prolonged contact with the sealant, causing the sealants to fail prematurely. As previously discussed, all sealant joints will fail, even those that are installed to maximize performance; also, they must be maintained to provide a watertight seal. It is vitally important for these sealants to be functioning at terminations of the barrier system, as they are part of what protects the building from precipitation and likely subsequent water intrusion.

The building, however, had no safe or reasonable means of accessing the exterior façade to inspect and repair the sealant joints. There was no davit system installed for swing stages or fall protection. Furthermore, due to the tiered configuration of the towers, there were areas that could not be accessed by a typical roof-mounted davit system.

The EPS insulation boards installed as part of the barrier EIFS were adhesively attached to fiberglass-faced gypsum sheathing with a notched trowel in vertical, horizontal, and irregular swooping patterns. This disorderly network of channels, created by the adhesive application behind the insulation board, created various courses and directions for water to travel down the wall. Water traveled throughout the wall system, accumulating at various locations and causing damage throughout the building.

As water travels down the walls behind the barrier EIFS insulation board, it is able to enter the wall cavity through terminations of the sheathing panels and accumulate at each horizontal deck projection. Similar to decks at the penthouse level, the EPDM membrane waterproofing at the projecting, weather-exposed residential decks also allowed water to enter behind the membrane (Photo 8).

If the water intrusion into the wall cavities wasn’t enough, a foil-faced vapor retarder was installed at the interior side of the exterior walls, exacerbating damage because the moisture was trapped within the wall assemblies. By installing the vapor retarder on the inside of the wall, in combination with the EPS insulation board on the outside, moisture became trapped within the wall cavity, creating a warm, humid condition in these cavities. This caused additional corrosion of the steel framing,
and several of the sill tracks were so severely damaged that pieces of the steel could be removed by hand during the investigation (Photo 9).

Not only did the original construction of the building envelope components fail to protect the interior space from the outdoor environment, the façade was also unable to control water draining down the face of the building in a manner that would have complied with the building code. The drainage across the multiple cornices was being discharged onto the sidewalks below with no means of directing the water into a gutter or downsput system in order to discharge the water to a safe location (Photo 10). The climate in Denver is unique in that the city receives over 300 days of sunshine on average every year. The sunshine is prevalent, even in the winter months. This creates conditions where snow can accumulate during a storm, then melt away the following day. During warmer days after it snowed, surface drainage from the cornices would flow onto the public walkways, directly onto the sidewalks where customers accessed retail establishments. Before it could evaporate or be absorbed by the concrete, this water would then freeze at night as the temperature dropped drastically, creating dangerously icy conditions. Furthermore, the cornices were constructed of mass amounts of EPS insulation adhered to the sheathing and essentially held in place by the EIFS lamina. As constructed, the cornices were unable to withstand the weight of the snow and ice or meet the code-prescribed loads.

Following the extensive forensic investigation performed by SBSA staff, which concluded in the summer of 2008, reports were compiled and submitted to the plaintiff’s attorney. A settlement was reached between the plaintiff and defense parties in early 2009 for an undisclosed amount; however, it was the second largest construction defect case award in the history of Colorado. Given the extensive knowledge of the building system failures identified during the forensic investigation, SBSA was naturally the best candidate to assist in the repair design and provide owner representation during construction. The construction repair phase of the project allowed for SBSA to provide ongoing support to the contractor and owner to ensure that the finished product has eliminated all issues associated with the original noncompliant construction.

**BEAUVALLON REPAIRS**

Constituting the largest construction defect repair project in the history of the city and county of Denver, repairs at the Beauvallon Condominiums began in mid-to-late 2009. Construction costs to repair the multitude of issues, which existed from the roof to the bottom floor of the parking garage, totaled approximately $18 million.

Many challenges were presented throughout the year-and-a-half construction period. The team of contractors, designers, consultants, and property managers worked together to overcome these challenges and minimize the impact on the daily lives of the tenants, who remained in the residences throughout the construction repairs. Among the most intrusive aspects of the construction repair was the interior remediation that was performed in units identified to have potentially harmful biological growth. This multiple-day process in each unit made certain that all wall assemblies and interior finish materials in which biological growth had manifested was properly cleaned or replaced and that the areas were subsequently verified by a certified industrial hygienist to ensure proper remediation protocols were followed.

Before repairs could commence, the
Photo 11 – Ongoing repairs at the east elevation of the Beauvallon Condominiums. Repair work is complete on the upper portion and in progress on the lower floors of the south tower (left). Repairs have commenced on the north tower (right).

design process had to be completed to address all of the noncompliant construction identified during the investigation and keep within the allowable budget. Repair recommendations developed during the litigation phase allowed costs to be estimated and included in the settlement. Final construction documents were submitted for permitting by the selected general contractor. Contractor mobilization began shortly thereafter as repairs began on the south tower in late 2009. The repair plan scheduled demolition and subsequent repair in different phases of the building to maximize the productivity of the work. At any one time during the peak of the schedule, particular areas were either fully repaired, in the process of repair or demolition, or had yet to be accessed at all (Photo 11).

