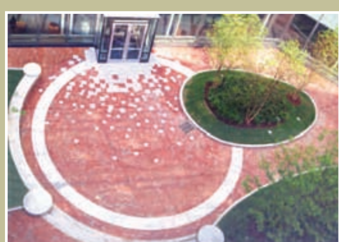
BRICK IN ARCHITECTURE
From the Brick Industry Association

The 2007 Brick in Architecture Awards



BEST IN CLASS WINNERS

IN THIS ISSUE – DECEMBER 2007

CONTINUING EDUCATION AIA

Since 1989, the Brick in Architecture Awards have been one of the most prestigious national architectural award programs featuring clay brick. Architectural firms from around North America enter their best material to be judged by a jury of their peers.

This year, architects and landscape architects from around the United States independently reviewed and scored each of the entries. Based on the technical and creative use of brick in meeting the aesthetic and functional design challenges, the Brick Industry Association is pleased to showcase the following projects which were chosen as the Best in Class in their respective categories.

Archie Bray Foundation Resident Artist Studio Helena, Montana

Exceptional Masonry Craftsmanship Is Hallmark of Ceramic Arts Facility

The new Resident Artist Studio represents the first phase of the campus master plan for the Archie Bray Foundation, a non-profit institution dedicated to the enrichment of the ceramic arts.

Located on the 26-acre site of a former brick manufacturing company, the complex includes the studio building, an indoor kiln building, a kitchen/lounge building, and an outdoor wood kiln area.

A principal design goal of the foundation was that the facility reflect the spirit of the location, both in architecture and function. The board of directors set a goal that the new complex should “disappear” into the surrounding campus.

Towards that goal, the building is intentionally understated, drawing design cues from nearby industrial buildings. At first glance, the simple warehouse shape appears unexceptional. On closer examination, however, it is remarkable in its connection to its history, its well-planned functionality, and its seamless integration with the surrounding environment.

Brick was the obvious material of choice given the history of the site and purpose of the building, but exceptional expression of the masonry craft was essential to the success of the facility. Subtle detailing and inspired placement of elements express a continuum with the history and function of the site. With carefully crafted details including articulation, arches, and sculptured murals, the architecture reflects the values, aspirations, and spirit of the Archie Bray Foundation and the ceramic artists it serves.

Brick was the obvious material of choice, but exceptional expression of the masonry craft was essential to the success of the facility.

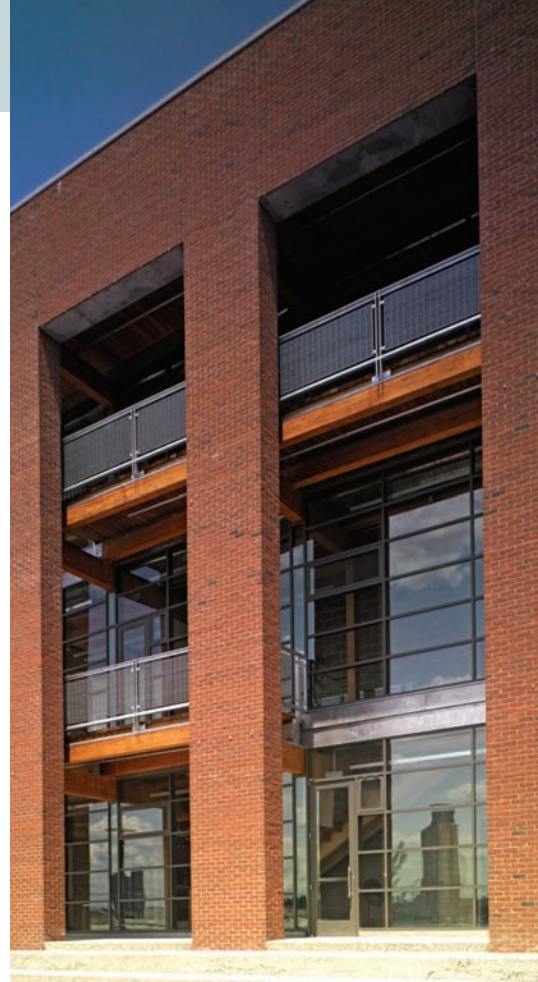
Architectural Firm:
Mosaic Architecture

Principal:
Bennett Tintinger, AIA

Photographers:
JK Lawrence Photography
Jeff Van Tine Photography

Manufacturer:
Summit*Lakewood Brick Sales

As verified by architect



Frederick Douglass-Isaac Myers Maritime Park Baltimore, Maryland

New Life for Baltimore's Oldest Waterfront Warehouse

The Frederick Douglass-Isaac Myers Maritime Park is the new flagship campus for a non-profit organization that provides hands-on educational and job-training programming for Baltimore's disadvantaged youth.

To create this new facility, the oldest standing industrial warehouse on Baltimore's waterfront was renovated and joined with a larger, newly constructed building.

Brick masonry is central to the project's expression and fulfills a number of aesthetic and functional roles. First, it creates an industrial aesthetic that is sensitive to the site and its history. The original warehouse was preserved according to U.S. Department of the Interior standards, with brick needed to complete it salvaged from the demolition of a nearby historic building.

Second, from a functional perspective, the brick brise soleil not only shades the addition's interior spaces, but also gives an appropriately monumental public scale to the building. On a practical level, brick provides a low-maintenance façade and the

low life-cycle costs keep within the client's limited operating budget.

Brick plays an important role in the design of the public plaza as well. Genuine clay pavers complement the campus' overall aesthetic, while expressing the footings from historic warehouse buildings long since demolished.

Finally, brick ties the building to the client's pedagogy. The scale of the individual brick in relation to the building as a whole is a metaphor for entrepreneurial collaboration, a hallmark of the client's focus on empowering disadvantaged youth.

Clay pavers contribute to the campus' aesthetic while expressing the footings from historic warehouse buildings.

Architectural Firm:
Ziger/Snead, LLP
Principal:
Steve Ziger, AIA
Photographer:
Alain Jaramillo
Manufacturers:
Redland Brick, Inc.
Pine Hall Brick Company
Distributor:
L & L Supply Corporation

As verified by architect

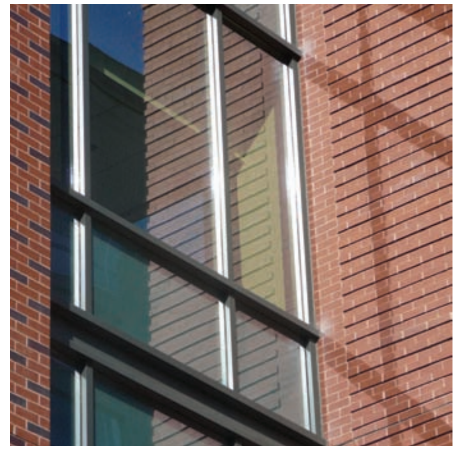
The Moakley Building at Boston Medical Center Boston, Massachusetts

Medical Facility Carries On Neighborhood's Creative Use of Masonry

The newly constructed, 134,000-square-foot Moakley Building at Boston Medical Center establishes a consolidated identity for the hospital's cancer care programs, while merging and expanding other key programs within the facility.

