Period Covered: April 1 through June 30, 2006 (Quarterly Report)

KSDOT Progress Report
for the

State Planning and Research Program

PROJECT TITLE: Construction of Crack-Free Concrete Bridge Decks		
PROJECT MANAGER: Richard L. McReynolds, P.E.	Project No: TPF-5(051)	Project is: ____ PLANNING ___X__ RESEARCH & DEVELOPMENT
Annual Budget	**Multi Year Project Budget** $950,000	

Progress:

Construction Activities

The trial batch (5/31/06) and trial slab (6/8/06) were cast and a meeting (6/12/06) to discuss the trial slab occurred for the second LC-HPC bridge cast in Kansas. The work is being performed by a different contractor than the firm responsible for the other six LC-HPC bridges that have been let in Kansas. Kansas DOT provided feedback that the trial slab was an important learning tool for this project to ensure specification compliance for the deck construction. Cores from the trial deck indicate that large coarse aggregate particles remain near the top surface of the deck and are not worked away from the surface during finishing operations. Construction of the second LC-HPC bridge deck in Kansas occurred on June 24, 2006 with participation of the KU research team.

The trial slab was cast for the third LC-HPC bridge in Kansas on May 24, 2006. This was the fourth experience (two trial slabs and two placements on the first bridge) for this contractor operating under the LC-HPC specifications, and performance has improved with each experience. Cores from this deck also indicate that large coarse aggregate particles remain near the top surface.

Changes to the specifications have been made based on trial slab and bridge construction observations. These changes include: requiring grinding of hardened concrete for the entire deck surface, requiring the barriers, as well as the deck, to be constructed using LC-HPC, and clarifying that the trial batch (6 yd^3) and trial slab must meet specifications, be qualified, and are not for practice.

Crack surveys were preformed as an initial 6-month check for the first LC-HPC bridge deck and companion control bridge deck in Kansas. Due in part to the near ideal weather conditions at time of construction, both Kansas decks showed virtually no cracking at this early age. A one-year crack survey was preformed on a second control bridge in Kansas. Cracking was evident.

Laboratory Activities

Work continues in the materials laboratory. Specimens were cast to determine the effect of mineral admixtures on drying shrinkage and strength. For this series, the total paste volume and water-cement ratio were held constant (equivalent to 535 lb/yd^3 of cement with a 0.42 water-cement ratio) by adjusting the water content for different volume replacements for cement. Specimens cast for each mix were cured for either 7 or 14 days. Binary mixtures cast during the last quarter include batches with 20 and 40% replacements of cement with Class F fly ash, 30 and 60% replacements with Grade 120 GGBFS, and 3 and 6% replacements with silica fume. Based on preliminary results from this series, additional binary mixtures were cast in the current quarter. They include mixtures with an 80% replacement of cement with Grade 120 GGBFS, a 60% replacement with Grade 120 GGBFS, a 60% replacement with Grade 100 GGBFS, and 3

and 6% replacements with silica fume obtained from an additional source.

In addition to the mineral admixture series, free-shrinkage, strength, and permeability specimens were cast for concrete with water-cement ratios ranging from 0.36 to 0.42 to determine the effect of water-cement ratio on combined drying and autogenous shrinkage, strength, and permeability. For this series, the paste content was again held constant (equivalent to 535 lb/yd^3 of cement with a 0.42 water-cement ratio).

Finally, a series of free-shrinkage and strength specimens to determine the effect of three different aggregate types (limestone, granite, and quartzite) on drying shrinkage and strength were cast. This series included concrete with a reduced the cement content (497 lb/yd^3 at a water-cement ratio of 0.42) to maximize the aggregate content, along with companion specimens (with paste content equivalent to 535 lb/yd^3 of cement and a water-cement ratio of 0.42) containing 60% GGBFS.

Results

The free-shrinkage study comparing mixtures with a shrinkage reducing admixture (535 lb/yd^3 of cement, 0.42 water-cement ratio, and 8 ± ½ percent air content) indicate significantly decreased shrinkage compared to control mixtures. The effect is more pronounced as the dosage rate is increased.

Preliminary results for the free-shrinkage study to evaluate binary concrete mixtures using Grade 120 GGBFS (30, 60, and 80% replacements), Grade 100 GGBFS (60% replacement), Class F fly ash (20 and 40% replacements) and silica fume (3 and 6% replacements) indicate that silica fume and both grades of GGBFS decrease shrinkage with increased levels of replacement. These results are more pronounced for specimens cured for 14 days and are especially evident for the 60 and 80% slag mixtures. All of the mixtures exhibited good cohesiveness and workability.

Project Personnel: David Darwin (Principal Investigator), JoAnn Browning (Co-Principal Investigator)

SUMMARY OF ACTIVITIES EXPECTED TO BE PERFORMED NEXT QUARTER:

The third LC-HPC bridge deck in Kansas and the second control bridge deck in South Dakota will be cast in the next quarter. Current LC-HPC specifications will continue to be reevaluated based on the latest field and laboratory results.

The eighth, ninth, and tenth LC-HPC bridge decks in Kansas will be let during the next quarter.

Binary and ternary concrete mixtures using slag, silica fume, and shrinkage reducing admixtures will continue to be developed in the laboratory and compared with our current LC-HPC concrete mix design (535 lb/yd^3 cement, 0.42 w/c, and 8 ± ½ percent air content). In addition to free shrinkage and strength, permeability specimens will be cast for mixes demonstrating low shrinkage. New sources and types of fly ash, including fly ash with gypsum to mitigate increased shrinkage, will be included. Based on the preliminary results of ongoing tests, focus will continue be placed on mixtures with higher levels of GGBFS.

Sampling and testing of the permeability specimens cast for the cement type/water-cement ratio/curing time study will continue.

STATUS AND COMPLETION DATE

Percentage of work completed to date for total project is: 65%

___X___ on schedule _____ behind schedule, explain:

Expected Completion Date: _____March 31, 2008