BRICK IN ARCHITECTURE

From the Brick Industry Association



Brick For Sustainable & Green Building Design

INSIDE THIS ISSUE — OCTOBER 2007

CONTINUING EDUCATION AIA

Read the newest technical discussion on *Sustainability & Green Building Design with Brick Masonry* and earn one AIA/CES credit hour by completing the questionnaire at www.gobrick.com/ArchitectCredit. After reading this article you should be able to:

1. Understand sustainability as applied to building design
2. Identify sustainable design strategies utilizing brick
3. Understand sustainable practices used in brick manufacturing

Norman-sized brick requires fewer units and takes less time to install, and helped keep the courthouse project within budget.

A Case for Sustainable Public Buildings

In downtown Denver, the Alfred A. Arraj United States District Courthouse projects an image of respect and reflects the city's rich architectural heritage. This landmark 10-story, 318,850 square foot courthouse was designed to not only meet the latest security and functional requirements of the courts, but to demonstrate the General Service Administration's commitment to environmental stewardship as a showcase for sustainable design.

The Arraj Courthouse was not originally planned to be a brick building. When the GSA set the budget for the project, the construction market was depressed. By the time the construction documents were completed, however, conditions had changed and design architects HOK had to stretch the budget in order to deliver on their plans. The exterior façade was quickly changed to masonry as a cost-cutting measure.

Recalls Bob Schwartz, AIA, Principal Architect, "Since this was a federal project, everything had to be metric. A 92mm Norman-sized brick made the most sense because it's a larger-sized unit that required less time and labor to install. That helped contribute to our cost savings even more."

Once the goal was set to create a sustainable building, it became even more important to select materials that met the building's environmental needs. Brick again was a natural choice because of its extreme durability.

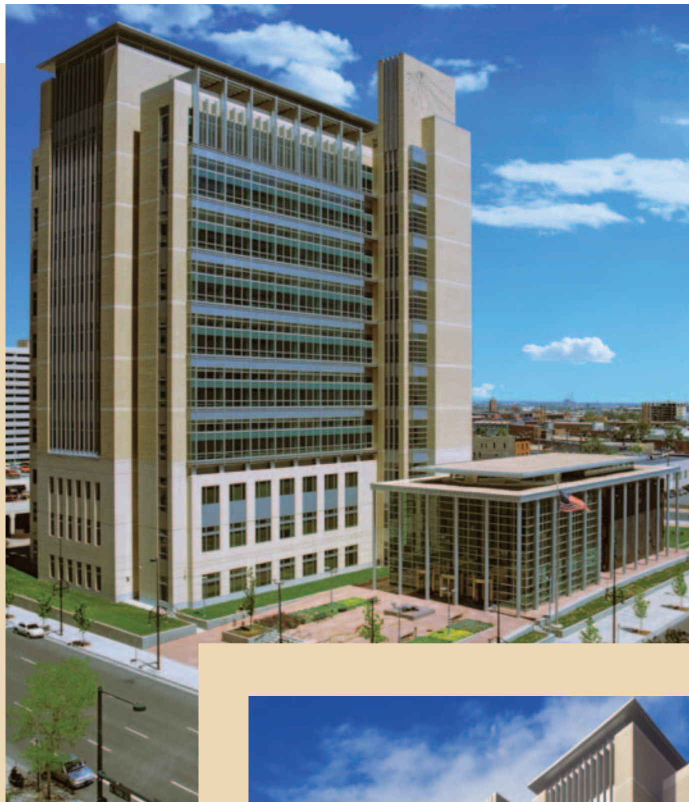
"The courthouse was meant to be a hundred-year building, so we wanted a building system that would have longevity," Schwartz comments. "We also had to be sensitive to life-cycle cost. And that's one of the reasons we used masonry. Brick is one of the most durable materials available, needs very little upkeep to maintain it, and is also a material that's in keeping with a courthouse."

The massing of the courthouse relative to the other structures in the area was a driving force in the design process. The Arraj building supplements an existing courthouse across the street, but it is also situated within a complex of other federal facilities, which are all masonry buildings. Therefore, brick was an appropriate selection to harmonize with the established aesthetics of the area.

Being a federal courthouse, designing proper security measures are paramount. One major feature of the Arraj Courthouse is the rotunda inside the lobby. Although the main entrance is encased in glass, the cylindrical rotunda that houses the security screening area is constructed of the same brick masonry used on the exterior. Once visitors pass through the massive brick rotunda, symbolically and physically separating the exterior from the interior, they enter the secure areas of the courthouse.

"The building has gotten very good response from the public," Schwartz recalls. "The courts like it, and the people really identify with it as a courthouse. Oftentimes courthouses are done in marble, but here we demonstrated how it can be done very successfully in brick."

Alfred A. Arraj United States Courthouse — Denver, CO



Architectural Firms:
HOK (Design Architect)
Anderson Mason Dale (Architect of Record)
Principal:
Bob Schwartz, AIA, LEED AP
Photographers:
Frank Ooms Photography
Maguire Photographics
Brick Manufacturer:
Acme Brick

As verified by architect

Brick is a durable and timeless material well-suited to the aesthetic and functional needs of a courthouse.

Virginia School Earns Honors for Green Building Design

The Langston High School and Langston-Brown Community Center facility has the high honor of being the first building in Virginia to earn LEED certification from the U.S. Green Building Council. Located in an established, mixed-use neighborhood in Arlington, Virginia, the school and community center replaces Arlington's first African-American elementary school, built in the 1920s.

Bordered by commercial establishments, a fire station, and residential communities, the small and challenging site was selected based on the county's need to replace an existing building that was slated for demolition. The task of developing a new building was presented to BeeryRio Architecture + Interiors, but their vision for the new building's design was significantly impacted by an initiative from the local county board to make it a sustainable project.

"This was the first LEED building in the area," recalls Bill Brown, AIA, Principal Architect. "Nobody was really sure what to ask for, so we sat down for a big brainstorming meeting to explore the environmental commitment of the client. We outlined the potential LEED points and identified different strategies for each one. It was a really helpful way of educating everyone about green building and really encouraged some 'out of the box' thinking. And to go a step further, we also had to educate the community about the kind of building they were going to get, what the sustainable elements were, and how they would affect the environment."

