Technical Report Documentation Page

1. Report No. FHWA DTFH61-01-X-00042 (Project 3) IHRB Project TR-484	**2. Government Accession No.**	**3. Recipient's Catalog No.**
4. Title and Subtitle Materials and Mix Optimization Procedures for PCC Pavements		**5. Report Date** March 2006 **6. Performing Organization Code**
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12. Sponsoring Organization Name and Address Federal Highway Administration U.S. Department of Transportation 400 7th Street SW, HIPT-20 Washington, DC 20590 Iowa Highway Research Board Iowa Department of Transportation 800 Lincoln Way Ames, IA 50010		**13. Type of Report and Period Covered** Final Report **14. Sponsoring Agency Code**
15. Supplementary Notes Visit www.ctre.iastate.edu for color PDF files of this and other research reports.		

16. Abstract

Severe environmental conditions, coupled with the routine use of deicing chemicals and increasing traffic volume, tend to place extreme demands on portland cement concrete (PCC) pavements. In most instances, engineers have been able to specify and build PCC pavements that met these challenges. However, there have also been reports of premature deterioration that could not be specifically attributed to a single cause. Modern concrete mixtures have evolved to become very complex chemical systems. The complexity can be attributed to both the number of ingredients used in any given mixture and the various types and sources of the ingredients supplied to any given project. Local environmental conditions can also influence the outcome of paving projects.

This research project investigated important variables that impact the homogeneity and rheology of concrete mixtures. The project consisted of a field study and a laboratory study. The field study collected information from six different projects in Iowa. The information that was collected during the field study documented cementitious material properties, plastic concrete properties, and hardened concrete properties. The laboratory study was used to develop baseline mixture variability information for the field study. It also investigated plastic concrete properties using various new devices to evaluate rheology and mixing efficiency. In addition, the lab study evaluated a strategy for the optimization of mortar and concrete mixtures containing supplementary cementitious materials.

The results of the field studies indicated that the quality management concrete (QMC) mixtures being placed in the state generally exhibited good uniformity and good to excellent workability. Hardened concrete properties (compressive strength and hardened air content) were also satisfactory. The uniformity of the raw cementitious materials that were used on the projects could not be monitored as closely as was desired by the investigators; however, the information that was gathered indicated that the bulk chemical composition of most materials streams was reasonably uniform. Specific minerals phases in the cementitious materials were less uniform than the bulk chemical composition. The results of the laboratory study indicated that ternary mixtures show significant promise for improving the performance of concrete mixtures. The lab study also verified the results from prior projects that have indicated that bassanite is typically the major sulfate phase that is present in Iowa cements. This causes the cements to exhibit premature stiffening problems (false set) in laboratory testing. Fly ash helps to reduce the impact of premature stiffening because it behaves like a low-range water reducer in most instances. The premature stiffening problem can also be alleviated by increasing the water–cement ratio of the mixture and providing a remix cycle for the mixture.

17. Key Words cementitious materials—concrete mixtures—portland cement concrete		**18. Distribution Statement** No restrictions.	
19. Security Classification (of this report) Unclassified.	**20. Security Classification (of this page)** Unclassified.	**21. No. of Pages** 107	**22. Price** NA

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