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Beyond LEED: New Fly-Ash Bricks Reduce Energy and CO_2 Emissions

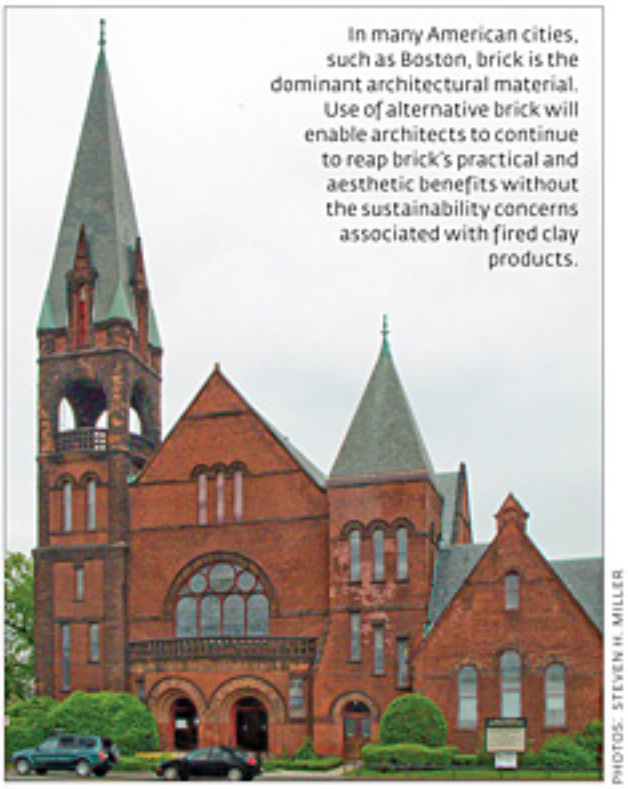
Clay brick masonry has a number of environmentally friendly characteristics, such as durability and thermal mass. Clay can also be mined and processed locally to qualify as a regionally produced material. However, as our collective understanding of environmental science—and especially of climate change—advances, we've had to revise our definition of green building. The manufacturing of building materials is responsible for about 12% of all carbon dioxide (CO_2) emissions. Manufacturing of energy-intensive building materials is going to be subject to EPA-mandated energy audits. As manufacturers re-engineer their processes to use less energy, architects will have to reassess the materials they specify to stay environmentally competitive.

A new masonry material, fly-ash brick (FAB), has been developed to provide the traditional benefits of brick masonry while significantly reducing the energy consumed and CO_2 emitted in brick production. Why consider fly-ash brick? Clay bricks are energy-intensive to manufacture because clay only becomes hard and durable when it is fired for up to three days in kilns operating at about 2000°F. These kilns generally are kept hot even when they are not in use, and are shut down only for maintenance. The heat for most kilns is generated by burning natural gas. Other brick producers use fuels that are not as clean-burning as gas: The largest brick manufacturer in North America burns coal exclusively, and two plants have used CO2-intensive petroleum coke. All of these fuel sources emit significant CO_2 during combustion.

An increasingly important way to measure a product's environmental impact is to audit its embodied energy and CO_2—the amount of energy consumed and CO_2 released to extract, transport and process raw materials and manufacture the finished product. The National Institute for Standards and Technology's (NIST) Building for Environmental and Economic Sustainability (BEES) database lists the average embodied energy for a common fired clay brick at about 8800 BTUs. At best, a state-of-the-art fired clay brick plant operating at optimal efficiency might be able to reduce this figure to slightly below 5000 BTUs. CO_2 emission is often a by-product of energy consumption; each clay brick fired with fossil fuel releases about 1.3 lbs of carbon dioxide into the atmosphere. By contrast, fly-ash brick prototypes have achieved embodied energy and CO_2 emission levels 85% lower than those of clay brick.

HOW FLY-ASH BRICK IS DIFFERENT

Producing fly-ash brick consumes less energy and emits less CO_2 because it does not require firing to harden the masonry units. Additionally, FAB contains a high percentage of recycled material content. Its principal ingredient is fly ash, a pre-consumer by-product of coal-fired power generation.



In many American cities, such as Boston, brick is the dominant architectural material. Use of alternative brick will enable architects to continue to reap brick's practical and aesthetic benefits without the sustainability concerns associated with fired clay products.

PHOTOS: STEVEN H. MILLER

In the eco-conscious era of LEED, use of fly ash in construction has expanded rapidly; it is used, for example, in concrete, soil stabilization and as filler for paint and plastic. Fly ash is defined in ASTM C 618, Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete as "the finely divided residue that results from the combustion of ground or powdered coal and that is transported by flue gases." It is a powdery substance composed of glassy-smooth particles. Two classes of fly ash are defined by chemical composition. Class F generally contains less than 10% calcium oxide (lime), and is used as a pozzolanic additive to replace some Portland cement in concrete. Class C can contain over 20% lime, giving it both cementitious and pozzolanic properties.

The brick products Calstar will produce will contain 40% recycled Class C fly ash, composed mainly of silicon dioxide, aluminum oxide and lime. The remaining volume includes sand and iron oxide pigments produced from recycled steel. Adding a small amount of water and proprietary additives initiates a chemical reaction between these compounds similar to cement hydration. The brick is compacted in molds and gains strength through this chemical reaction, without the need for firing.

FAB tests to meet or exceed the performance standards in ASTM C 216 Standard Specification for Facing Brick, including the stringent dimensional tolerances for Type FBX architectural facing brick. FAB is also well below the allowable shrinkage limits for concrete brick in ASTM C 55,

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Standard Specification for Concrete Building Brick, which is why architects can use conventional clay brick details instead of the costlier and more complex details required for cement brick. Field trials by professional masons have determined that FAB has good mortar adhesion and is easy to build with using conventional masonry techniques. FAB will be available initially in modular and utility sizes, a smooth surface texture and a palette of six earth tones: deep red, rich brown, natural buff, mustard, charcoal and light rose. In addition to building brick, Calstar produces a line of interlocking pavers made with fly ash.

The pricing of conventional clay brick varies widely, with transportation costs as a significant factor. In the commercial brick market in Chicago, high-quality clay brick typically sells to the masonry subcontractor at $500 to $650 per thousand units; fly-ash brick prices are expected to be competitive with this. The first FAB manufacturing plant will be located in southeastern Wisconsin, close to a power plant that provides a ready supply of fly ash.

FAB BENEFITS FOR NOW & THE LONG-TERM

Clay brick manufacturers have suggested that the high-embodied energy of clay brick should be viewed in the context of the product's durability and "amortized" over the many decades of a building's expected service life. To do so, however, sidesteps the relationship of embodied energy to CO_2 emissions and marginalizes the climate damage done by CO_2 today. A 100-year amortization of climate change is not an option.

More than half of the 72 million tons of fly ash produced annually in the U.S. are now dumped in ponds and landfills. FAB production diverts fly ash from landfills or retention ponds, and binds and immobilizes it into a safe product, thus transforming fly ash from an environmental burden into a useful material. With over 50% of the U.S. electricity grid powered by coal, it may take many decades before energy sources with smaller carbon dioxide footprints can displace coal-fired generation. In the meantime, coal will be burned to generate electricity whether or not the fly ash serves any worthwhile purpose. The beneficial reuse of this industrial by-product clearly contributes to sustainability now. ◻

Brick made from fly ash utilizes a high proportion of recycled content and low CO_2 emission associated with production. Colors are achieved by pigmenting with color-fast mineral oxides.