The character of the existing campus and the nearby historic South End neighborhood offered ample precedent for the use of brick as a primary cladding material. A number of nearby examples creatively use brick to add texture and a sense of craft to the built environment. The goal with the Moakley Building was to interpret this context in a way that both harmonizes with the surrounding neighborhood and showcases Boston Medical Center as a leader in advanced health care delivery.

While a four-story, articulated glass atrium marks the entrance to the building, the remaining portions of the exterior are primarily brick masonry with punched window openings and copper cladding accents. Details such as alternating brick reveals relate to the banding and base expressions found on many of the buildings around the Boston Medical Center campus. Color variations provide additional visual interest and texture, as evidenced by a modified Flemish bond containing an iron-spot brick accent. To maximize views and daylighting, larger-scale openings in the masonry are incorporated at stairs, waiting areas, and the infusion area.



Overall, the Moakley Building is contemporary in nature, but its façade still relates to the surrounding context through the proportion and rhythm of its openings and the texture, scale, and craft of the materials.

The Moakley Building interprets the surrounding neighborhood's creative use of brick through the texture, scale, and rhythm of the materials.

Architectural Firm:
Tsoi/Kobus & Associates, Inc.
Principal:
Edward T.M. Tsoi, FAIA
Photographer:
Jeffrey Totaro / Esto
Manufacturer:
Carolina Ceramics Brick Company
Distributor:
Spaulding Brick Company, Inc.

As verified by architect

Our Lady of Good Counsel Catholic Church Vienna, Virginia

Brick Forms a Dignified and Inventive Space to Gather and Worship

Just outside of Washington, D.C., Our Lady of Good Counsel Catholic Church has become one of the largest parishes in northern Virginia. With the area's recent growth, the parish outgrew its existing 1,000-seat sanctuary and building infrastructure. So the Church embarked on an expansion program, with a new 250-seat chapel to supplement the existing worship space and satisfy the need for a more intimate worship environment. The plan also included a new multi-purpose space, flexible classrooms, and a music suite, as well as an expanded narthex in the main worship space.

The new facilities extend the original church's brick masonry palette and unify the campus. Brick serves its traditional role as both an attractive and durable material, but in the new chapel in particular, brick is expressed in an aesthetically and functionally inventive design. Inside, the full-height articulated brick perimeter walls create a sense of unity within a quietly dignified space, while the strength of the material appropriately suggests the enduring strength of the Church as an institution. The interior brick are laid in a Flemish bond pattern with header courses omitted, creating excellent acoustics for congregational singing and music. Above it all, smooth white ceiling planes float above the reddish-brown walls, suggesting the heavenly purity of the Holy Spirit above the earthen masonry that defines the worship space.

Brick played a central role in helping Our Lady of Good Counsel create an enduring space that reflects its values and needs, and embodies the church's commitment to its future.

Articulated interior brick walls create a sense of unity, while the strength of the material suggests the enduring strength of the Church.

Architectural Firm:
LeMay Erickson Architects
Principal:
Jared D. Willcox, AIA
Project Team:
Robert R. Kifer, AIA
Jennifer A. Organsky, Assoc. AIA, IIDA
Photographer:
Dan Cunningham Photography
Manufacturer:
Continental Brick Company

As verified by architect

Orland Park Public Library
Orland Park, Illinois

An Energy-Efficient New Landmark of Knowledge, Culture, and Community

The new Orland Park Public Library beautifully delivers a host of amenities and functionality to meet the priorities established by local citizens and the library staff. The building is distinctive yet aesthetically compatible with the surrounding community. It also provides a warm, welcoming environment that is energy efficient, durable, and easy to maintain. Brick was a logical material for the architects to use in satisfying all of these varied requirements because these are also the qualities that brick represents.

Design of the Orland Park Public Library relates to its setting, while simultaneously establishing a new landmark of culture, knowledge, and communication for the entire community. The monumental stair tower is a visual anchor, and the sky-lit entry canopy is an open and welcoming invitation to the residents of the community. In addition, brick from the exterior is carried inside to foster and blend the relationship between interior functional spaces with the exterior landscape.

The building also incorporates a number of sustainable design elements—including recycled and green-sourced building materials—without the cost premiums normally associated with green design. In addition, low maintenance and energy-efficient brick cladding accented by Low-E glass curtain walls results in overall superior energy performance, on a per-square-foot basis, compared to the previous building.

Today, the residents of Orland Park enjoy a public library that will serve as a cultural and civic center for many years into the future.

Brick was a logical material to embody the warmth, efficiency, durability, and maintainability that the community desired.

Architectural Firm:
Lohan Anderson
Principal:
Floyd D. Anderson, AIA
Photographer:
Craig Dugan / Hedrich Blessing
Brick Manufacturer:
Endicott Clay Products Company
Distributor:
Illinois Brick Company

As verified by architect

Northeastern University
Boston, Massachusetts

A Grand Entrance and Promenade in an Artful Masonry Tapestry

At Northeastern University, the construction of two new buildings presented the opportunity to create a new campus entrance from the adjacent Avenue of the Arts, a major Boston thoroughfare and home to multiple cultural institutions. The new gateway entrance, defined by the two buildings, skillfully utilizes genuine clay brick pavers to establish an inviting planned sequence of pedestrian experiences.

Entering the university campus, students, faculty, and staff are invited to follow wide, curving brick pathways that comfortably accommodate pedestrians, joggers, and the handicapped. As visitors continue along these paved thoroughfares, they encounter small pocket parks, promenades, and open quadrangles.

Traditionally used throughout the university campus, the red brick pavers blend harmoniously with the warm tones of the surrounding buildings. They will maintain their color and functionality over time with minimal maintenance. The brick also offers a highly durable surface that readily accommodates emergency and service traffic.

To enliven and distinguish the outdoor seating areas at the building entrances, the main path's carpet of red clay pavers is punctuated with accent pavers. The rigid lines and saw-cut edges of the contrasting pavers are softened by a surrounding field of irregular, hand-molded lines of specialized clay brick.

For all who visit, the finished hardscape creates an inviting gateway and welcome oasis in the midst of the busy surrounding urban environment.

