A Structure as an Electric Battery?

Concrete Block Serves as Electrical Batteries and Sensors

By Peter Roberts

A new class of material has become the focus of much research in the field of cement science and concrete design. *Geopolymers* were initially named by French materials scientist Joseph Davidovits in 1979, who attributed this term to the amorphous to semi-crystalline tri-dimensional alumino-silicates that can be formed at low temperature and short time by alkali reaction with naturally occurring alumino-silicate solid materials – quite a mouthful but a precise representation of the chemistry involved.

Geopolymers create the potential for providing strong, robust, energy-efficient concrete buildings, where the concrete structure itself acts as an electrical battery to store energy and deliver power. These novel batteries can be charged by solar panels, wind turbines, or other renewable energy. The high thermal mass of the building's masonry shell provides passive operation capabilities because the masonry acts as a thermal sink. This heat sink can also be actively controlled with power delivered by the electrical storage capacity of these novel masonry batteries in the event of power loss from the grid. This arrangement provides better management of excess energy by feeding to the grid during peak demands, which has the double benefit of providing increased resiliency and improved energy efficiency.

This technology is featured in the use of novel potassium geopolymeric (KGP) cementitious material to make concrete block and configure this masonry as an energy storage receptacle and a self-sensing structural material. Geopolymers are being explored as a replacement for Ordinary Portland Cement (OPC), whose manufacture is a contributor to greenhouse gases. KGP's piezoresistive properties also allow it to detect stress within a structure for real-time diagnostics. KGP exhibits good ionic conductivity, which can be exploited for electrical storage and power. It has high strength, excellent high-temperature resistance, thermal stability, durability, and is easy to manufacture. This technology holds the potential to address both partial and complete power loss. Once fully developed and tuned, this concept could save up to 100% of a building's energy needs.

Because geopolymers use fly ash as part of their activation process, this novel material can help provide a valuable role for the vast waste repositories of fly ash created by burning coal to fuel electrical powerplants. If fully developed, tuned, and implemented, geopolymers could help turn the liability of fly ash deposits into a valued commodity in geopolymer production.

Electrical batteries currently serve as a component of some Distributed Energy Resource (DER) systems that are deployed to help provide a more robust energy distribution system. DER is a tactic used increasingly across the U.S. to provide increased resilience for buildings in the face of widespread electrical outages, which have become more frequent and prevalent in the wake of severe weather events. For example, the National Oceanic and Atmospheric Administration report "2017 U.S. billion-dollar weather and climate disasters: a historic year in context" listed 16 separate billion-dollar extreme weather event disasters in the U.S. resulting in power loss to significant portions of various communities. Currently, battery-based DER systems exist as a separate component from the building which they serve and occupy a significant footprint within the building. In other words, they are in the way of building occupants. The concrete block system places batteries within the structural wall of the building, out of the way of building occupants.

This innovation is expected to have a significant impact on efficiency and safety of buildings, on the efficiency and resiliency of the power grid, on reducing greenhouse gases produced by OPC, of finding a valuable use for fly ash waste, and in providing safe, secure, resilient homes and buildings. By creating affordable, easy-to-use concrete blocks as a distributed component of the evolving new smart power grid, customer acceptance is expected to be easy and adoption rapid for a large market segment.▪

*Peter Roberts, President, Spherical Block LLC, has been developing topological manufactured concrete block for roofing and complete building envelopes for over 30 years. (**roberts.peter01@gmail.com**)*