Development and Demonstration of high-carbon CCPs and FGD By-products in Permeable Roadway Base Construction

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Report No. CBU-2002-02

ABSTRACT

This report summarizes the work completed during the period from October 1, 2001 through December 31, 2001 as well as reports all of the work completed during the first year of the project. During this period, testing and evaluation work pertaining to Task 3 of the project, "Testing and Evaluations," was completed through the age of 182 days with the exception of Series 9 permeable base course mixtures incorporating fly ash sources FGD-1 and FGD-2. Long-term testing related to Tasks 3 is in progress.

The laboratory evaluation completed to-date is composed of two parts. The first describes experimental work related to characterization of constituent materials. The second part deals with development of mixture proportions, and manufacturing and testing of mixtures for base course materials. Currently, experimental work is in progress pertaining to long-term testing of second part of the investigation. Constituent materials of the permeable base mixtures (fine aggregate, coarse aggregate, cement, and CCPs) were tested and evaluated using applicable ASTM standards or other applicable standards. Three sources of CCPs (FGD-1, FGD-2, and FGD-3) were selected for this investigation. FGD-1 and FGD-2 contained high levels of sulfite/sulfates and therefore did not meet the ASTM C 618 requirements for coal fly ash for use as mineral admixtures in concrete. FGD-3 conformed to the ASTM C 618 requirements for Class C fly ash. Both FGD-1 and FGD-2 contained high amounts of sulfate and unburned carbon as measured by loss on ignition (LOI).

Mixture proportions for the base course materials were developed and optimized using a two-step process. The first step involved developing mixture proportions for permeable base course materials without CCPs. The optimum mixtures developed from the first step of the experimental process were used for developing mixture proportions for the second step of the optimization process. The second step of the mixtures included various combinations of CCPs for developing mixtures for base course materials.

Experimental work pertaining to the first step of optimization has been completed. To date, a total of 56 concrete mixtures have been proportioned, manufactured, and tested in nine different series of experiments. Of these, 26 mixtures were proportioned for the first step of optimization. All concrete mixtures were tested and evaluated for fresh and hardened concrete properties using applicable ASTM standards. The fresh concrete properties measured were air content, unit weight, and temperature. Ambient air temperature was also recorded.

For the first step of optimization, hardened concrete properties measured were density and compressive strength. For this step of investigation, the effects of amount of cement and water to cementitious materials ratio on the performance of permeable base course mixtures were also investigated. Based on the compressive strength results, three

candidate mixtures were selected which formed the basis for mixture proportioning for the second step of optimization.

For the second step of the optimization process, a total of 30 mixtures were proportioned using FGD-1, FGD-2, and FGD-3. Three series of mixtures were developed, one open-graded base course structure (Series 7), one intermediate-graded (Series 9), and one dense-graded (Series 8) base course structure. Each series of mixtures incorporated all three sources of CCPs material used for this project. Mixtures for the intermediate-graded base course have been completed over the last quarter. Long-term evaluation of the open-graded and dense-graded series mixtures are currently in progress while testing of the intermediate-graded base course will also continue into the next quarter. Each mixture is being tested for strength and durability-related properties. The strength properties include compressive strength, tensile strength, and flexural strength. These properties are being measured as a function of time up to the age of one year. The durability-related properties include shrinkage, sulfate resistance, and freezing and thawing resistance. Freezing and thawing testing is expected to be completed over the next quarter, while long-term testing of shrinkage and sulfate resistance will continue over the next two quarters.