The genuine clay pavers blend harmoniously with the warm tones of surrounding buildings and will maintain their color over time.

Landscape Architect:
Pressley Associates,
Landscape Architects
Principal:
William Pressley, FASLA, LEED AP
Photographer:
Damianos Photography
Brick Manufacturer:
The Stiles and Hart Brick Company

As verified by architect

Gold Winners

Commercial

Charlotte Bobcats Arena

Location:	Charlotte, North Carolina
Architect:	Ellerbe Becket
Manufacturers:	Triangle Brick Company
	Taylor Clay Products, Inc.

East 29th Avenue Town Center at Stapleton

Location:	Denver, Colorado
Architect:	4240 Architecture
Manufacturer:	Summit*Lakewood Brick Sales

Educational

Harte Research Institute for Gulf of Mexico Studies

Location:	Corpus Christi, Texas
Architect:	Richter Architects
Associate Architect:	WHR Architects
Manufacturer:	Acme Brick

John S. Martinez School

Location:	New Haven, Connecticut
Architect:	Svigals + Partners
Manufacturer:	Glen-Gery Corporation
Distributor:	Mack Brick Company

Regis Center for Art at the University of Minnesota

Location:	Minneapolis, Minnesota
Architect:	Meyer, Scherer & Rockcastle, Ltd.
Manufacturer:	Endicott Clay Products Company
Distributor:	Corning-Donohue, Inc.

Wilson Elementary School

Location:	Cicero, Illinois
Architect:	FGM Architects Planners, Inc.
Manufacturer:	Glen-Gery Corporation
Distributor:	Illinois Brick Company

Health Care Facilities

Clinical Services Building at Toronto General Hospital

Location:	Toronto, Ontario
Architect:	HOK
Manufacturer:	Hanson Brick

The John A. Moran Eye Center at the University of Utah

Location:	Salt Lake City, Utah
Architect:	FFKR Architects
Manufacturer:	Interstate Brick

Houses of Worship

Mixed-Use Project for Christ Church Cathedral

Location:	Houston, Texas
Architect:	Page Southerland Page, LLP
Manufacturer:	Acme Brick

Municipal / Government

Northgate Library, Community Center, and Urban Park

Location:	Seattle, Washington
Architect:	The Miller|Hull Partnership
Manufacturer:	Interstate Brick
Distributor:	Eastside Masonry

Paving & Landscape Architecture

American Tobacco Historic District Renovation

Location:	Durham, North Carolina
Architect:	Belk Architecture
Landscape Architects:	Coulter Jewell Thames, PA
	Smallwood, Reynolds, Stewart, Stewart & Assoc.
Manufacturer:	Pine Hall Brick Company

Medinah Country Club

Location:	Medinah, Illinois
Landscape Architect:	Private Gardens, Public Places, Inc.
Manufacturers:	The Belden Brick Company
	Endicott Clay Products Company
Distributor:	Illinois Brick Company

Silver Winners

Commercial

Betenbough Companies Headquarters

Location:	Lubbock, Texas
Architect:	CamargoCopeland Architects, LLP
Manufacturer:	Acme Brick

First Savings Bank of Renton

Location:	Renton, Washington
Architect:	Baylis Architects
Manufacturer:	I-XL Industries Ltd.

Sports Center

Location:	Mauldin, South Carolina
Architect:	DP3 Architects
Manufacturer:	Hanson Brick

Educational

Blythewood High School

Location:	Blythewood, South Carolina
Architect:	Perkins + Will
Manufacturer:	Carolina Ceramics
Distributor:	The Exum Company

Student Union at the University of Akron

Location:	Akron, Ohio
Architect:	WTW Architects
Manufacturer:	The Belden Brick Company

The Walter and Leonore Annenberg Science Center

Location:	Hightstown, New Jersey
Architect:	Hillier Architecture
Manufacturer:	Glen-Gery Corporation
Distributor:	Tri-State Brick & Stone, Inc.

Unity Junior High School

Location:	Cicero, Illinois
Architect:	FGM Architects Planners, Inc.
Manufacturers:	Glen-Gery Corporation
	Endicott Clay Products Company
Distributor:	Illinois Brick Company

Health Care Facilities

Clarian North Medical Center

Location:	Carmel, Indiana
Architect:	HKS, Inc.
Manufacturer:	The Belden Brick Company
Distributor:	Indiana Brick Corporation

Health Care Facilities (continued)

Evanston Hospital
Location: Evanston, Illinois
Architect: Eckenhoff Saunders Architects
Manufacturer: Glen-Gery Corporation
Distributor: Brann Clay Products Company

Houses of Worship

Contemplation & Relaxation Shrine
Location: Austin, Texas
Architect: Alarife, PLLC
Manufacturer: Acme Brick

Municipal / Government

Dumbarton Oaks Library
Location: Washington, District of Columbia
Architect: Venturi Scott Brown & Associates, Inc.
Manufacturer: Watsontown Brick Company
Distributor: Capital Brick, Inc.

Bronze Winners

Commercial

230 Congress Street Façade Renovation
Location: Boston, Massachusetts
Architect: Wessling Architects
Manufacturer: Watsontown Brick Company

Jack Kent Cooke Foundation
Location: Lansdowne, Virginia
Architect: Hickok Cole Architects
Manufacturer: Endicott Clay Products Company
Distributor: Potomac Valley Brick and Supply Company

Regester Place
Location: Bloomington, Illinois
Architect: RATIO Architects
Manufacturers: Acme Brick
The Belden Brick Company
Distributor: Indiana Brick Corporation

The Jefferson Library at Monticello
Location: Charlottesville, Virginia
Architect: Hartman-Cox Architects
Manufacturers: General Shale Brick, Inc.
Old Virginia Brick Company

Educational

Alumni Center at Oklahoma State University
Location: Stillwater, Oklahoma
Architect: Page Southerland Page, LLP
Manufacturer: Acme Brick

Chemistry Research Building at Yale University
Location: New Haven, Connecticut
Architect: Bohlin Cywinski Jackson
Manufacturer: Redland Brick, Inc.

Health & Recreation Complex at Butler University
Location: Indianapolis, Indiana
Architect: RATIO Architects
Manufacturer: Carolina Ceramics
Distributor: Indiana Brick Corporation

Health, Wellness, and Athletic Center at Westminster College
Location: Salt Lake City, Utah
Architect: VCBO Architecture
Manufacturer: Interstate Brick

High School for Construction Trades, Engineering, and Architecture
Location: Ozone Park, New York
Architect: STV
Manufacturer: The Belden Brick Company
Distributor: Belden Brick Sales & Service, Inc.

