Period Covered: January 1 through March 31, 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

A post construction meeting was held with KDOT and the contractor for the first LC-HPC bridge cast in Kansas. Key items of discussion included: finishing the deck surface with a bull float without using fogging as a finishing aid, grinding the entire deck surface instead of spot grinding, and protecting the deck from freezing during the entire curing period. The contractor and KDOT provided positive feedback regarding the concrete mixture noting that it was very workable, pumpable and once the temperature was controlled, only a couple tests did not meet the specification.

Changes to the specifications have been made based on construction observations from the first two placements of LC-HPC decks and laboratory observations. These changes include: a reduction in the water-cement ratio from 0.45 to 0.42, reducing the maximum cement content from 564 to 535 lb/yd^3, and clearly specifying that fogging is not to be used as a finishing aid.

Laboratory and Other Activities

Work continues in the materials laboratory. A series of free-shrinkage specimens to determine the effect of mineral admixtures on drying shrinkage is being cast using Class F fly ash, ground granulated blast furnace slag (GGBFS), and silica fume. Two replacement levels were examined for each type of mineral admixture while keeping the total paste content and water-cement ratio constant (equivalent in volume to 535 lb/yd^3 of cement with a water-cement ratio of 0.42). The binary blends include a 20 and 40% replacement of cement with Class F fly ash, 30 and 60% replacement with GGBFS, and 3 and 6% replacement with silica fume.

In addition to the mineral admixture series, free-shrinkage specimens were cast using three samples of cement with varying fineness. The Blaine fineness for the three samples currently being tested range from 3230 to 3790 cm^2/g. The chemical composition for these cement samples has also been determined and will help provide additional guidance in determining the suitability of coarse-ground cement for use in LC-HPC bridge decks.

Finally, a series of free-shrinkage and strength specimens to determine the effect of shrinkage reducing admixtures (SRAs) has been completed. Shrinkage reducing admixtures have been examined previously and were found to significantly reduce shrinkage. For this series, the water-cement ratio was reduced from 0.45 to 0.42, and the cement content was decreased from 630 to 535 lb/yd^3 to match the prototype LC-HPC bridge deck mix.

Results and Analysis

The free-shrinkage study to determine the effect of superplasticizers (HRWRs) on free-shrinkage continues to be monitored. For this study, specimens with a three inch slump were cast using three different HRWRs and compared with a control mix in which the paste content was increased (by increasing cement and water contents at a constant water-cement ratio) to obtain the desired slump. The results continue to show little difference between specimens cast with HRWRs and the control mix, indicating that the HRWRs increase free shrinkage for constant paste content, but that, from a practical point of view, there is no effect.

The free-shrinkage study comparing mixtures with a shrinkage reducing admixture (535 lb/yd^3 of cement, w/c = 0.42, and 8 ± ½ percent air content) indicate significantly decreased shrinkage. While significantly decreased shrinkage has been observed, further evaluation with different dosage rates is needed due to difficulties with the fresh concrete properties.

Preliminary results for the free-shrinkage study to evaluate binary concrete mixtures using GGBFS (30% and 60% replacement) and Class F fly ash (20% and 40% replacement) and silica fume (3% and 6% replacement) indicate that GGBFS decreases shrinkage with increasing replacement levels. These results are more pronounced for specimens cured for 14 days. Specimens containing class F fly ash, at both levels of replacement, have a higher initial shrinkage rate during the first 30 days as compared to the prototypical LC-HPC control mix, as did earlier mixes containing Class C fly ash. An analysis of the silica fume used for this study indicates that the material is much coarser than expected. As a result, the silica fume mixes will be rebatched using silica fume that is more representative of what is normally seen in practice.

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

SUMMARY OF ACTIVITIES EXPECTED TO BE PERFORMED NEXT QUARTER:

Crack surveys will be performed on the first LC-HPC bridge deck and the control deck in April. Two more bridges and their accompanying trial slabs are also scheduled for the next quarter, one near Kansas City and one northwest of Topeka.

Binary and ternary concrete mixtures using slag and silica fume will continue to be developed in the laboratory and compared with our current LC-HPC concrete mix design (535 lb/yd^3 cement content, w/c = 0.42, and 8 ± ½ percent air content). Based on the preliminary results of ongoing tests, focus will be placed on mixtures with higher levels of GGBFS and mixtures using GGBFS containing from different sources.

Investigation will continue for mixtures containing SRAs. Multiple dosage rates and mixes containing both mineral admixtures and SRAs will be evaluated.

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: 60%

__X__ on schedule _____ behind schedule, explain:

Expected Completion Date: March 31, 2008