PROJECT FACTS

UNIVERSITY OF KENTUCKY
CENTER FOR APPLIED ENERGY RESEARCH

The Fabrication of Value-Added Cement Products from Circulating Fluid Bed Combustion Ash

PARTICIPANTS

UK Center for Applied Energy Research
UK Department of Civil Engineering
East Kentucky Power Cooperative

SPONSORS

Ky. State Dept. of Energy Dev. and Independence (Formerly Governor's Office of Energy Policy)

PROJECT VALUE

State: $227,482
Industry: $100,000
UK: $122,746

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Portland cement is the most ubiquitous construction material used. More than 1.54 billion tons were consumed worldwide in 2000. It is energy intensive to form and mill, and large quantities of CO_2 are emitted from its principal component, the limestone calcination.

Low CO_2 generating calcium sulfoaluminate-belite cement (CSAB) can be made from calcium sulfate, limestone and aluminum-rich materials. Thus, CSAB potentially can be produced from calcium sulfate and lime sources, like spent bed ash from fluidized bed combustion (FBC), which would result in lower CO_2 emissions versus Portland cement manufacture.

Our objective was to provide the technical basis to support developing CSAB-based concrete in the US. CSAB differs from Portland cement in that the initial cementitious component formed is ettringite, a hydrous calcium sulfoaluminate. Belite (dicalcium silicate) can provide longer-term strength. CSAB concrete can be generated with strength comparable to Portland cement concrete, however questions remain about its handling, workability and durability for Ready Mix concrete.

Our research was divided into two phases. In the first phase we formulated small batches of CSAB clinker using FBC ash, limestone, bauxite and Class F fly ash as the raw materials. FGD gypsum was used to "activate" the clinker hydration. These small batches of cement were examined for cement phases present and hydration reactivity. Based on these results, larger batches of CSAB cement were produced for mortar testing. The CSAB mortar tests included set time, compressive strength development, dimensional stability, and susceptibility to carbonation.

The study found that CSAB cements could be produced using FBC ash and FGD gypsum as principle ingredients, in quantities as high as 40% by weight of the cement. The use of Class F fly ash as a raw material generally caused large amounts of belite to form in the clinker, which did not react appreciably even after 6 months hydration. The CSAB cements hydrated and gained strength rapidly and exhibited excellent expansion characteristics and drying shrinkage. Milling Class F fly ash with the CSAB clinker as a process addition, along with the FGD gypsum activator, improved the overall dimensional stability of the cement but did not contribute to strength development.

The use of FBC ash and FGD gypsum as raw ingredients in CSAB cement production imparts a low energy requirement and CO_2 emission compared to Portland cement production. However, bauxite was still a necessary ingredient, which would increase cost significantly. Future research will therefore focus on substitution of bauxite with alumina- and iron-rich waste materials such as red mud.