Florida Department of Transportation Research

Development of Calcined Clays as Pozzolanic Additions in Portland Cement Concrete Mixtures

November 2018

Project Number
BDV25-977-38

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Current Situation

Concrete is certainly one of the most widely used construction materials. Extensive studies aimed at improving concrete's strength and durability have identified a number of supplementary cementitious materials (SCMs) that can improve the performance of concrete. In Florida, the most common SCM is Class F fly ash, produced by the burning of certain types of coal. Because coal is widely used in U.S. power plants, Class F fly ash has been relatively cheap and abundant. As natural gas and other energy sources displace the use of coal in power generation, the supply of Class F fly ash is expected to decrease, and a good substitute is needed which is also abundant and inexpensive.

This barren landscape is actually a Florida sand mine. The layers of clay that are often removed to expose the sand may find a new use in making cement.

Research Objectives

Recent studies have shown that certain clays can be altered to become effective SCMs. In this project, University of South Florida researchers examined a number of Florida clays to determine if they could be used in this way.

Project Activities

Clays for evaluation in the project were obtained from nine clay pits throughout Florida. Of 20 samples collected, 11 were chosen for further study. After separating the sand and clay components in the selected samples, the clay components were analyzed using X-ray techniques for their chemical and mineralogical composition. The oxide content of the clay samples was of particular interest, including oxides of silicon, aluminum, and iron that are important for effective SCMs. All the clay samples were found to have sufficient amounts of these oxides, with low sulfur oxide levels, to be useful as SCMs.

In order to transform the clays into SCMs, the materials are heated, usually in the range of 500°F to 800°F, which causes critical changes in the chemical makeup and structure of the clays. The researchers subjected the samples to step-wise temperature studies to determine how much heat treatment was needed to convert the clays into SCMs. They found that at 600°C (1,100°F), the transformation was complete in all the studied clays. X-ray techniques used to monitor the step-wise process showed no additional changes when the samples were heated to 800°C.

Cement was made using each treated clay as 10% of the constituent materials. The researchers examined the mineral content of the cement and the cement's strength. Because cement cures and strengthens over time, mortar compressive tests for strength were conducted after seven days and again after 28 days. Strength testing showed that cement containing 10% of the treated clay met standard requirements. Based on the positive results of this short-term study, the researchers recommended long-term studies to examine the strength and durability of cement made with treated clay SCMs.

Project Benefits

This project creates a new possibility for making strong and cost-effective concrete from locally sourced Florida materials.

For more information, please see www.fdot.gov/research/.