A fundamental principle of green building concerns not with the building itself, but the fossil fuels consumed in its construction. Sourcing materials locally is central to satisfying this requirement. The brick used on the exterior cladding was not only harvested from within the region, but is in itself an environmentally-responsible material, both for its durability and minimal maintenance requirements.

Explains Brown, "Given this 500-mile radius that we were working with, and then tie that to the fact that brick is a natural material that is traditionally used on schools, we had a great opportunity to take credit for doing the right thing by using materials from the earth. By using locally-made brick, we created a win-win situation: we bought local materials, reduced the need for fossil fuels for delivery, utilized a traditional school material, and were able to take LEED credit for it."

Another compelling reason for selecting brick was its durability. Although not a specific requirement within some sustainable building rating systems, durability is recognized as an important factor in creating a sustainable building—the longer a building lasts, the fewer materials and less energy it will consume over the long term. As a civic building, the school also needs to achieve a service life of at least 50 years.

"For any client that we have, we don't serve them well if we don't give them a durable building. They're almost synonymous—durability and sustainability—because a building can't be sustainable if it's not durable," comments Brown.

Brick also extends into the building's entry, creating a transitional space that connects inside to outside. These brick entry walls also frame the two 11,000-gallon, above-grade rainwater collection cisterns, further emphasizing the connection between indoor and outdoor.

"Brick really enhanced the quality of the building," Brown concludes. "It's a great product that allowed us to recognize the history of the community while creating a modern aesthetic. Plus it gives the neighborhood a new image and a building that is considerate of its environmental impact on its community."

Brick was selected for its durability, and a building cannot be sustainable if it is not durable.

Langston High School and Langston-Brown Community Center — Arlington, VA

Architectural Firm:
BeeryRio Architecture + Interiors
Principal:
Bill Brown, AIA REFP LEED-AP
Photographer:
Duane Lempke, Sisson Studios
Brick Manufacturer:
Redland Brick, Inc.
Brick Distributor:
Potomac Valley Brick and Supply Company

As verified by architect

Use of local brick reduced transportation costs,

satisfying an important LEED certification requirement.

Lower Manhattan's New Address is a Model for Green Building Design

The Solaire, located at 20 River Terrace in New York City, is a 27-story, brick residential tower in Battery Park City. As a planned residential and commercial neighborhood directly adjacent to the site of the former World Trade Center, the community has a high percentage of public open space. Design guidelines were developed in 2000 by the Battery Park City Authority (BPCA) for all buildings in the neighborhood, dictating building height, overall massing, and exterior materials as well as sustainable building design goals. Required materials included red brick with stone trim. The Solaire was the first building designed in accordance with these new environmental guidelines.

David Hess, AIA, Senior Associate at Pelli Clarke Pelli Architects recalls, "By the time construction on the Solaire began, the additional environmental design guidelines had been added by the BPCA. Any building constructed within their jurisdiction has to conform to these guidelines. Many conventional building details were re-evaluated and the resultant building has a LEED Gold rating."

For the design team, these guidelines were not the only requirements that shaped the look of the Solaire. Although brick was originally selected to satisfy the BPCA guidelines, it proved to be an excellent material choice for other reasons as well. New York City architecture has a long history of brick being used for multi-family residential construction. Brick has also historically been an economical form of construction in the city, due to prevailing labor traditions and the availability of material.

Much of the clay brick used in the Solaire was purchased as a local material. Fifty percent of it was sourced within a 500-mile radius, with raw materials for the brick production coming from local origins as well. Additionally, some of the brick contained a small amount of post-industrial recycled content. All this contributed to the overall sustainability of the project.

The Solaire was designed as a rental building with the developer, the Albanese Organization, as the intended long-term owner and operator. As a result, life cycle costs and overall building performance were influential considerations in its design. Typical New York City multi-family residential construction has a service life of 75-100 years. It was, therefore, essential to specify durable materials that would perform well over an extended time frame, while continuing to be handsome and easy to maintain.

Hess reflects, "Life cycle cost is a very important factor, and the durability of materials unquestionably has a high value. With brick, it's an extremely durable product and the long-term maintenance that's needed is low for the brick itself. The construction technology of the brick cavity wall and its overall energy efficiency, on the other hand, needed to be researched and tested so that optimum thermal efficiency was achieved."

Accordingly, the final exterior wall design of the Solaire reflects the results of extensive testing intended to determine air-infiltration rates and energy efficiency for traditional masonry walls. Computer simulations were developed to test alternative options as well. Product manufacturers and contractors also assessed overall constructability to achieve optimum performance of a traditional brick-and-block wall. Although brick dominates the exterior envelope, energy-producing photovoltaic panels are woven through the façade and further contribute to the building's sustainability.

Throughout its construction, the design team investigated many issues for which there was little precedent. As the first building built under the new BPCA environmental guidelines and with its success thus far, the design and performance of the Solaire is being extensively documented by public agencies to serve as a test case for future projects and for instituting comparable requirements in other New York City buildings.

Using brick is one of the most economical forms of building in New York City because of the labor environment and the availability of material.

The Solaire — New York, NY

Architectural Firm:
Pelli Clarke Pelli
Senior Associate:
David Hess, AIA
Photographer:
Jeff Goldberg, Esto
Brick Manufacturer:
Bowerston Shale Company
Brick Distributor:
Consolidated Brick & Building Supply, Inc.

As verified by architect

By having a brick façade, the architects ensured that the Solaire fit responsibly within the local planning framework and neighborhood aesthetics.

Middle School is a Lesson in Green Building Design

The Woodward Academy in College Park, Georgia is the largest private K-12 day school in the continental United States, with students hailing from all over Atlanta. To accommodate its large student population, the Jordan N. Carlos Middle School was added to the campus in 2004.

Designed by Perkins+Will in Atlanta, this state-of-the-art, five-acre addition is comprised of three buildings. The main instructional building is the LEED Silver-Certified, 80,000-square-foot Brand Tucker Hall. Designed with a number of sustainable features, the new middle school is a beautiful, resource-efficient, pedestrian-friendly learning environment that demonstrates the school's enduring commitment to the environment and the surrounding community.

