Photo by George Faulkner Jr., AIA

The selection of a unitized flashing system was part of the overall moisture proofing strategy for the Hampton University Student Dining Facility in Hampton, Virginia. Architect of record: Livas Group Architects, P.C. in Norfolk, Virginia.

Moisture Management in Masonry Buildings

Unitized flashing provides an integrated design solution

Sponsored by Mortar Net® USA, Ltd. | *By Celeste Allen Novak, AIA, LEED AP*

Masonry construction, one of the oldest building systems in the world, requires a complex integration of a variety of elements to control moisture. The construction of a masonry building requires the knowledge of how this material weathers and reacts to seasonal changes such as snow, sleet, wind-driven rain, and humidity. Ancient civilizations building in equatorial zones using 3-foot-thick walls did not have to worry about a freeze-thaw cycle when they chose masonry, stucco, and brick as their most common building material. However, as civilization moved north to more temperate climates, new construction methods reduced the impact of moisture from seasonal temperature variations on buildings. The modern development of wood and steel structural frames with masonry cladding included the development of flashing systems that can expel moisture from these new building enclosures. The main line of defense that protects a wall system from moisture damage is in the construction detailing of wall flashing.

Early technical manuals such as the AIA's *Ramsey and Sleeper Architectural Graphic Standard* as well as 21st century editions provide numerous details for preventing moisture damage in masonry and masonry clad buildings. In the 1939 *Brick Engineering Handbook of Design*, the author states that at "the outset, it might be stated that no flashing at all is better than poor flashing."[1] The International Masonry Institute and the Building Enclosure Council provides information on codes, technical and non-technical bulletins on materials and techniques. Flashing materials and assemblies require code-compliant standards for durability, plasticity, and permeability. With all of this support, the evidence is clear that the variety and compatibility of moisture-proofing materials, flashing, expansion and control joints are providing many choices for successful field applications of flashing in masonry buildings.

Contractors are required to monitor the installation and compatibility of numerous materials specified by design professionals who are often not aware of the specific field conditions during construction. A lot can and

does go awry when building a masonry building. There is also an increasing emphasis on the design of high-performance buildings for energy efficiency and durability as part of a sustainable design portfolio. To design a moisture-proof, high-performance building, architects need to carefully detail and specify all of the components that are part of this system. They may also want to choose from a new variety of engineered products that unitize some of the basic components of the flashing system to improve the constructability of masonry wall systems.

As architects explore new forms: curved walls, canted overhangs, multifaceted edges, and masonry cladding in high-rise buildings, the integration of materials for moisture proofing wall systems can be an important design component. Three-dimensional detailing as part of information modeling has helped develop a more focused look at the many corners, breaks, and openings in modern buildings. "Designers sometimes forget how beautiful details are!" says Jim Stevens, AIA, an associate professor of architecture at Lawrence Technological University. Stevens reports that the plans for the renovation of a courthouse in St. Louis displayed corner boots, end dams, and flashing pieces that could have been exhibits of modern sculptures. A review of the components in wall flashing will show how unifying the components allows for easier installation and better moisture control in buildings.

MOISTURE AND MASONRY

Masonry is a porous material and all masonry buildings absorb moisture. From roof to foundation, what may appear to be an impenetrable building component is in fact, a system that needs to breathe to expel moisture. Masonry walls are typically constructed with an air gap between the brick veneer or exterior wythe of brick and the structural wall. Brick veneer is primarily decorative and is connected to the structural wall system by metal brick ties. Between the veneer and the structural wall is an air gap that is the "lungs" of the wall system—the place where air and moisture is channeled to be expelled at any place where the solid wall is interrupted by an opening such as a window, an interior or exterior corner and primarily at the end of the vertical wall. The Brick Industry Association (BIA) defines a cavity wall as having a continuous air space. Depending upon the skill of the mason, mortar droppings can fill a wall cavity so the BIA recommends a 2-inch minimum cavity to allow for proper drainage and airflow. However, the BIA Technical Note 21A allows rigid insulation to occupy one-half of the 2-inch cavity creating an even tighter allowance for proper mortar placement.

Photo courtesy of Mortar Net® USA, Ltd.

New Jersey's Louis I. Kahn Trenton Bath House uses a unitized flashing system on two new walls.

The most common reasons for excess water in a brick wall cavity can come from:

- Inadequately filled or over-sanded mortar joints
- Extreme acid cleaning
- Design details – Rowlocks or Soldier courses
- Construction materials – weather exposure

A publication of best practices from the 2006 AIA Convention, describes the need for considering moisture penetration as part of an early design phase. "Effective prevention involves implementing a successful water management system, understanding the sources of moisture ingress, and identifying potential problems. Studies have shown that uncontrolled rainwater penetration and moisture ingress are two of the most common threats to the performance of a building's envelope and together they represent up to 80 percent of all construction-related liability claims in the United States."[2] Detailing of the drainage system through proper flashing is considered one of the top means of effective moisture management.

