



Analysis of Performance of Cements and Pozzolans

Description The Geotechnical and Structures Laboratory (GSL) conducts analyses of the performance of cements and pozzolans to assist Corps of Engineers projects with concrete construction and compliance testing. Because standard specifications often do not cover the problems encountered with these materials (alone and in combination with other materials, such as admixtures), specialized knowledge is often necessary to ensure successful concrete construction.

Capabilities GSL expertise includes state-of-the-art knowledge of cements and pozzolans and specialized laboratory investigations to analyze the causes of their poor performance in concrete. These investigations enable Corps project engineers to address concrete construction issues related to premature, false, and delayed setting; interactive reactions of additives; and heat of hydration.

Supporting Technology In addition to equipment and methodology for testing cements and pozzolans for standard properties, calorimetric techniques and modified standard test methods have been developed for executing a detailed analysis of early-hydration reactions in cementitious materials. Cement hydration reactions in cements and pozzolans are sometimes affected by interactions among concrete materials in such a way as to result in unusual early behaviors that are not detectable by standard methods. These behaviors include loss of workability, as well as highly accelerated or highly retarded setting times.



Calorimetry instrumentation for analyzing cement reaction rates and effects of admixtures

Benefits This expertise helps ensure the satisfactory long-term performance of cements and pozzolans by verifying compliance with standard specifications. Application of this expertise also prevents costly construction delays--by analyzing the cause of nonperformance problems not covered by standard specifications and developing case-specific solutions. In contrast, a lengthy work stoppage to resolve such problems could potentially result in multimillion-dollar claims against the project.

Success Stories Standard specification-compliance testing has detected unsuitable materials in many civil works structures. Notable examples are listed below.

- GSL researchers identified an interaction between Class C fly ash and portland cement that causes early stiffening in concrete. This early stiffening causes concrete to be very difficult to place and consolidate, resulting in severe losses in productivity and wasted materials during construction. This interaction was identified at Old River Auxiliary Control Structure, Red River Lock and Dam (L&D) 4 and 5, Olmsted L&D, and Montgomery Point L&D. Using their capability to analyze cement hydration reactions,

GSL researchers identified combinations of materials and placing conditions to minimize this problem. Contractor claims of several million dollars could result if such problems are not resolved.

- At Red River L&D 3 and at Cooper Lake, early stiffening reactions due to an interaction between the portland cement and the water-reducing admixture were identified. Based on a rapid screening of a variety of admixtures, ERDC team members identified products that would not cause the adverse reaction in the cement in use at the project.
- At McAlpine L&D, GSL researchers identified a highly unusual three-way interaction among fly ash, cement, and admixture in noncritical concrete that caused a delay of more than 3 weeks in time of setting. Had this phenomenon occurred during a critical phase of construction, it could have been very expensive to resolve.
- Using standard and modified standard techniques for the analysis of ASR (alkali-silica reaction), an unusual expression of ASR at the Fort Campbell, KY, was investigated. The ASR was causing expensive and continuing airfield repairs within 5 to 10 years after construction. Repair costs for airfield pavements had totaled nearly \$1 million. Recommendations on materials to be used in new concrete are expected to extend the service life of the concrete by at least 20 years.

Point of Contact

Toy S. Poole
601-634-3261, fax 601-634-2873
Toy.S.Poole@erdc.usace.army.mil