The Woodward Academy campus is semi-traditional in appearance, so brick was a natural choice to continue that architectural heritage. However, other reasons influenced the decision to select brick as the primary cladding material. Located within a small, mainly residential neighborhood, brick was the most appropriate material to ensure the school would properly reflect and fit into the context of the surrounding neighborhood. Additionally, brick was chosen because of its affordability and abundant local availability.

Since all three buildings were seeking LEED certification, distance from the brick manufacturer to the campus and transportation of the materials were important considerations.

"Two types of brick were used," recalls Paula Vaughan, AIA, Principal Architect. "One was manufactured in Georgia, not far away from the campus, and the plant is located only forty-five miles from the raw material. This brick is so popular on the Woodward Campus that it is actually named 'Woodward Blend.' The other was manufactured in North Carolina where the raw materials were only twenty miles from the plant. In both cases, the finished bricks were transported less than 500 miles to the school. It's this proximity that reduced our transportation costs and contributed to our green building strategies."

To reduce heat gain and help with heating and cooling, sunscreens line the tops of the buildings. This detail is held by angled supports anchored through the brick veneer to a steel beam in the exterior wall. It is also tied at the top and bottom into additional steel elements.

Brick not only dominates the exterior façades, but is prominently featured in the interior as well. It was a natural continuation because of its durability to wear from the students and because it helps to carry the architectural vocabulary throughout the buildings, allowing the exterior to fully translate through to the interior corridor.

As a finishing detail, low brick garden walls surround the three buildings and create outdoor classroom areas. The central courtyard features brick-lined walkways and a star emblem made up of donor bricks.

The three middle school buildings of the Woodward Academy have gained the approval of administrators and the community, and they stand as a testament of the school's commitment to the future of both its students and the environment.

Brick naturally carries out the architectural tradition of the campus and harmoniously reflects the feel of the surrounding community.

Jordan N. Carlos Middle School at the Woodward Academy — College Park, GA

Architectural Firm:
Perkins+Will
Principal:
Paula Vaughan, AIA
Photographer:
Chris Little
Brick Manufacturer:
Boral Bricks

As verified by architect

The interior use of brick continues the architectural vocabulary throughout the building.

Use the following learning objectives to focus your study while reading the article below. To receive credit, follow the instructions found at the end of the article, which direct you to the complete the AIA questionnaire found at www.gobrick.com/ArchitectCredit.

Learning Objectives:

After reading this article you should be able to:

1) Understand sustainability as applied to building design
2) Identify sustainable design strategies utilizing brick
3) Understand sustainable practices used in brick manufacturing

The Whole Building Design Guide developed by the National Institute of Building Sciences discusses sustainable design in terms of "whole building design." In their words:

Whole Building design in practice requires an integrated team process in which the design team and all affected stakeholders work together throughout the project phases and to evaluate the design for cost, quality-of-life, future flexibility, efficiency; overall environmental impact; productivity, creativity; and how the occupants will be enlivened. The 'Whole Buildings' process draws from the knowledge pool of all the stakeholders across the life cycle of the project, from defining the need for a building, through planning, design, construction, building occupancy, and operations.

[Whole Building Design Guide]

This issue of *Brick in Architecture* will focus on how brick masonry can be used to create sustainable "whole building" designs. Readers will also learn about sustainable practices utilized in brick manufacturing.

WHAT IS SUSTAINABLE BUILDING DESIGN?

Sustainable building design is about creating high- performance buildings that meet the needs of today without compromising the ability of future generations to meet their own needs. Sustainable buildings are designed in a way that uses available resources efficiently and in a responsible manner, balancing environmental, societal, and economic impacts. A sustainable building should be considered in light of the broader context of high-performing buildings. Objectives of a high-performance, sustainable building design include accessibility, aesthetics, cost-effectiveness, functionality/operation, durability, productivity of occupants, security and safety, and environmental performance.

Sustainable Design and Building Rating Systems

A number of building rating systems have been developed to help assess the sustainable attributes of building design and construction. Most of these rating systems focus on the environmental aspects of sustainable design in the five broad categories of energy use, water use, site impacts, material use, and indoor environment. While an important aspect of sustainable design, environmental objectives are only one part of the "triple bottom line" of sustainable design. Economic and societal goals are equally important. It is therefore important to view sustainable buildings in a broader context than the environmental rating systems.

Sustainable Design Elements

Every sustainable building is unique, designed specifically for its site and the programming requirements of the user. However, all high-performance, sustainable buildings should consider the following components of design:

- Environmentally responsive site planning
- Energy efficient building shell
- Thermal comfort
- Energy analysis
- Renewable energy
- Water efficiency
- Safety and security
- Daylighting
- Commissioning
- Environmentally preferable materials and products
- Durability
- Efficient use of materials
- High-performance HVAC
- High-performance electric lighting
- Life cycle cost analysis
- Acoustic comfort
- Superior indoor air quality
- Visual comfort

[High Performance School Building Resource & Strategy Guide]

SUSTAINABLE DESIGN WITH BRICK

Many of the objectives of sustainable design do not impact building material selection, but instead focus on building systems such as plumbing, lighting, air conditioning, etc. However, the versatility and durability of brick facilitate the use of brick masonry as part of many elements of sustainable design.

Environmentally Responsive Site Planning

Environmentally responsive site planning includes consideration of site selection, site disturbance, storm water management, and the effect of the building on its surroundings. The use of brick masonry is an appropriate choice for achieving several elements of environmentally responsive site planning.

Reuse Existing Brick Buildings. The first step in site planning is selection of the building site. Reuse or renovation of an existing building can result in significant reductions in environmental impacts compared to new construction. Because of the aesthetic appeal and durability of brickwork, buildings using brick are often chosen for reuse. In many cases, load-bearing brick buildings are reused in their entirety. Historic load-bearing brick masonry buildings benefit from the thermal mass inherent in brick to provide thermal comfort to occupants. In other cases, the brick façade is retained while a new structure is constructed. By utilizing brick masonry in new construction in a responsible manner, future reuse is facilitated.