Jordan Hall of Science at the University of Notre Dame
Location: Notre Dame, Indiana
Architect: The S/L/A/M Collaborative
Manufacturer: The Belden Brick Company

Student Housing at Butler University
Location: Indianapolis, Indiana
Architect: RATIO Architects
Manufacturer: Carolina Ceramics
Distributor: Indiana Brick Corporation

Thompson Hall at the University of New Hampshire
Location: Durham, New Hampshire
Architect: Goody Clancy
Manufacturer: Star Kilns, Inc.

Health Care Facilities

Jordan Hospital Expansion and New Main Entry
Location: Plymouth, Massachusetts
Architect: TRO Jung|Brannen
Manufacturers: The Belden Brick Company
Endicott Clay Products Company
Morin Brick Company
Distributor: Spaulding Brick Company, Inc.

Houses of Worship

Multi-Faith Spiritual Center
Location: University Park, Pennsylvania
Architect: James Oleg Kruhly + Associates
Manufacturer: Glen-Gery Corporation
Distributor: Ollinger Bros., Inc.

Municipal / Government

Damascus Community Center
Location: Damascus, Maryland
Architect: PSA-Dewberry, Inc.
Manufacturer: The Belden Brick Company
Distributor: Potomac Valley Brick and Supply Company

Prince Frederick Library
Location: Prince Frederick, Maryland
Architect: Grimm + Parker Architects
Manufacturers: Acme Brick
Hanson Brick
Distributor: Potomac Valley Brick and Supply Company

All credit information appears as it was provided in the entry by the architect or BIA member company.

Use the following learning objectives to focus your study while reading the article below. To receive credit, read the technical discussion. When finished, simply minimize this PDF to return to the previous screen and take the test.

Learning Objectives.

After reading this article, you should be able to:

1. Understand how water enters and moves through exterior walls.
2. Identity the components of exterior walls and understand their function in water penetration resistance.
3. Select the appropriate wall system to manage water in exterior walls.

Introduction

The exterior building envelope—the roof and walls—serves the primary purpose of protecting the building interior and occupants from the elements. With differing locations and weather conditions, the levels of needed protection against sun, rain, wind, and temperature extremes vary significantly. However, the wall and roofing systems providing protection share a number of functional similarities regardless of the amount of protection needed or the materials used for construction. This article examines the traits of an exterior wall section which allow it to manage the elements of combined wind and rain.

Components of an Exterior Wall

In modern construction, there are a variety of materials available, used in countless ways to provide attractive and functional exterior walls. Typically, the structural system, whether steel, concrete, masonry, or wood, does not serve alone to protect the interior space from the weather outside. Rather, the structural frame is enclosed by building walls that have claddings applied or attached that provide the necessary protection. Although there are many types of cladding materials, most claddings are typically composed of up to four basic layers that provide methods for managing water present on the exterior face. The cladding components under discussion are depicted in Figure 1.

The Outer Surface

Every wall system has an outside face that is first to receive wind, rain, sun, and other elements. In most instances, this outer surface provides nearly all the building's protection against wind-driven rainfall. Glass curtain walls and vinyl siding are examples of wall systems that rely on their outer skin almost exclusively for water penetration resistance, blocking the rainfall without allowing any to penetrate. Other systems, such as brick, have an outer surface that is mostly water-resistant and provides the majority of weather protection, while still relying on other components on the interior side of the surface to provide additional and often redundant protection.

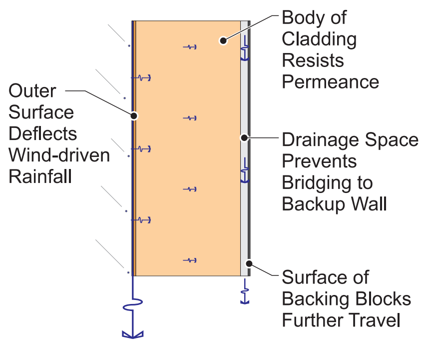


Figure 1. Water Management in Cladding

The Body

In the cladding system, the thickness of material below the exterior surface can vary from very thin, such as vinyl siding, to relatively thick, such as masonry veneer. As the thickness increases, the material offers additional resistance to water penetration.

Early stone and masonry walls were designed and built with multiple layers (wythes) of units, with the spaces between the units filled with mortar. This wall relied mainly on its thickness to manage wind-driven rainfall by providing such a massive barrier that water could not find its way entirely through the wall. Less massive wall cladding systems, such as masonry veneer, also rely on the relative impermeability of the brickwork to provide at least a partial barrier to water penetration. Cladding systems relying on the body of its materials for water penetration resistance typically also have an outer surface which stops the majority of the water from reaching that body.

The Drainage Space

Constructing walls with thick bodies and water-resistant outer surfaces typically provides an excellent level of water penetration resistance. However, in recent decades, the original barrier wall concept has been replaced for most construction with the drainage wall. The drainage wall is designed such that the outer skin and body provide the majority of protection, but allow for the possibility of a small amount of water penetrating the skin and body and making its way toward the interior of the wall. Drainage walls place a drainage space or medium (typically air) in the water's path to stop inward movement and direct water typically downward and back out of the cladding system. Some types of Exterior Insulating Finishing Systems (EIFS), and all masonry veneers and cavity walls, provide this drainage space behind the outer skin and body of the cladding.

The Backing

The final layer of protection in most cladding systems involves at least the outer surface of the backup wall. This backing, placed directly behind the body of the wall or drainage space, acts similarly to the exterior surface. Materials used typically provide a water-resistant surface that blocks any received water from traveling into the body of the backup wall or other spaces not intended to receive water.

Water Management

The goal of any exterior wall cladding system, in regard to water and moisture protection, is to manage wind-driven rainfall so that water is kept out of interior spaces. In other words, the cladding is there to keep a building from leaking when it rains. To better understand how best to achieve this simply-stated goal, a more detailed look at the complex path of water must be undertaken.

Paths of Water

Water generally does not move directly through an exterior wall. The reason is that most materials used as cladding have a very low permeability, i.e., they do not easily allow passage of water. However, when subject to the right forces, water can penetrate the surface and body by way of imperfections, holes, cracks, and penetrations in the assembly. In addition, where cladding assemblies allow the passage of air, water vapor goes along for the ride, allowing moisture behind the low-permeability skin and potentially into backing materials.

Wind-Driven Rain. In the absence of wind, rain drops essentially fall straight down, never striking the vertical surfaces of buildings, and never resulting in water penetration of the cladding. In fact, even if a wall is subject to water on its surface, without wind, virtually all of the water flows down the surface rather than penetrating it. However, every building is subject to wind and wind-driven rainfall.

