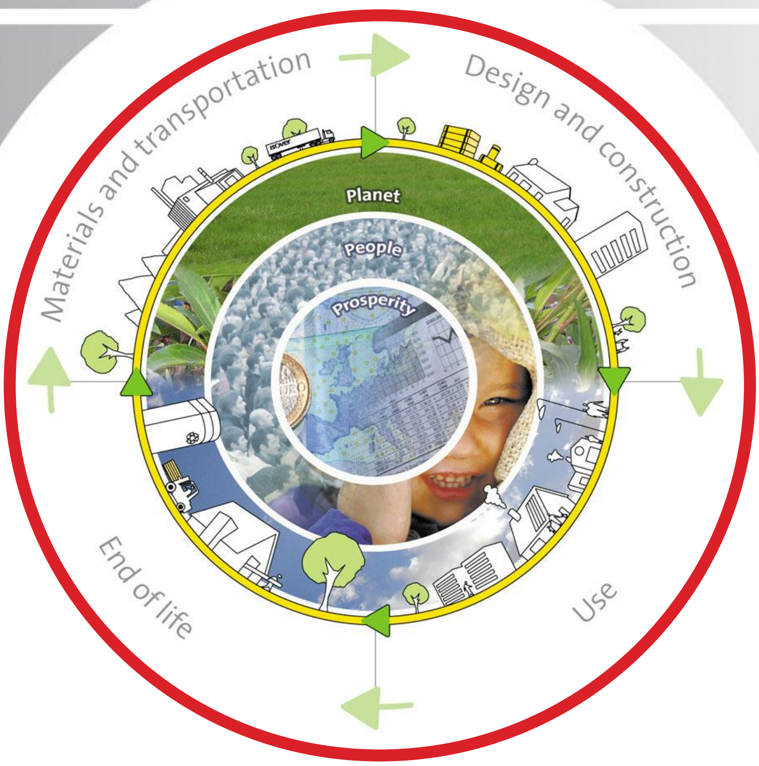

TECHNICAL NOTE #18

Sustainability & Sustainable Design

This Technical Note discusses sustainability and sustainable design and their relationship to brick use and recycling. The use of brick masonry is an appropriate choice for achieving several elements of environmentally responsive sustainable design for buildings.

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Environmentally Friendly

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SUSTAINABILITY & SUSTAINABLE DESIGN

"Sustainable design" is a term that has entered the vernacular of building design and construction. As more buildings are designed and constructed using sustainable design principles, the need for information on building products and their sustainable design features also grows. In assessing the sustainable attributes of building products, consideration must be given to how the product is manufactured, used and disposed of.

WHAT IS SUSTAINABILITY?

Sustainability is defined as "meeting the needs of the present without compromising the ability of future generations to meet their own needs" [Ref. 2]. Sustainable buildings are designed in a way that uses available resources efficiently and in a responsible manner, balancing environmental, societal and economic impacts to meet the design intents of today while considering future effects.

Sustainably designed buildings are energy efficient, water-efficient and resource-efficient. They address the well-being of the occupants by considering thermal comfort, acoustics, indoor air quality and visual comfort in the design. They also consider the impact of a building's construction, operation and maintenance on the environment, and the environmental impact of the building's constituent materials.

A sustainably designed building considers all of these aspects through the entire life cycle of the building, including its operation and maintenance.

Often the tendency is to focus on one aspect of sustainable design, such as energy use or environmental impacts.

This approach leaves out other equally important elements necessary for true sustainability. Truly sustainable design is best described as achieving the "triple bottom line," that balance of environmental goals, societal goals and economic goals.

A high-performance, sustainable building design should include accessibility, aesthetics, cost-effectiveness, durability, functionality/operation, productivity of occupants, security and safety, and environmental performance.

There are as many ways to achieve this "triple bottom line" as there are design possibilities. Understanding general sustainable design issues helps identify areas in which design has an impact.

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 [Ref. 14]:

- 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

The versatility and durability of brick facilitate its use 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 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 and Renovation.
The first step in site planning is selection of the building site. Reuse or renovation of an existing building (see Photo 1) can result in significant reductions in environmental impacts as compared with new construction. Because of aesthetic appeal and durability, brick masonry buildings often are chosen for reuse. In many cases, load-bearing brick buildings are reused in their entirety. In other cases, the brick façade is retained while a new structure is constructed.

Using Brick in Urban Areas.
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 limitations on site accessibility and can also accommodate irregularly shaped lots.

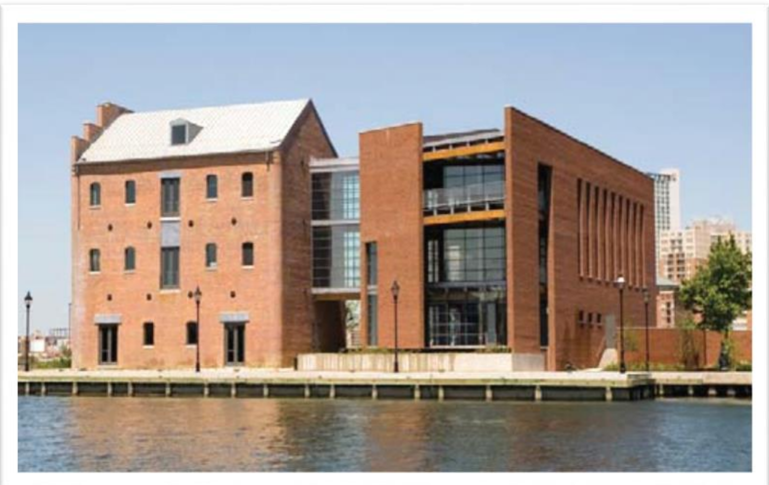
Maximizing Open Space.
On any site it is desirable to maximize the amount of open space on the site, either by limiting the building footprint or by minimizing the extent of site disturbance adjacent to the building. Because brick masonry construction does not require large staging areas or large equipment 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.