Permeable Pavers and Pavements Reduce Storm Water Runoff. By managing storm water runoff, increasing on-site filtration, and eliminating contaminants, the disruption and pollution of natural water flows is limited. Permeable pavers and flexible brick pavements can be used as part of a strategy to reduce the quantity and improve the quality of runoff through on-site treatment. Pavements that utilize clay

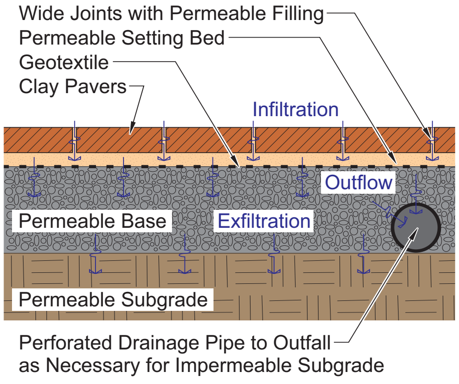


Figure 1. Typical Permeable Pavement Section

Langston High School was built to replace an existing elementary school in Arlington, Virginia. The existing brick school building was demolished, and 83% of the building was recycled. The brick from the demolition was given to neighbors who wanted to keep a piece of history from the original structure, while the remaining brick was taken by the county and was crushed for use as structural fill in excavations for water main breaks.

Langston High School
Architect: BeeryRio Architecture + Interiors
© Duane Lempke / Sisson Studios

pavers over an aggregate setting bed and base can reduce storm water runoff by about 10 percent. Such systems should use permeable aggregate between and under pavers to promote drainage.

Light-Colored Pavers Reduce Heat Island Effect. Building projects have an effect on their surroundings, particularly in urban areas. The use of light-colored materials can help reduce the heat island effect. Heat islands occur when dark surfaces retain heat for a prolonged period, particularly in urban areas. To demonstrate appreciable reduction in heat, surfaces with a Solar Reflectance Index (SRI) of at least 29 are generally accepted as demonstrating appreciable heat reduction. Light-colored pavers that qualify typically are light tan, buff, or cream in color and can be used on vegetated roofs to provide access paths or on non-roof pavements as part of a strategy to reduce this effect.

When locating new construction, it is desirable to select sites near existing infrastructure. Utilizing brick masonry in urban development can help meet requirements for fire resistance and separation, overcome limitations on construction site accessibility, and accommodate irregularly shaped lots.

On any site it is desirable to maximize the amount of open space on the site, either by limiting the building footprint or by minimizing the extent of site disturbance adjacent to the building. Because brick masonry construction does not require large staging areas or large equipment for placement, the amount of site disturbed can be kept to a minimum. In addition, brick paving in an open space can provide a pedestrian-friendly surface.

Energy Efficient Building Shell, Thermal Comfort, and Energy Analysis

An energy-efficient building envelope is a key component in sustainable building design. Incorporation of brick masonry's thermal mass provides numerous energy benefits, including the reduction of peak heating and cooling loads, moderation of indoor temperature swings (improved thermal comfort), and potential reduction in the size of the HVAC system. The benefits of thermal mass have been demonstrated when brick is used as a veneer, and are even more pronounced when brick masonry is also exposed on the interior of the building.

In order to thoroughly account for the thermal mass benefits of masonry, energy analysis using simulation software is necessary. BLAST or Energy Plus are the most suited for analysis of buildings with masonry.

Rain-screen walls are another example of a high-performance brick wall. Rain-screen walls can provide superior thermal performance through the reduction of air movement through the building envelope. In addition, moisture penetration is one of the most common causes of problems in buildings. Rain-screen walls minimize rain infiltration by applying principles of pressure equalization. A brick masonry pressure-equalized rain-screen wall utilizes intentional openings in the brick masonry and compartmentation to equalize the pressure in the cavity behind the exterior brick and thus minimize rain penetration.

Renewable Energy

Incorporation of renewable energy sources into a building design can significantly reduce reliance on fossil fuels used by the building during operation. Passive solar energy is a free resource, and brick masonry can be utilized as part of several passive solar design strategies.

Safety and Security

Brick masonry promotes occupant health and safety through fire-resistant construction and resistance to impacts and wind-borne debris. In addition, the durability of brick masonry gives long-lasting results.

Environmentally Preferable Materials and Products and Durability

Consideration of the environmental impact of building materials and products is an important element in a sustainable design, though it is only one of several criteria to be considered for product selection. Materials should be evaluated over their entire life cycle, from raw material extraction to end of useful life. This life cycle assessment (LCA) of a building material or product must include accurate evaluation of product service life.

Brick masonry has a service life of over 100 years. Environmental effects associated with brick are distributed over this long lifespan. Other products used with brick masonry may have considerably shorter lifespans. It is important in the design and detailing of a building to recognize these differences.

Building construction can generate significant amounts of waste. Because of the small, modular nature of brick, on-site construction waste can be almost completely avoided through careful design and detailing. In addition, scrap brick is easily crushed and recycled for new uses, thus avoiding the landfill. Packaging from brick is minimal and easily recycled.

Use of salvaged materials avoids the environmental impacts associated with new products. Salvaged brick, especially sand-set pavers, can be reused when care is taken to determine material performance characteristics.

Many environmentally preferred product listings focus on materials that incorporate recycled content. By utilizing recycled materials, the assumption is that the environmental impact is lowered. Recycled materials can come from either post-consumer or post-industrial (pre-consumer) sources. Brick masonry can contain many recycled products. Brick units may incorporate recycled materials such as sawdust and manganese. Mortar and grout can include recycled materials, such as fly ash, and most steel reinforcement used in reinforced brick masonry has a high recycled content.

By selecting materials from regional sources, environmental impacts associated with the transport of materials can be reduced. Most brick is manufactured with nearly 100% of the materials obtained from within a few miles of the manufacturing plant. In addition, nearly every major urban area in the United States is within 500 miles of at least one brick plant.