As a rain event starts, individual drops strike a wall surface at an angle, with momentum. This momentum typically causes the drops to spread out, either adhering to or soaking into the surface of the cladding. As the rain continues, additional drops impact near the first, eventually building into a continuous sheet of water coating the outer surface of the wall. The wind pushing the outer surface of the water sheet creates pressure within the water, which in turn pushes against the outer surface of the cladding. The pressure pushes water into cracks and voids, and water permeates into porous materials.

Penetration. If one were to fill an empty soda can with water, then put a small hole at the bottom of a side, water would drain out of the hole. The larger the hole, the faster the water would drain. And, as the can became more empty, the water would drain more slowly. The reasons behind this behavior are similar to the mechanics involved in water penetrating an exterior wall system. In the can, the weight of the water above the hole induces a pressure on the water at the hole, pushing it through. Principles of fluid mechanics confirm intuition that for a given pressure, the larger the hole, the faster the flow. Thus for cladding with small holes, such as cracks, a given wind pressure will push part of the sheet of water through the hole at a rate proportionate to the size of the hole. The smaller the crack or the less prevalent the cracking throughout the surface, the less water can be pushed through.

In addition to direct pressure, water also experiences capillary action when confined to tight spaces, as confirmed in a childhood science experiment involving celery and food coloring. Capillary action tends to pull water through gaps (minute cracks or separations), from the wet side to the dry side. As with wind-induced movement, the fewer paths for capillary action in the cladding, the less water will travel. Typically, the amount of water passage from capillary action is far less than that from wind pressure.

Permeance. Every material has an innate property known as water permeability, or its tendency to allow water to flow through it. A sponge or piece of cloth has a high permeability while glass or plastic has a very low permeability. The action of water soaking or flowing through a material is known as permeance and is similar to the water penetration described above, but on a much smaller scale. Water flow takes place through often-microscopic voids in the material, whether by direct pressure or capillary action.

Typical materials used on cladding such as acrylic, latex, or silicone caulk have low permeabilities and typically only allow water passage through pinholes, cracks, or other flaws. Cladding materials such as brick veneer provide additional resistance to water permeance through the low permeability of the body materials. However, other claddings such as unprotected fiber-cement siding or wood are subject to water permeance. Materials behind claddings such as gypsum sheathing, oriented-strand board (OSB), and open-cell foam insulation are also subject to water permeance. In most cases, the permeance of water through the body of the cladding is far lower than potential penetration through cracks and other imperfections.

Drainage. In a drainage system, water that first penetrates the exterior surface of a cladding then travels through the body of the cladding materials typically next encounters a drainage space. This space serves to block the direct path of water into the backing materials. The penetrating water is then affected by gravity and moves downward within the drainage space or medium. Without any further impedance, the water would travel downward until encountering a lintel, shelf angle, or foundation. At that location, with properly installed flashing and weeps, the water spreads out along the flashing surface until it either proceeds through weeps placed just above the surface of the flashing or seeps out under the cladding just above the flashing.

The inside surface of a drainage space is typically a water-resistive barrier at the surface of the backup wall. In some cases, this barrier is a separate material such as building paper or spunbonded olefin. Water on the barrier surface moves downward until reaching a horizontal surface. With the bottom edge of the barrier integrated with or overlapping flashing, the water from the membrane is channeled out of the wall as described above.

Moisture Infiltration

Liquid water accounts for the majority of potential water penetration in buildings along the paths described above. However, in addition to the liquid form, water can potentially enter a building in vapor form.

Air Leakage. The air around us is a mixture of various gases, including oxygen and nitrogen, with various other substances carried in suspension. Dust, smoke, and steam are examples of highly concentrated suspensions of particles in the air, but even without visible evidence, lower concentrations of such particles are always present. Where the air travels, the particles, including suspended water (moisture), also go. In most instances, this moisture is of such a sufficiently low concentration that it remains in suspension and causes no particular concern. However, in excessively humid conditions, the moisture can be transferred to building wall materials. This moisture, if present in spaces not designed to accommodate moisture, even if never converted back to liquid water through condensation, can contribute to mold growth, corrosion, and other indoor air quality related issues.

It should be noted that in addition to potential effects of the suspended water on materials, moisture in the air also transfers heat. Essentially, water particles hold heat far more efficiently than other particles in the air. As the air enters a space, it carries that heated moisture with it, potentially allowing heat loss or gain which bypasses whatever insulation might be installed.

Condensation. Air has a limit to the amount of water that it can carry, which is a function of its temperature. The higher the temperature, the more water the air is capable of carrying. Thus, when warm, highly moist air is cooled, the air loses its ability to carry the same amount of water, and some water may be expelled from the air in the form of condensation. Cooled air occurs around cold objects, such as a cold drink container, and therefore, condensation forms on the surface of the object.

In summer conditions in large portions of the United States, outdoor air tends to be hot and laden with moisture. Indoor conditions tend to be much cooler. When highly moist outdoor air comes in contact with cooled indoor surfaces, condensation occurs. In winter conditions, indoor temperatures tend to be significantly higher than outdoor temperatures and the moisture of the indoor air can condense on the interior surfaces of windows or other cold building components. Once the water is taken from the air, it can travel paths similar to those described above, depending on the location of condensation within the wall section. In an ideal case, condensation would never form within an interior space or on a surface not intended to receive water. However, it can be difficult to accommodate both summer and winter conditions with a single solution.

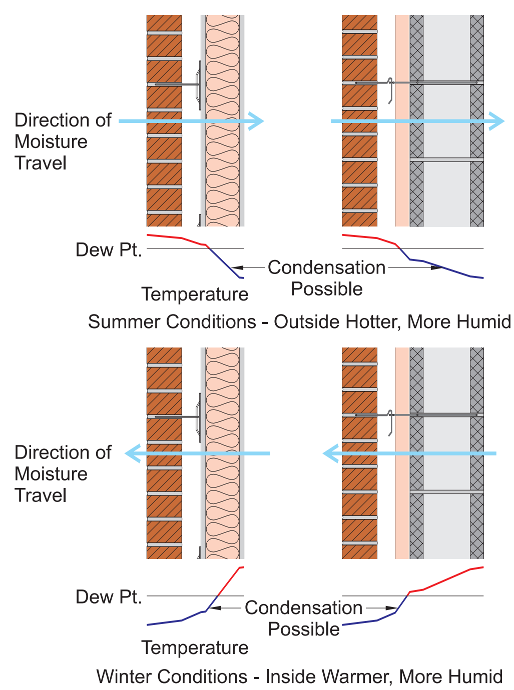


Figure 2. Possible Locations of Condensation

Figure 2 depicts the predicted locations of condensation for two brick veneer wall configurations subjected to both winter and summer conditions. Additional information on predicting condensation locations for other areas of the country or other wall designs can be found within BIA's *Technical Note* 47.