Managing Storm Water Runoff.
By managing storm water runoff, increasing on-site filtration and eliminating contaminants, the disruption and pollution of natural water flows are limited. Flexible brick pavements can be designed as permeable pavements to allow percolation of storm water through the pavements, thereby reducing runoff, recharging groundwater aquifers and removing contaminants from surface water (see Photo 2).

Reducing the 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. 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 reduce this effect.

ENERGY-EFFICIENT BUILDING SHELL, THERMAL COMFORT AND ENERGY ANALYSIS

Energy-Efficient Building Envelope.
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 also is exposed on the interior of the building.



Reused brick is combined with New Brick in this extended commercial building.

Energy Analysis.
In order to thoroughly account for the thermal mass benefits of masonry, energy analysis using simulation software is necessary. BLAST [Ref. 4] or EnergyPlus [Ref. 5] are the most suited to analysis of buildings with masonry.

Brick Rain Screen Wall.
A brick rain screen wall is another example of a high-performance brick wall. Moisture penetration is one of the most common causes of problems in buildings. Rain screen walls minimize rain infiltration by applying principles of drainage and pressure equalization. A brick masonry pressure-equalized rain screen wall utilizes intentional openings in the brick masonry and compartmentalisation of the cavity to equalize the pressure in the cavity behind the exterior brick and thus minimize rain penetration.

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.

Life Cycle Cost Analysis

Due to durability of brickwork construction, a life cycle cost analysis can often demonstrate the long-term benefits of building with brick.

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.

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. Brick paving can be used in interior applications to store heat and moderate temperature swings.

ENVIRONMENTALLY PREFERABLE MATERIALS AND PRODUCTS

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

Life Cycle Assessment.
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.

Construction Waste.
Building construction can generate significant amounts of waste. Because of the small, modular nature of brick, on-site construction waste can be dramatically reduced 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.

Recycled Content.
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 postconsumer or post-industrial (pre-consumer) sources.

Brick masonry can contain many recycled products. Brick units may incorporate recycled materials such as sawdust and metallic oxides. 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.

Regional Sources.
By selecting materials from regional sources, environmental impacts associated with the transport of materials can be reduced. Most brick are manufactured from materials obtained from within a few miles of the manufacturing plant.

Durability and Designing for Longer Life Expectancy

Designing a high-performance wall considers not only the multiple functions a wall can perform, but also the different life expectancies of those elements that make up the wall. It is important “when designing systems with many components, such as curtain walls, endeavour to make all components equally durable to prevent premature failure of one part of the system.

When possible, provide for easy inspection, maintenance, and/or replacement of less durable components” [Ref. 13]. This approach is especially important in achieving a sustainable building design. Brickwork is extremely durable, having a life expectancy of hundreds of years. Repointing may be required only every 50 years or more. Thus it is important to recognize this fact when detailing those elements that interface directly with brick masonry that have shorter life expectancies or require more frequent maintenance. One example of this is flashing. Some flashing materials, such as stainless steel and copper sheet, have been documented to have a life expectancy of more than 100 years.

Efficient Use of Materials

Multiple Functions.
How a building material is used also should be considered when examining the sustainability of a material. Brick masonry walls are able to perform multiple functions that often require several 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 width can do all of the following:

- Serve as a load-bearing structural element.
- Provide an interior or exterior finish without the need for paints or coatings.
- Provide acoustic comfort.
- Regulate indoor temperatures as a result of thermal mass.
- Provide fire resistance.
- Provide impact resistance from wind-borne debris or projectiles.
- Improve indoor air quality by eliminating the need for paint and coatings (no VOCs).
- Provide a non-combustible material which does not emit toxic fumes in fires.
- Provide an inorganic wall that is not a food source for mould.
- Serve as a heat-storing element in a passive solar design.
- Last for generations.

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

Superior Indoor Air Quality

Avoiding Volatile Organic Compounds.
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). Brick will last a lifetime without costly paints or other maintenance.

Resisting Mould.
Mould is another area of concern for indoor air quality. Brick masonry is not a food source for mould. As a result, it does not promote mould growth, even if wetted, and is easily cleaned if needed. Other interior wall materials can be literally eaten up by mould if moisture problems occur.

Interior brick paving can be used in lieu of carpeting in high-traffic areas, thereby reducing indoor VOC content associated with carpet and adhesives and eliminating the need for regular replacement of flooring.

Brick Recycling and Reuse

Brick can be recycled in many ways. Raw brick and fired brick are recycled in the manufacturing process. Scrap brick and brick from demolition can be crushed as brick chips for landscaping (see Photo 3). Recycled brick also can be used as subbase material for pavements, on quarry roads or even as aggregate for concrete.

Brick also can be reused. Individual brick units can be salvaged and reused with proper precaution. Sand-set brick pavers are the easiest to reuse because they are easily removed and typically remain physically unaltered. Mortared units, pavers and facing units must be carefully cleaned of old mortar before reuse.

Care must be taken when reusing older brick units, as they may not be as durable as those currently manufactured. Reused brick should be tested to verify that they meet the requirements of the current specification for their intended use. Units that will be laid in mortar must have adequate open pores to ensure proper bonding.

Because of the durability of brick masonry and the historic value often associated with brick buildings, reuse of brick masonry buildings is increasingly popular. By adapting existing structures to new uses, both resources and energy are saved and environmental impacts are reduced. This adaptive reuse of brick masonry buildings is a testimony to the longevity and durability of brick masonry.

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