Efficient Use of Materials

Brick masonry walls are able to perform a number of functions that often require multiple components in other wall systems. By designing walls that serve multiple functions, materials are used efficiently. This translates into reduced environmental impacts for the building. A single brick wythe can:

- Serve as a load-bearing structural element.
- Provide an interior or exterior finish without the need for paints or coatings.
- Provide acoustic comfort with a sound transmission class (STC) rating of 45 of greater.
- Regulate indoor temperatures as a result of thermal mass.
- Provide fire resistance (a nominal 4-in. brick wall has a one-hour fire rating).
- Provide impact resistance from wind-borne debris or projectiles.
- Improve indoor air quality by eliminating the need for paint and coatings (no VOCs).
- Provide an inorganic wall that is not a food source for mold.
- Serve as a heat-storing element in a passive solar design.
- Potentially last a thousand years.

In addition, other innovations in brick masonry design can further decrease the raw materials used. The use of pre-stressed brick walls capitalizes on the inherent compressive strength of brickwork resulting in typically thinner, taller walls.

Brick manufactured to a smaller thickness uses less material. Brick manufactured to meet ASTM C 1088, Specification for Thin Brick Veneer Units Made from Clay or Shale, have a maximum thickness of 1 3/4 in. (44 mm). When adhered to a load-bearing wall substrate, these units can provide a brick finish with minimal thickness.

Anchored masonry veneer can be a minimum of 2 5/8 in. (67 mm) thick, according to the Building Code Requirements for Masonry Structures, which is referenced by the International Building Code. Such brick is available from most brick manufacturers, but are usually used in residential applications.

Brick units meeting the requirements of ASTM C 652, Specification for Hollow Brick, utilize less raw material while performing the same function. In addition, these units can be used in reinforced or pre-stressed brick masonry walls.

Life Cycle Cost Analysis

Life cycle cost analysis projects the total cost of a building over time. Total life cycle costs include the cost of initial design and construction as well as operating and maintenance costs.

With a long life cycle of more than 100 years and minimal maintenance, brickwork fares well compared to other cladding materials. Software is available to assess life cycle costs through the Whole Building Design Guide (www.wbdg.org) and the U.S. Department of Energy (www.eren.gov/buildings/tools_directory).

Acoustic Comfort

Acoustic comfort is a key element in a superior indoor environment. Brick masonry walls provide superior resistance to sound penetration with a sound transmission class (STC) of 45 or greater.

Superior Indoor Air Quality

Because brick masonry can be used on the interior of a building, serving as structure and finish material without the need for paints or coatings, brick can contribute to improved indoor air by avoiding volatile organic compounds (VOCs). In addition, because the appearance of brick will last a lifetime without costly paints or other maintenance, this benefit continues for the life of the building. Mold is another area of concern for indoor air quality. Brick masonry is not a food source for mold. As a result, it does not promote mold growth, even if wetted, and is easily cleaned if needed. Other interior wall materials can be literally eaten up by mold if moisture problems occur.

The building envelope was a primary focus of the design of The Solaire, a 27-story glass and brick residential tower in Manhattan. Constructed as a brick and block cavity wall, the building envelope was extensively analyzed using DOE-2 and other energy models to optimize the performance of the brick/block construction. In addition, photovoltaics were interwoven with the brick and glass exterior. Special attention was given to detailing to protect the integrity of the envelope. Double sealants were used at windows, and the through-wall flashing was secured using a termination bar to minimize penetration of the backup wythe. Stainless steel drip edges and flashing end dams were used to provide construction details to match the durability of the masonry construction.

The Solaire
Architect: Pelli Clarke Pelli
© Jeff Goldberg / Esto

High-Performance Brick Wall

Designing a brick wall section for maximum impact on the overall sustainable design often involves incorporating a few minor adjustments to a traditional brick wall assembly. Consideration should be given to the thermal performance elements of the wall as well as the use of air and vapor barriers. As discussed earlier, air and vapor barriers can limit moisture and air movement through the building envelope. The need for and location of air and vapor barriers depends on climate and building envelope materials. However, vapor barriers, when needed, should generally be located on the warm side of the primary insulation. Figure 2 shows a high-performance brick and block wall with a spray-on foam insulation that also acts as an air barrier. The insulation seals completely around wall ties to form a continuous air barrier. A vapor barrier, if needed, would be placed on the warm side of the insulation, on the interior in cold climates, or outside of the insulation in warm climates. Figure 3 shows a wall system in which the insulation, air barrier, and vapor barrier are distinct elements. In this case the vapor barrier is located on the warm side of the insulation on the interior of the wall system while the vapor-permeable air barrier is a continuous membrane in the wall cavity.

Recommended details for an exterior brick veneer wall include the following:

- Minimum 2-inch (51 mm) air space to reduce possibility of water bridging cavity.
- Horizontal expansion joint below shelf angle to allow expansion of brickwork.
- Durable anchors, ties, flashing materials, and metal drip edges to match the design life of the building.
- Pre-formed end dam and corner flashing pieces to promote drainage.
- Termination bar securing flashing in cavity to minimize penetration of the building shell and thermal envelope.
- Sealant and fiber insulation at top of concrete masonry infill wall to minimize air leakage.
- Continuous air and/or vapor barrier as required by climate with attention to sealing around ties and other penetrations.
- Continuous insulation layer to prevent thermal bridging.
- Vents through brick veneer below shelf angles and at weeps to maximize ventilation of cavity and equalize air pressure inside and outside of cavity.
- Jamb flashing systems to minimize air and moisture infiltration.