Water and Moisture Penetration Resistance

Effective water and moisture penetration resistance involves building defenses against the paths of penetration described above. Some components serve more than one purpose, but few materials can effectively defend all forms of penetration. In general, the components are passive in nature, unable to be adjusted or modified once initial construction is complete. Therefore, matching the right combination of defenses to the anticipated water and moisture penetration is an essential part of initial building design.

In the ideal case, each part of the water penetration defense would be completely effective, blocking all water from further infiltration. However, the properties inherent in building products and imperfections in construction keep the effectiveness below the ideal levels. Multiple layers of protection can provide the redundancy of water penetration resistance needed to overcome these imperfections.

Water- and Moisture-Resistant Brick Masonry

The majority of brick masonry today is constructed as a drainage wall system, using each of the three layers described above to manage water penetration. The outer skin includes the surface of the brick and mortar as well as the intimate surface bond between the two materials. The body is the depth of the brick and mortar joints, that is, the thickness of the veneer. The drainage space is the air space behind the brick veneer, backed by a water-resistive barrier.

Workmanship

The quality of the outer wythe of masonry (the first two layers of protection) greatly influences the effectiveness of water management of the wall. The lower the amount of water penetrating the masonry, the less likely imperfections in the backing materials are to be exploited. Though selection of materials, including matching mortar mixes to the initial rate of absorption (IRA) of the brick, has some effect, testing has shown that the majority of water penetration resistance at the surface of the brickwork is provided by full head and bed joints which are properly tooled. Tooling with a concave steel jointer compresses the outer surface of the mortar while forcing the mortar joint edges fully against the adjacent brick, further solidifying the contact between the two materials. The better this contact, the less likely it is to break or separate during the building's life, limiting paths water can travel due to wind-driven pressure or capillary action.

Within the body of the brickwork, water penetration resistance is provided by intimate contact between the low-permeability mortar and brick. The more complete the contact, the better the resistance to water penetration and permeance. This contact can be best established by providing full head and bed joints with fresh and properly mixed mortar at the optimum water content. Using detergents or other unapproved mortar additives, or slight movements of the brick after initial set of the mortar, tend to degrade the bond and decrease the water penetration resistance of the masonry.

Air Space

The air space provides a barrier to water traveling directly from the brickwork to the backing while also allowing evaporation of water from the back surface of the brickwork. The continuity of the air space, without interruption by excessive mortar protrusions or other debris, is essential to provide water a viable path from the back of the brick down to the flashing and weeps.

Where insulation is placed within an air space, it is essential that a 1-inch space be maintained between the back of the brickwork and the face of the backing or insulation board. Without this space, or where this space is spanned excessively by mortar or other debris, water can more easily reach the backing materials.

Our Lady of Good Counsel Catholic Church

The use of brickwork on both the interior and exterior played a pivotal role in the defining both form and function of the church. On the exterior, a brick veneer drainage wall keeps water from penetrating. Inside, by laying the interior brickwork in a Flemish bond pattern without headers, excess sound is allowed access to and is absorbed by acoustical insulation behind the brickwork. As a result, the acoustics of the space are attuned for singing and worship.

Architect: LeMay Erickson Architects

© Dan Cunningham Photography

Water-Resistive Barriers

To prevent any water which bridges the air space from penetrating to the backing materials beyond, building codes require that the materials used behind a brick veneer and air space must be water-resistive. The most commonly used material is building paper, placed in a "shingle" fashion such that any water running down the surface of one piece drips off onto the surface of the next sheet down without being able to penetrate behind the building paper. The bottom edge of the barrier, whether building paper or another material, should overlap the top edge of the flashing below to make sure the water reaching the bottom of the barrier is not permitted to seep behind the flashing.

Flashing and Weeps

Water penetrating the brickwork and traveling down the back of the brick or down the face of the water-resistive barrier can potentially leak into the interior of the building unless it is provided a path to exit the drainage space. Proper flashing installed at horizontal interruptions of the air space perform this function, interrupting the path of flow and redirecting the water. At the backing, the flashing is turned up the wall a minimum of 8 inches (203 mm) and its top edge is placed behind the water-resistive barrier. At the outer face of the wall, the flashing edge exits the brickwork and is turned down to form a drip edge, or is sealed to a separate metal drip edge piece. This outer edge treatment keeps water from circling back underneath the flashing when subjected to wind pressures. Any free ends of the flashing are turned up into head joints in the brickwork to form end dams, eliminating the path for water to flow off those flashing ends. The final configuration of the flashing gives three sides of waterproof material with one side enclosed only by the brick and mortar. The addition of proper weeps provides an easy path for water building up on the flashing to exit the wall. Without proper configuration of the flashing and weeps, water will find the easiest path, which often can be further into the wall.

Additional items placed at the flashing level can promote water drainage out of the wall. It is common for the flashing to become at least partially covered by mortar droppings from the placement of brickwork above. This buildup, where excessive, can bridge the air space, giving water an easier path to the backing than to the flashing. The droppings can also clog small weep openings, allowing water to build up on the flashing rather than exiting the wall. The placement of mortar drainage material on top of the flashing can help to break up the mortar droppings and keep them at a level above the backs of the weeps. Where these materials are used, the top edge should be below the top edge of the flashing, such that any water bridging the cavity along the top of mortar droppings cannot seep into the backing behind the flashing materials.

Air Barriers

In certain situations, air barriers are desired to prevent the flow of air and other suspended particles through exterior walls and into interior spaces. The air barrier is typically placed at the exterior face of the backup wall, also acting as the required water-resistive membrane. Depending on the choice of material, the barrier can also act as a vapor retarder, effectively blocking all forms of water and air passage from one space to another. The most common materials are either roll-on formulations for masonry backings or poly-olefin membranes (commonly referred to as house- or building-wraps). The continuity of the air barrier is crucial for its success; penetrations and seams must be sealed to ensure proper performance.

Vapor Retarders

In addition to the measures described above which address liquid water penetration, additional protection can be provided by the installation of a vapor retarder (also commonly referred to as a vapor barrier). The vapor retarder limits the transfer of moisture particles through the barrier medium, preventing the migration of moisture from outside to inside or vice versa.