Photo courtesy of Mortar Net® USA, Ltd.

Unitized flashing systems can be specified using any of the most common flashing materials.

EFFECTIVE FLASHING

Flashing is a membrane installed within a masonry wall to either prevent moisture infiltration, or divert moisture, which does penetrate the wall, back to the exterior of the building. Flashing provides a controlled path for water through walls. Unless specified as a unified component, the pieces that comprise a flashing system are membranes, weeps, termination bars, drip edges, and adhesives. Driving rain or sleet and the build-up of condensation on the interior of a masonry wall is directed by gravity to the lowest point in a building. Without flashing, the collection of moisture increases maintenance costs and can even cause building failures. Water can be prevented from getting out of a wall by the omission or incorrect installation of wall flashing and weep holes that can be clogged by mortar. Damage to masonry buildings due to moisture penetration can include efflorescence, spalling, steel stud failures, mold penetration, and even the collapse of the entire wall system.

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Learning Objectives

After reading this article, you should be able to:

1. Identify the components of a proper flashing system.
2. Compare and contrast membrane systems used in typical flashing systems.
3. Summarize design methods and materials to provide a moisture-proof masonry wall system for a high-performance building.
4. Review a variety of flashing details for corners, curved walls, and other wall systems.

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ADVANTAGE OF UNITIZED FLASHING MATERIALS

When installed at the base of a masonry wall, flashing spans from the exterior to the interior of that wall. Flashing covers the gap between the masonry and the substrate backup wall or in the case of a single wythe system, covers the open cells in blocks. Flashing should primarily be durable and resist and direct moisture as part of a complete system. Flashing materials should be tough enough to resist puncture by a mason with a trowel as subsequent layers of mortar and masonry are added to the wall. The flashing material should be flexible enough to be formed and placed on the wall. Flashing is adhered to the wall with adhesives that allow for expansion and contraction without cracking during seasonal changes. The flashing material must be compatible with the masonry, back-up substrate wall, adhesives, sealants, air barriers, mortar, salts, and masonry. Flashing materials should not cause staining on the wall and should be almost invisible when placed along the wall surface.

The estimated life of the flashing should match the life of a building. Replacing flashing, particularly in high-rise buildings, is difficult and expensive. Lower-cost solutions for building flashing, for example the use of asphalt-impregnated felts or tar paper, almost always lead to higher replacement and maintenance costs for the building owner.

The advantages of selecting a unitized flashing system are that the design professional will specify a material that:

- Decreases the probability of improper installation of materials—especially at difficult locations such as overlaps, rough openings, inside and outside corners.
- Manages mortar damming so water can easily flow out of the wall cavity.
- Prevents air pressure differentials that can force moisture in the building envelope.
- Can specify a material that has recycled content to help with LEED® certification.
- Assists with timely delivery on site.
- Provides compatible materials and prefabricated components for end dams and corner boots.
- Is one product instead of five separately manufactured and sourced products.
- Predetermines overlaps and enhances uniform installation.
- Avoid excessive labor installation costs of multiple layers of materials.

Unitized flashing systems can be specified using any of the most common flashing materials as a membrane. Unitized flashing has pre-designed laps, screws, weeps, termination bars, drip-edges, and a mortar collection device that meets the requirements of the ASTM E-514 water test. These durable systems are easy to install, particularly for high-rise buildings as well as buildings with numerous changes of materials and wall orientation. New products include roll flashing with a mortar collection system directly attached to the flashing membrane, clean lap spaces, and weeps. This adds to the ease of installation and reduces the cost of labor. In addition, the uniform placement of weeps and the clean edges of the flashing are almost indiscernible on the building facade.

COMPONENTS OF FLASHING SYSTEMS

There are several components of a flashing system that needs to be installed and work together for moisture collection. The flashing membrane is the material that extends from the inside to the exterior of the wall system. Mortar collection is a strategy that in the past has been provided by a variety of installation techniques but now can be specified as part of a collection system. In addition, a flashing system includes weep hole vents, termination bars, and drip edges—all of which may be adhered to the wall by screws or adhesives that must be compatible with a variety of materials. The latest flashing systems provide prefabricated corner "boots" and end dams that allow for more precise fittings at different edges and corners of the building. All of these components can be specified in a variety of materials, and weep hole vents and drip edges can also be selected by color. One of the advantages of unitized flashing systems is that these components can be easily coordinated and specified.

COMPOSITE, UNITIZED FLASHING CHOSEN FOR HAMPTON UNIVERSITY

Architect George Faulkner Jr., AIA, senior designer and project architect for the Hampton University Student Dining Facility worked with moisture consultant, Stephen Hentz, P.E., of Hentz Engineering, to detail this important campus building. The dining hall will serve as an institutional focal point that will be located on the shoreline of the Hampton River on the campus of Hampton University overlooking downtown Hampton, Virginia.