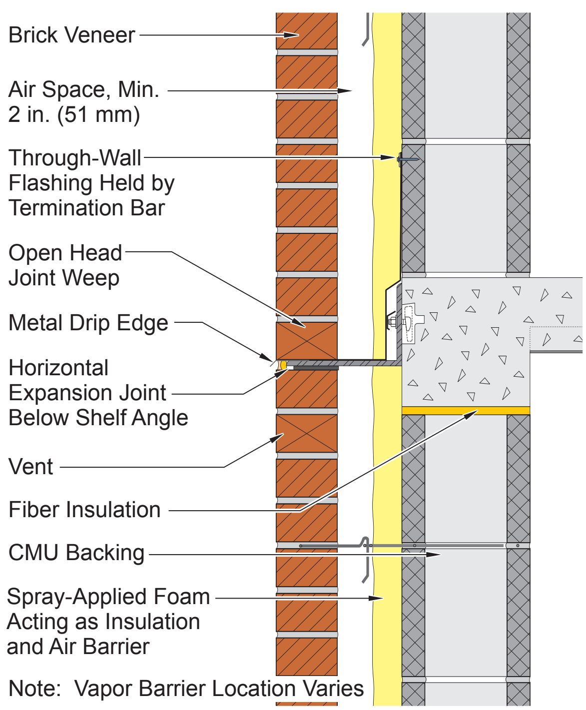


Figure 2. High-Performance Brick/CMU Wall Section

SUSTAINABLE PRACTICES IN MANUFACTURING

Brick has been used as a building material for thousands of years. The manufacture of brick has evolved over time from handmade, sun-dried adobe brick to manufactured units made entirely by machine. Advances in recent years have reduced the environmental impact of brick manufacturing while improving production efficiencies.

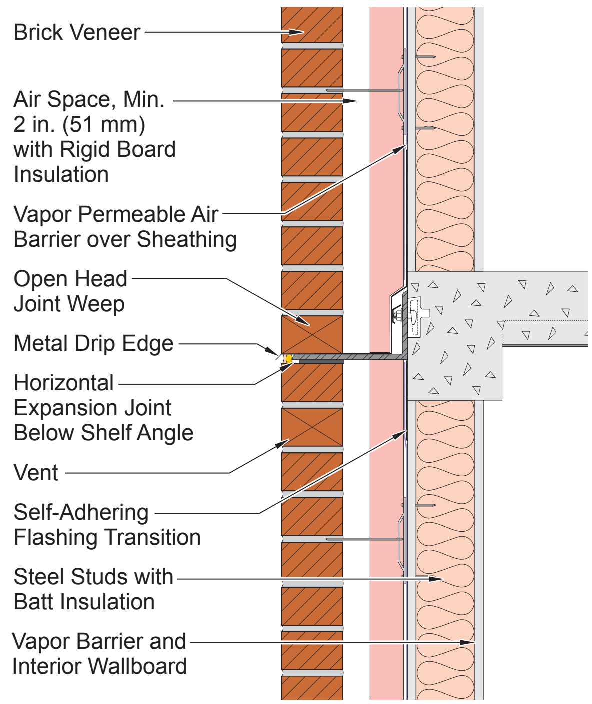


Figure 3. High-Performance Brick/Steel Stud Wall Section

Raw Material Use

Brick is made primarily from clays and shales, which are abundant natural resources. Most of the clays and shales used in brick-making are mined in open pits located near brick manufacturing facilities. In fact, brick manufacturing plants are typically located within two miles of the mine. Most plants use material from the same pit extracted through multiple soil layers for a minimum of 50 years, thus minimizing their impact to the surface area. Conveyors and other power equipment are typically used to transport the clay from the mine to the plant. Brick manufacturing plants, in turn, are located throughout the country, putting them within a short distance of most urban areas.

Storm water runoff from clay pits is controlled by regulations from the Mining Safety and Health Act. Manufacturers use techniques such as settling ponds, filtration through marshes and wetlands, and catch basins. Dust is controlled by spraying organic, biodegradable oils or water.

Once the clay is mined, it is ground to suitable particle size and then mixed with water. This mixture is then formed into brick. Nonhazardous waste products are sometimes incorporated into the mixture. For example, petroleum-contaminated soil or sludge can be used. Recycled waste from other industries, such as bottom-ash and fly-ash from coal-fired generators, and other ceramic material waste can be used. Reclaimed industrial metallic oxides can be used as colorants in brick. Because fired brick are inert, brick can safely encapsulate many materials.

Nearly all of the material mined for brick production is used, resulting in near zero waste of raw materials. Processed clay and shale removed in the forming process before firing are returned to the production stream. Brick not meeting standards after firing are culled from the process and ground to be used in manufacturing brick or crushed to be used as landscaping material or structural fill.

The Leadership in Energy and Environmental Design Rating System for New Construction and Major Renovation (LEED-NC) is the most widely used building rating system in the U.S. Developed by the U.S. Green Building Council, the LEED-NC Rating System is organized into five environmental categories. As described in this *Brick in Architecture*, brick masonry can play a role in achieving the following LEED credits:

Sustainable Sites. This category in LEED-NC covers the selection and development of a project. Four credits potentially relate to brick masonry:

Credit 2: Development Density & Community Connectivity (1 point)— The intent of this credit is to encourage development of urban areas and to protect greenfields and natural habitats. By developing an urban, infill-type lot, 1 point can be earned. Brick masonry lends itself well to designs that can take advantage of small, irregularly-shaped lots. In addition, utilizing noncombustible masonry on the exterior means that buildings can be closer together.

Credit 5.2: Maximize Open Space (1 point)— Minimizing disturbance of site and maximizing open space are the intent of this credit. By utilizing brick, large staging areas during construction can be avoided. Brick pavers may be used on paths in open areas.

Credit 6: Storm Water Design (2 points)— This credit has two parts and is intended to limit the disruption and pollution of natural water flows by managing storm water runoff, increasing on-site filtration, and eliminating contaminants. Credit 6.1 awards 1 point for reducing the quantity of runoff. Credit 6.2 awards 1 point for improving the quality of runoff through on-site treatment. By utilizing permeable brick pavements as part of a strategy to manage storm water, both credits can be earned.

Credit 7: Heat Island Effect (2 points)— The intent of this credit is to reduce heat islands by providing shade and/or light-colored materials. Up to 2 points can be earned: 1 for roof surfaces and 1 for non-roof surfaces. Light-colored brick pavers can be used on vegetated roofs to provide access paths or on non-roof pavements as part of a strategy to earn these points. Light-colored pavers must have a Solar Reflectance Index (SRI) of at least 29 to meet this criterion.

Energy & Atmosphere. This credit category covers a number of different topics related to energy use and the atmosphere. Of these, only one relates directly to brick masonry.