Access to the areas around the entire building and each tower was accomplished with a network of scaffolding positioned around the façade to provide workers with a safe work area to perform the required demolition and subsequent repairs. Tenting was installed on the scaffolding to control debris during demolition, as well as to protect the building from weather during the repair process. This inconvenienced the residents, who lost the downtown and mountain views they had become accustomed to. The tenting also helped control demolition debris, in particular the light-weight beads that comprised the previously existing EPS insulation board. Although the tenting ruined the view for residents, removing the EPS without protection would make little white beads of foam fly around the city like fresh, light snow regardless of that day’s weather.

Building envelope repairs began by removing the steel and copper panels on the penthouse units to install a weather-resistant barrier and flashings rated for the high temperatures. These panels were properly integrated with the windows and slider doors, as well as the new application of EPDM membrane waterproofing. The EPDM membrane was installed continuously over the cornice and terminated with a sheet metal flashing drip at the leading edge to promote the surface drainage away from the exterior walls clad with a new moisture-managed EIFS below.

The failed barrier EIFS was removed, exposing underlying damage. In order to assess the integrity of the corroded steel-framing members, many of the exterior wall cavities were exposed from the outside by removing the existing sheathing. Corroded steel framing was sealed with a product that converted the rust into stable magnetite. Deteriorated sheathing was replaced following the treatment of the corroded steel framing. The first component of the new moisture-managed EIFS was the application of corrugated housewrap that was properly interfaced with all required weep mechanisms and flashing materials. Weep mechanisms were provided to allow the water to be discharged from the system at interfaces to deck surfaces, projecting cornices, window heads, soffits, and other horizontal terminations of the moisture-managed EIFS.

Photo 12 – Full repair has been completed above the floorline. A weep mechanism was incorporated into each floorline of the moisture-managed EIFS, and all new windows provided water shedding and underlying moisture management performance capabilities.
New, energy-efficient windows and slider doors were installed to replace the existing fenestrations. This upgrade to the building was not part of the settlement reached during litigation but was decided upon by the HOA and property management since it was an opportunistic time with the scaffolding already in place. The existing windows were still serviceable and were donated to Habitat for Humanity. The installation of the new window units was a design challenge due to the recessed configuration of the openings.

To achieve a continuous air and water barrier around the perimeter of the windows and allow for effective surface drainage off the recessed sills, a configuration of self-adhered and rigid flashings was utilized. The self-adhered flashing was installed into the window opening at the sill, with a formed back dam at the backside of the window unit, and up the jambs to form a three-sided pan flashing that can effectively direct water onto the weather-resistive barrier where it can be discharged from the system. Expansion joints were installed at each of the floor lines where the steel framing was secured to the concrete floor slabs. To promote the drainage capability of the moisture-managed EIFS, weep mechanisms at each floor were installed that consisted of a shingle-lapped configuration of the drainage tracks, weather-resistive barrier, and prefinished sheet metal flashings to direct any water out and away from the wall system (Photo 12). The existing EPDM membrane waterproofing at the exposed residential decks was replaced to provide proper integration with the moisture-managed EIFS and to improve the drainage capability below the pedestal and paver walking surface.

Following the complete installation of the weather-resistive barrier, associated flashings, and weep mechanisms, the final components of the moisture-managed EIFS were installed, beginning with expanded metal lath. EPS insulation boards were adhered over the lath with a vertically oriented groove application that provides additional space for water drainage behind the system and toward the weep mechanisms installed at horizontal terminations (Photo 13).

Modifications to the projecting cornices that surround the Beauvallon towers were performed, beginning with the addition of structural support within the large cornices, which project out from the building as much as 7 ft. The repairs included the installation of custom-fabricated steel framing to support the code-required loads imposed upon the projections. Underlayment rated for high-temperature applica-
tions was applied under prefinished standing seam roofing installed over cornices (Photo 14). These projections away from the building allow water to travel down the multитiered façade and collect on the lowermost tier, where it is directed into a gutter and downspout system that discharges into the storm sewer system (Photo 15). While highly effective at controlling the water and snow from draining onto the public walkway below, the drainage system was designed and constructed in a manner that blends with the new façade of the Beauvallon, seamlessly blending practical engineering principles, architectural form, and beauty.

The Beauvallon Condominiums was a highly successful construction-defect-and-repair project. The five-year process allowed for the luxury residence to maintain its prominent reputation. In the end, though the residents were inconvenienced through the investigation and repair phases of the project, the final product was a completely repaired building envelope that performs. In September of 2011, Peter Manetti, HOA board president, told SBSA that they had not received a single complaint of water intrusion during the previous two months of heavy rain.