The 80,000-square-foot facility will be housed on two levels with the second floor set back from the main façade to create a dramatic two-story atrium along the waterfront. The main floor will house a central dining area with food service kiosks around the perimeter of the atrium. The second floor will house a full-service market-style food court and administration areas. The design will also include exterior eating areas with views of the river. To maximize the benefit of its prime waterfront location, the composition of the building will be designed to accommodate views to downtown Hampton through a three-story convex glass curtain wall that will be the length of the building. The building is also designed to complement the other masonry buildings on this historic campus. A contrast of old and new, reflective and permanent, major building materials are brick, precast concrete, and glass. The building is designed with a canted facade, curved walls, and defined edges between the masonry and glass detailing.

Photo by George Faulkner

Controlling water penetration on campus buildings was important when designing a building that is clad in brick, glass, and precast concrete.

The exterior brick veneer wall system for the dining facility was installed over a 2-inch air cavity with a commercial air and moisture barrier applied to a 5/8-inch fiberglass sheeting backed up with 6-inch or 8-inch steel studs. The veneer is drained to the base of the wall through a unitized flashing system that incorporates a mesh cavity drainage material, membrane flashing, termination bar, and stainless steel drip into a panelized product. The flashing panels were installed and sealed together at the end laps using multiple sealant beads. At termination points in the flashing, pre-molded end dams were utilized to direct water to the exterior of the wall cavity. Due to the varying slopes and curves of the curtain wall system, several custom brick veneer cavity closures were fabricated and sealed to the moisture barrier using flashing membrane tapes and stainless steel for rigidity and long service life.

During construction, site visits were performed to observe the installed components for compliance with the project documents. Working with a moisture proofing consultant, the architect commented that the "choice of unitized flashing was presented by the consultant who had previous experience with this unique product." This selection is part of the overall requirements to design a long-lasting, permanent campus facility.

Membranes

The choice of the flashing material is important when specifying any flashing system. There is a wide variety of materials to select from for a typical flashing system as well as for a unitized flashing system, including the following products that have been re-engineered to meet higher performance standards. According to Steven Fechino, engineering and construction manager at Mortar Net® USA, Ltd., some of these types of flashing include the following:[3]

Copper laminate. Copper flashings are one of the oldest of all flashing materials and one of the most permanent. New systems include a laminated mesh of polyethylene on both sides of the copper. This durable product is almost impossible to damage with a trowel during installation. Copper flashing can cause staining on masonry if not properly detailed. Many new copper laminates are compatible with most building products as they do not contain asphalt as a binder.

Stainless steel. This high-end product is usually specified for institutional buildings and those buildings meant to be a legacy for future generations. One of the most expensive flashing materials, installation is labor intensive and requires bending, soldering, mechanical fasteners, and adhesives.

Photo courtesy of Mortar Net® USA, Ltd.

Multicolored weep vents blend in and are less noticeable along the face of a building.

Rubberized asphalt. One of the most common types of flashing used by masons and often is installed with a "peel and stick" placement on the back up wall. The type of primer used with this product as well as proper installation is the key to successful moisture management. It is sensitive to ultra-violet rays and can be damaged if left exposed during construction. Rubberized asphalt can also be incompatible with polyvinyl chloride (PVC) molds used for corners and end dams. The plasticizers in the PVC may leach into the asphalt and reduce the plasticity of the asphalt over time.

Thermovinyl plastics with non-migratory plasticizers (PVC): The current PVC flashing materials have been developed from products well-tested and used for roof flashing. This product is durable, flexible, and strong. It is compatible with many polyurethanes, polyethers, and butyls.

Thermoplastic polyolefin (TPO). This flexible membrane has a 30-year life span when installed on a roof and almost unlimited life span when used as wall flashing. The laps on this product can be sealed with a butyl rubber or primed polyether adhesives as well as with heat welding.

Ethylene propylene diene monomer (EPDM). Another roofing material that has migrated for use in wall flashing, EPDM is durable, flexible, and easy to install but may need to be specified with matching EPDM components to avoid incompatibility with some PVC corner boots and end dams.

Comparison of Common Flashing Material Properties

Material	Advantages	Disadvantages
Stainless Steel	Durable	Difficult to bend. High installation costs. Must be preformed at factory. Usually requires steelworkers for installation.
Cold-Rolled Copper	Durable, flexible	May leave stains
Lead-Coated Copper	Easier to form	Lead-coated, does not stain
Galvanized	Widely accepted	Will deteriorate in acidic environment
Copper Laminates	Easier to form and join than metals	May tear. Asphalt degrades in sunlight.
EPDM (Man-made rubber)	Not affected by UV rays, good corrosion resistance, tear and puncture resistance	Requires adhesives for bonding. More difficult to work with than rubberized asphalt, resulting in higher labor costs.
Rubberized Asphalt Flashing System	Flexible at low temperatures, excellent tear/puncture, self-sealing around small holes	Affected by UV rays
Polyvinyl Chloride	Not recommended for through-wall flashings (BIA)	

Source: Mortar Net® USA, Ltd.

See endnotes in the online version of this article.

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