PROJECT FACTS

UNIVERSITY OF KENTUCKY
CENTER FOR APPLIED ENERGY RESEARCH

Superpozzolanic Concrete for Sustainable Construction and CO_2 Emissions Reduction

PARTICIPANTS

UK Center for Applied Energy Research
UK Department of Civil Engineering

SPONSORS

Kentucky Science and Engineering Foundation

PROJECT VALUE

KSEF: $83,943
UK CAER: $85,793

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Ultrafine pozzolans, such as silica fume and air-classified fly ash, have been used for years in the production of high-performance concrete, although their high cost and limited supply has kept usage relatively low. Ongoing research at the University of Kentucky has found that ultra-fine fly ash can be produced from ponded coal ash using a hydraulic classification technology. The enormous supply of stored ash in Kentucky and elsewhere, combined with a relatively simple technology, could result in much lower cost "superpozzolans" if the demand develops. In this study the pozzolanic properties of ultra-fine fly ash, which is produced from ponded fly ash, was examined with the objective of maximizing the replacement of Portland cement in concrete with fly ash. To accomplish this, the properties of mortar and concrete, both in the fresh and hardened state, have been tested. Also, experiments designed to better understand the pozzolanic reactivity of the ultra-fine fly ash have been conducted.

Research on fly ash mortar has indicated that ultra-fine ponded fly ash is very reactive and rapidly forms cementitious material that increases the mortor's compressive strength at early and late ages. The fine size and spherical nature of the ash provides 7-9% water reduction, which also contributes to higher strengths. In concrete the water reduction and early strength results were not as dramatic as with mortar; water reduction was approximately 6%, and the fly ash concrete required 2-3 weeks to achieve control strength. However, the ultra-fine fly ash did dramatically lower concrete permeability, which can improve durability. The fine particle size of the fly ash caused an increase in the quantity of air entraining admixture (AEA) required to achieve a specified air content, although the carbon in the ash appears to have little influence on the AEA dosage. This result was unexpected because unburned carbon is usually responsible for the higher AEA dosages required in concrete when fly ash is used. Analytical techniques, titration, and thermogravimetric analysis indicated that the ultra-fine ash consumes calcium hydroxide in the cementitious "paste" at a faster rate than standard Class F fly ash, which suggests that the ultra-fine ash is effectively forming additional cementitious material. Research indicates that ultra-fine fly ash produced from ponded ash can potentially be used to produce high performance concrete at competitive costs.