Credit 1: Optimize Energy Performance (up to 10 points)— The goal of this credit is to achieve increasing levels of energy performance above ASHRAE Standard 90.1-2004. Incorporation of brick masonry's thermal mass provides numerous energy benefits, including the reduction of peak heating and cooling loads, moderation of indoor temperature swings, and potential reduction in the size of the HVAC system. The benefits are even more pronounced when brick masonry is exposed on the interior of the building.

In addition, brick masonry can be utilized as part of a passive solar design to further reduce the fossil fuels used by the building during operation. In order to thoroughly account for the thermal mass benefits of masonry, energy analysis using simulation software is necessary. Energy Plus or BLAST are the most suited to analysis of buildings with masonry.

Materials & Resources. This category contains most of the credits related to brick masonry.

Credit 1: Building Reuse (3 points)— The intent of this credit is to preserve existing building stock and conserve resources. Up to 3 points can be earned. One point is earned if at least 75 percent of the existing building structure is maintained. A second point is earned if the total preserved is 95 percent. Another point can be earned by reusing at least 50 percent (by area) of the existing nonstructural elements. Brick masonry buildings, walls, and floors are ideal candidates for reuse because of their durability.

Credit 2: Construction Waste Management (2 points)— This credit is intended to reduce the amount of construction waste in landfills and to encourage recycling of construction waste. Up to 2 points can be earned, depending upon the amount of construction waste that is diverted from the landfill. Brick masonry materials are easily crushed and recycled for new uses. Packaging from brick is minimal and easily recycled. In addition, because of the small, modular nature of brick, on-site waste can be almost completely avoided through careful design and detailing.

Credit 3: Materials Reuse (2 points)— The intent of this credit is to encourage the use of salvaged materials in new construction. Up to 2 points can be earned, depending upon the value of salvaged materials used. Salvaged brick and pavers, especially in sand-set applications, can be used to meet this requirement.

Credit 4: Recycled Content (2 points)— This credit is intended to encourage the use of materials that have recycled content. Emphasis is placed in LEED-NC on post-consumer recycled content, but post-industrial wastes also are included. It is important to recognize that in order to earn 1 point in this credit, the value of the recycled content of all materials used on the project must be at least 10 percent of the total value of all materials used. Thus, no one material alone can earn this credit. A number of materials containing some amount of recycled content must be used. Brick can play a part in achieving this goal. As discussed previously, brick can incorporate recycled materials such as sawdust and manganese. Mortar and grout also may include recycled materials, such as fly ash, and most steel reinforcement has a high recycled content.

Credit 5: Regional Materials (2 points)— One point can be earned in this credit if at least 10 percent (by cost) of building materials are extracted and manufactured within 500 miles of the project site. A second point is earned if the percentage is 20 percent by cost. Because only the percentage of the material by weight that is within the 500-mile radius is counted, and most brick are manufactured with materials obtained from within a few miles of the manufacturing plant, nearly 100% of the weight of most brick can be used. In addition, nearly every urban area in the United States is within 500 miles of at least one brick plant.

Innovation & Design. This category in LEED is intended to award up to 4 points for sustainable strategies that greatly exceed the requirements of existing LEED credits or for those areas not currently covered by LEED. There are several areas not addressed by LEED that can contribute to a sustainable design utilizing masonry. It is important to note that within the LEED Rating System, Innovation & Design credits are awarded for a systematic application of a sustainable strategy to the entire building. Focusing on a single aspect of a building is not sufficient.

Indoor Environmental Quality— Because brick masonry can be used on the interior of a building, serving as structure and finish material without the need for paints or coatings, brick can contribute to improved indoor air by avoiding VOCs. In addition, because the appearance of brick will last a lifetime without costly painting and with minimal maintenance, this benefit continues for the life of the building. Mold is another area of concern for indoor environmental quality. Brick masonry is not a food source for mold. As a result, it does not promote mold growth, even if wetted, and is easily cleaned if necessary. Other interior wall materials can literally be consumed by mold if moisture problems occur.

Durability— Consideration of the life cycle of a building and its component materials is at the heart of sustainable design. Utilizing life cycle assessment in building product choices is recognized by LEED as a sustainable design strategy. It is important to consider a building's full life expectancy when conducting life cycle evaluations, and to recognize the limitations of life cycle assessment when making product choices.

Acoustic Comfort— Brick masonry walls provide superior resistance to sound penetration with a sound transmission class (STC) of 45 or greater. LEED has recognized acoustic design as a sustainable design strategy through the credit interpretation process. Other green building rating systems include credits for acoustic design.

Occupant Health and Safety— Brick masonry promotes occupant health and safety through fire-resistant construction and resistance to impacts and wind-borne debris.

The brick exterior cladding used on this project was transported less than 500 miles from the point of manufacture. The main field brick came from a brick plant in Smyrna, Georgia, while the iron spot accent brick were manufactured and sent from Salisbury, North Carolina. In both cases, the raw material used to produce the brick was located near the manufacturing facility.

Jordan N. Carlos Middle School at the Woodward Academy
Architect: Perkins+Will
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Manufacturing Process

The brick manufacturing process incorporates many other practices intended to conserve resources and promote sustainability. Lubricants, made from a waste by-product derived from processing organic materials, can be used in the forming of brick. Heat required for dryer chambers is usually supplied from the exhaust heat of kilns to maximize thermal efficiency. Water used in brick production is recycled and reused. Improvements in automation result in lower energy use.

Most of the energy required for brick production is used in the firing of the kilns. According to the AIA Environmental Resource Guide, the energy used to mine, manufacture, and transport brick (known as "embodied energy") is approximately 4,000 BTU per pound, or 14,000 BTU per standard brick equivalent (SBE). That's less per pound than concrete, glass, steel, aluminum, or even wood. This number has decreased since the guide was published, with most plants increasing their energy efficiency and new plants that operate more efficiently coming on stream. The current industry average is approximately 1,239 BTU per pound. While natural gas is the most frequently used fuel for firing during brick manufacturing, many manufacturers are using waste products, such as methane gas from landfills and sawdust. By utilizing waste materials as energy sources, brick plants not only reduce their consumption of fossil fuels, but also provide a beneficial means of disposal of potential wastes. Brick manufacturers also are taking steps to further improve their efficiency by using sawdust and petroleum coke as a burnout material in the clay or shale mixture, producing lower-weight units with less raw material.