The choice of material is largely dependent upon the backing being covered and whether the barrier is intended to also stop air movement. The most common materials include plastic sheeting and aluminum foil. Other sheet goods, such as extruded polystyrene, provide vapor barrier protection only if the penetrations in the boards and seams between the boards are sealed with compatible products. Other materials commonly used in the construction of brick wall sections, such as building paper or house wraps, typically do not provide vapor barrier protection.

The location of the vapor retarder is typically to the heated side of wall insulation. For typical stud walls with batt insulation in other than hot, humid climates, the vapor barrier would generally be placed between the studs and interior wallboard. For projects where vapor barriers are being considered, a condensation analysis should be performed to make sure placement will properly protect critical components such as gypsum sheathing or steel studs without inadvertently trapping moisture.

Rain Screen Walls

Recognizing the driving forces behind water penetration, the rain screen principle is an attempt to provide additional protection by limiting those driving forces and thus the potential for water entering a brick veneer wythe. This is accomplished by removing the differential air pressure between the outside wind and the air space. In doing so, wind-driven rainfall is stopped at the outer surface of the brickwork and virtually all of the accumulated water drains down the face of the wall rather than entering the air space behind the brick. Proper performance relies on stopping the flow of air through and around backing materials while allowing air flow into the air space. The increased ventilation of the air space and decreased liquid water behind the brickwork have proved to be an effective combination at eliminating damaging and costly leakage into interior spaces.

The Principle of Pressure Equalization

As described above, the pressure caused by wind can push water into cracks and separations in brickwork and potentially continue to push until the water reaches the air space beyond. This only happens because the pressure in the air space is lower than that caused by the wind. As with weather patterns or piping systems, flow travels from high pressure to low pressure. The rain screen principle supposes a construction where the pressure behind the brick and the pressure outside the brick are the same, meaning water will be pushed equally from both directions and will not move one way or the other based on wind pressure. Figure 3 shows forces acting on wind-driven rainfall with a pressure-equalized cavity.

In order to equalize air pressures from the outside to the air space, several things must occur and/or be prevented. First, air must be allowed to flow freely into the air space. Pressure within the air space is based on an amount of air entering and being confined within that cavity. The faster the air is allowed in, the faster the pressure within the air space will match the pressure outside the wall. Second, the air space needs to remain a rigid and airtight container for the air entering. Excessively flexible or air-permeable backings allow the air pressure within the air space to dissipate rather than build up to equal the outside pressure. Lastly, the air space behind the brickwork should be compartmentalized such that air entering at the windward side of a building does not flow from that side to the leeward side, also relieving pressures before full equalization is achieved. These three basic conditions form the basis for how to properly design and construct a rain screen wall.

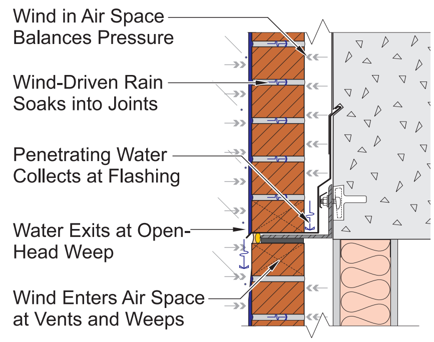


Figure 3. Typical Rain Screen Wall Function

Constructing Rain Screen Walls

Application of the rain screen principles to masonry veneer construction implies the use of standard water penetration resistant design details described in *Technical Note* 7, properly installed, along with additional features specific to rain screen walls. To provide the additional protection associated with these walls, all the components must be coordinated in both the design and construction phases. This section presents an overview of the design features that must be incorporated, but for complete design information, other sources, including BIA's *Technical Notes*, should be consulted.

Backup Wall. In a conventional brick veneer system, the backup wall is designed to handle lateral loads transferred through the veneer to the backing at veneer anchor locations. This places point loads at discrete locations along the height

Frederick Douglass-Isaac Myers Maritime Park

Meeting the project's program needs through two buildings—one a rehabilitated brick warehouse and the other a contemporary building with a brick drainage wall—allows for two different approaches to water management. The existing brick warehouse was originally constructed entirely of load-bearing, multi-wythe brick masonry. This wall relied on the thickness of the brickwork to act as a barrier to prevent water from entering. Water making its way into the exterior layer of brick masonry would have to penetrate through multiple layers (wythes) of brickwork to reach the interior.

A contemporary brick veneer drainage wall relies on the brick veneer to stop the majority of the water near its surface. Any water that does penetrate the veneer encounters an air space, where it drains down the back of the brick veneer to flashing and out of the wall through weeps.

Architect: Ziger/Snead, LLP

© Alain Jaramillo

of studs or masonry. With a rain screen, however, wind pushes on the front and back of the veneer, as well as on the sheathing or field of the backing. Therefore, spacing of studs and selection of sheathing materials and thickness become more critical decisions structurally. Typical details, such as steel studs spaced at 24 inches (610 mm) on center with 1/2 inch (12.7 mm) exterior gypsum sheathing, may not be sufficient to resist wind load applied over the entire face of the sheathing without excessive deflection. The deflection of the sheathing limits the wall's ability to quickly reach and hold pressure at the same level as outdoor conditions. Rigid materials such as concrete block typically provide sufficient stiffness for the backup wall of the air space.

Typically, a backup wall is faced with a water-resistive membrane. For proper function as a rain screen, this facing must also resist the passage of air from the cavity into the interior spaces. Design details should include the sealing at terminations and penetrations to maintain the air pressure in the cavity without air leakage.

Cavity Volume. As wind is first applied to a rain screen wall, air begins to enter the cavity through vents and weeps placed in the brickwork. Under constant wind conditions, the cavity eventually pressurizes to a level equal to that on the exterior face. However, this process takes time, and is limited by the size of the openings and the amount of air needed to fill and pressurize the cavity. As a practical matter, it is more appropriate to limit the cavity volume through compartmentation than to increase the percentage of wall openings to the level typically needed for a full wall width cavity. Further, larger wall openings provide additional direct paths for water to enter the air space.

Compartmentation. Movement of air around a building causes positive wind pressures on the windward side and negative pressures on other sides. With an open air space around the perimeter of a rain screen wall, the same positive and negative pressures are transferred to the back of the brickwork and the face of the backing materials. Due to differing air flow conditions outside the building and within the air space, the distributions of pressure will not be identical from outside to air space and the rain screen principles would be defeated. Therefore, the air space must be compartmentalized such that outside and air space pressure distributions are the same.

The size of the compartments should be based on the pressure differences across the exterior cladding. The corners and tops of buildings experience the greatest pressure differences; hence, the compartments located in these areas should be small. Where pressure differences are small, such as the center of the exterior cladding, the compartments can be larger. Sizing guidelines can be found within *Technical Note* 26.