The majority of brick today are packaged in self-contained, strapped cubes, which can be broken down into individual strapped sections for ease of handling on the job site. Layers of brick are separated by wooden or paper strips to reduce chippage and breakage. Such packaging does not use wooden pallets. Plastic straps and wood dividers can be recycled, resulting in little or no waste. Approximately 85 percent of brick are transported to the distributor's yard or job site by truck and 15 percent by rail.

The brick industry recognizes the need for compliance with state and federal regulations for clean air and the environment. Air emissions are minimized with controls such as scrubbers installed on kiln exhausts. Lime waste that accumulates in scrubbers often is recycled as a beneficial additive to soil. Dust in brick plants is controlled through the use of filtering systems, vacuums, additives, and water mists. Even vehicular emissions are being addressed, with brick manufacturers monitoring truck emissions; recycling waste oil, antifreeze, and hydraulic oil; and regulating truck speeds for improved fuel efficiency.

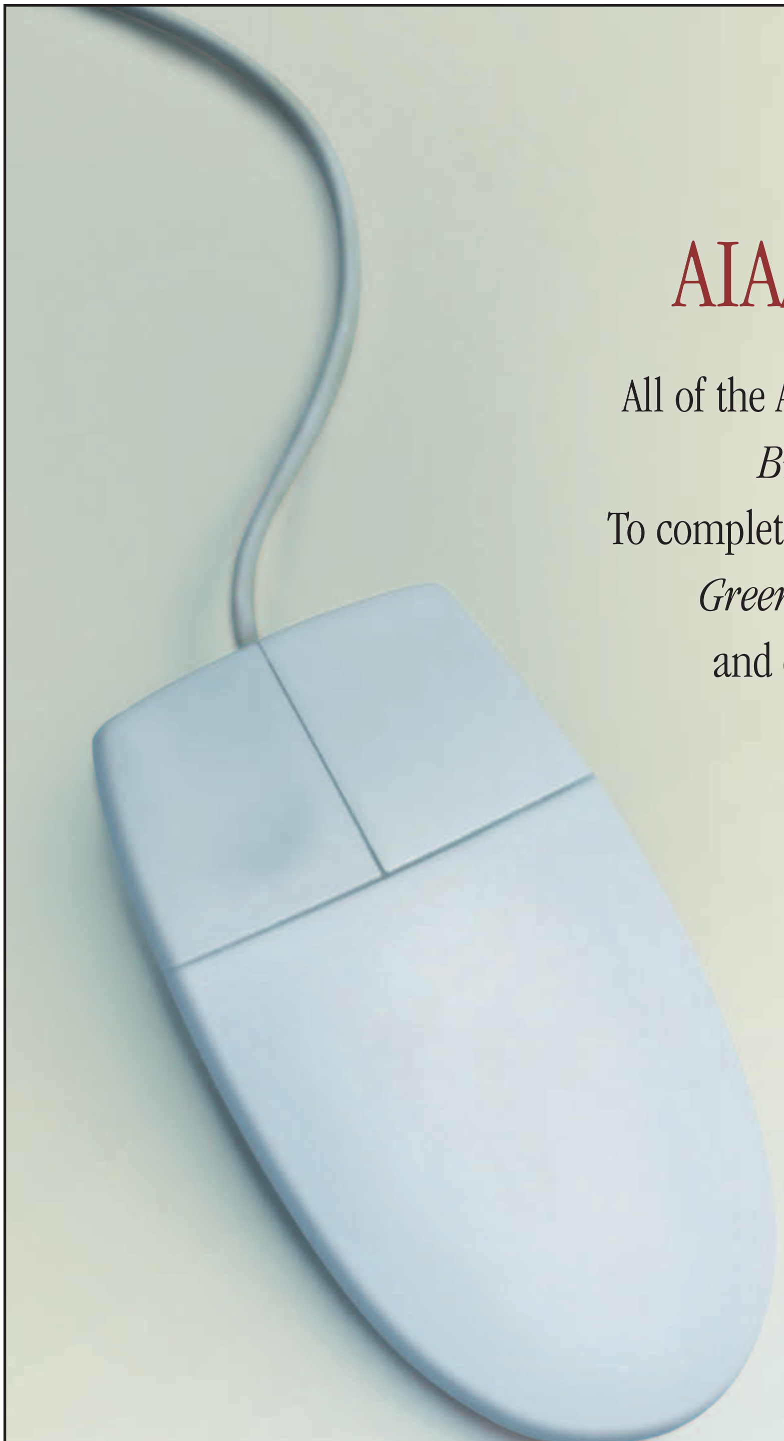
As part of a commitment to sustainability, mined areas are reclaimed for future use by replacing overburden and topsoil so the resulting property can be used for a wide variety of functions including farmland, residential and commercial sites, and even wetlands.

Summary

Brick manufacturing has made great strides toward environmental stewardship by substantially decreasing the amount of embodied energy required to produce a standard brick, and through programs to minimize waste, emissions, and impact on the environment. Brick is a durable cladding material that can be used to meet multiple sustainable design objectives in a project, whether complying with a specific environmental building rating system or not.

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 BIA engineering staff and members. 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 the sustainability of brick and brickwork, refer to *Technical Note 48 at* www.gobrick.com.



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For questions, contact Megan Inscoe at minscoe@bia.org or 703-674-1535.

THE BRICK INDUSTRY ASSOCIATION

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Let the Brick Industry Association know about your firm's sustainable and green building designs that feature clay brick. Your project will be considered for publication in upcoming issues of *Brick in Architecture*.

KELLY EWELL
Editor, *Brick in Architecture*
Brick Industry Association
1850 Centennial Park Drive
Suite 301
Reston, VA 20191

P. 703.674.1544 • F. 703.620.3928
kewell@bia.org • www.gobrick.com