Achieving compartments can be challenging in the field. Some projects have utilized vinyl or plastic fins mounted to the backup wall and tight against the back of the brick masonry. However, with the dimensional imperfections in brick masonry, this detail can be difficult to install. Greater success can be expected using a closed-cell compressible or pre-compressed material inserted between the brickwork and backing, sealed to the back of the brickwork. Other products, such as expanding polyurethane foam, should be used with care to ensure the adhesion to both surfaces and that no undue loads are placed on either side.

Wall Openings. With properly compartmentalized air spaces, open head joint weeps, at least 2 in. (50 mm) high, placed at 24 inches (610 mm) on center, as well as open head vents placed at the uppermost course of a brick panel, typically provide sufficient area to allow air flow into the air space fast enough to equalize pressures before significant water penetration can occur. Smaller weeps, such as tubes, or weep inserts that impede the flow of air, should be avoided. Where inserts are necessary, spacing of the vents and weeps should be closer to overcome the effect on air flow.

Every building wall provides some degree of protection against the elements. Most rely upon exterior cladding to manage wind-driven rainfall and prevent water leakage to the interior of the building. The cladding has up to four basic components, each contributing to the overall performance of the wall.

Surface skins, such as glass curtain walls or non-drainable EIFS, use an "all-or-nothing" approach, relying on the exterior surface alone to stop water from penetrating. Massive claddings, incorporated with load-bearing components, such as brick barrier walls, provide additional protection against water penetration by providing a thick, low permeability barrier blocking the path for wind-driven rain to penetrate. Brick drainage walls, such as brick veneer over stud construction, use the combination of a water-resistant outer surface, a low permeability body, a drainage space with flashing, and a water-resistive barrier to effectively manage exterior water. Additional features, such as moisture or air barriers, can provide further protection against not only liquid water, but also airborne moisture. Even more protection can be provided by applying the rain screen principle that manages water by eliminating the majority of differential wind pressure driving water through the outer skin and body. Less water penetration increases the effectiveness of traditional water management details used in brick drainage walls.

Orland Park Public Library

Construction for the library's shell utilized structural concrete clad with brick masonry featuring aluminum framing and glass curtain wall elements. The rain screen principle was applied to the exterior wall design, using the brick veneer as the initial rain screen with a vapor and moisture barrier on the concrete substrate wall beyond the air space behind the veneer. Special attention was given to the details to equalize pressure in the air space with air pressure on the exterior of the brick veneer to minimize the infiltration of wind-blown rain.

Architect: Lohan Anderson

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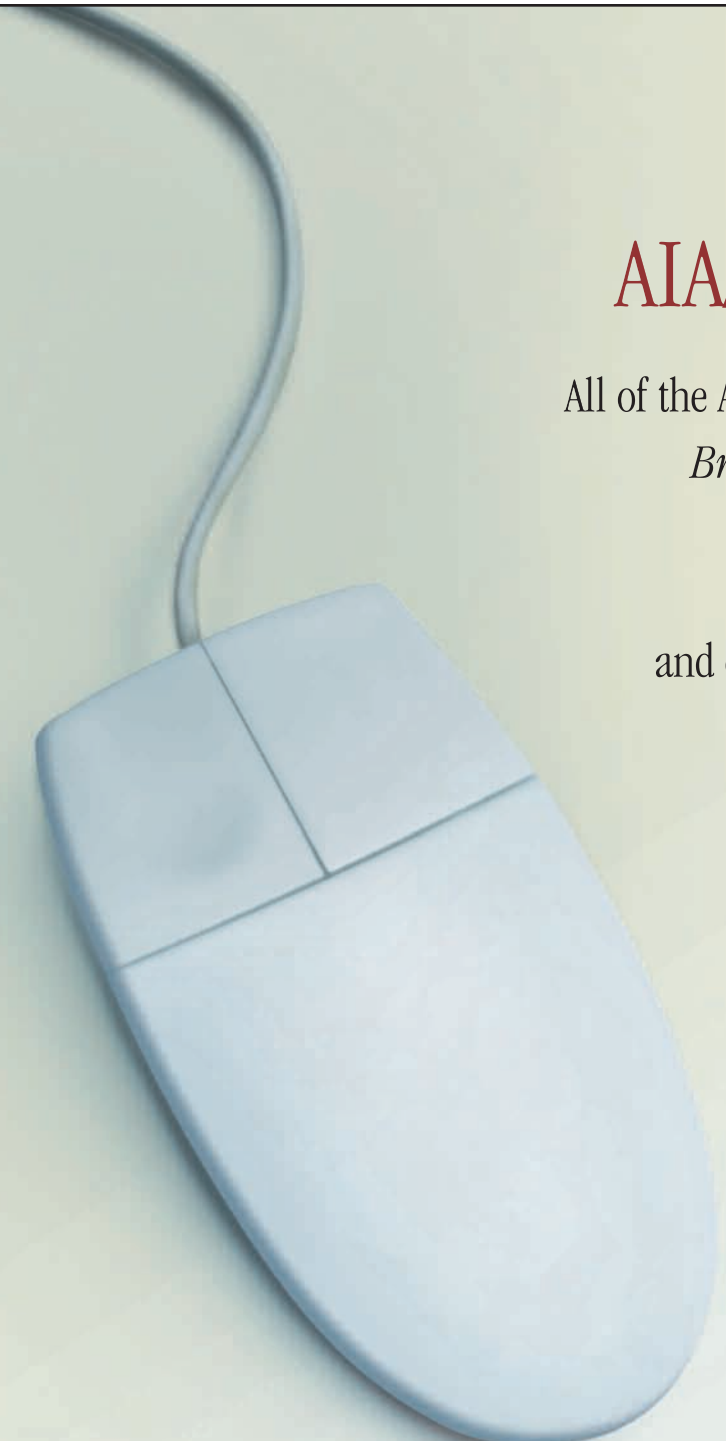
Summary

Problems associated with water and moisture infiltration of a building are well documented, including corrosion, staining, and mold or mildew. These issues are typically avoided through quality construction of appropriate design details within a cohesive water management scheme.

BIA *Technical Notes on Brick Construction*

The Brick Industry Association's (BIA) *Technical Notes on Brick Construction* have long provided guidance on brickwork to the design and construction professions. The information provided in the preceding technical discussion and in all issues of *Technical Notes on Brick Construction* is based on the available data and the combined experience of the engineering staff at BIA. The information must be used in conjunction with good technical judgment and a basic understanding of the properties of brick masonry. For further recommendations on how brick veneer walls provide superior water management, refer to *Technical Notes* 7, 21, and 28.



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