Period Covered: October 1 through December 31, 2005 (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

Activity this quarter continued to focus on construction of Low-Cracking High Performance Concrete (LC-HPC) Bridge Decks in Kansas. The following placements were completed:

- LC-HPC Bridge 1 Placement 1 completed on 10/14/2005 for bridge K-6371-01 EB Parallel Pkwy over I-635.
- LC-HPC Bridge 1 Placement 2 completed on 11/2/2005 for bridge K-6371-01 EB Parallel Pkwy over I-635.
- SFO control bridge K-6371-01 WB Parallel Pkwy over I-635 completed (control deck, 2 placements).

Changes to the KDOT specifications were made based on construction observations from the first two placements of LC-HPC decks and results from laboratory work. These changes include: a reduction in the maximum 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.

A pre-bid conference for a LC-HPC bridge deck in Jackson County, Kansas was held on October 10, 2005.

Laboratory and Other Activities

Work continues in the materials laboratory. A series of free-shrinkage specimens to determine the effect of coarse aggregate type on shrinkage were cast using three aggregate types: granite, quartzite, and limestone. This series was repeated with some changes from previous aggregate evaluations that were inconclusive. The changes include the addition of an air entraining agent to obtain an air content of 7 ± ½ percent. The water-cement ratio remained constant at 0.45, but the cement content was decreased from 630 to 535 lb/yd^3 to represent a prototypical LC-HPC bridge deck mix.

A series of trial batches were started to determine the lowest paste content feasible for bridge deck placement with the addition of mineral admixtures. Initial binary and ternary blends include the use of silica fume at a 3% replacement of cement by volume and ground granulated blast furnace slag (GGBFS) at a 25% replacement of cement by volume. Class F fly ash will also be included in the evaluation at an initial cement replacement of 25% by volume. Strength and workability characteristics are being used as the initial measure of acceptance, with additional permeability and free-shrinkage tests planned to determine optimum blends of the cementitious materials. Workable mixtures with adequate strength have been achieved with paste volumes as low as 20.75% (equivalent to 474 lb/yd^3 of cement with a 0.42 water-cement ratio).

A cost estimate was completed for the use of liquid Nitrogen for cooling concrete on Bridge 43-033 Co Rd 150 over US-75.

To date, the results from the 3rd quarter free-shrinkage series to determine the effect of superplasticizers on free-shrinkage while maintaining a constant slump indicate no significant change in shrinkage with the use of superplasticizers (HRWR). In these tests, the paste content for the control mix was increased (by increasing cement and water contents at the constant water-cement ratio) to obtain the desired slump.

The results from the free-shrinkage tests examining different coarse aggregate types indicate that concrete made with limestone has the greatest shrinkage followed by concretes made with quartzite and granite. A statistical study is currently underway and will be completed during the next quarter to aid in identifying significant differences in shrinkage.

The free-shrinkage study comparing two cement types (Type I/II and Type II coarse ground), three water-cement ratios (0.45, 0.43, and 0.41) obtained by reducing the water content of the mix, and two curing periods (7 and 14 days) continues to be monitored. Permeability specimens cast as a part of this study have just finished the 90-day ponding cycle and are ready for sampling. Preliminary results indicate that increasing the curing period from 7 to 14 days, in addition to the anticipated improved permeability, decreases shrinkage for both cement types and each water-cement ratio examined. In addition, decreasing the water-cement ratio, and thus the paste content, significantly decreases shrinkage and is anticipated to result in lower concrete permeability. For these reasons, a maximum water-cement ratio of 0.42 has been incorporated into the current KDOT LC-HPC concrete specifications.

The aggregate optimization and concrete mix design Excel workbook, KU Mix 1.0 Beta 1, was released to KDOT for evaluation. Adjustments and subsequent releases of KU Mix will be made as necessary. A copy of this program was sent by email to all participating state representatives.

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

SUMMARY OF ACTIVITIES EXPECTED TO BE PERFORMED NEXT QUARTER:

A post construction meeting will be held with KDOT and contractor for the K-6371-01 EB Parallel Pkwy over I-635 bridges.

Binary and ternary concrete mixtures using slag, Class F fly ash, and silica fume will continue to be developed in the lab to supplement the current prototypical LC-HPC concrete mix design (535 lb/yd^3 cement, 0.42 w/c, and 8 ± ½ percent air content).

Chemical analysis will be performed on the silica fume, slag and Type F fly ash, and a new shipment of Type II coarse ground cement. Pending the results of a cement analysis, additional laboratory work is planned to evaluate concrete mixes made with Type II coarse-ground cement.

The effect of curing compounds and post-applied shrinkage reducing admixtures on free-shrinkage, as well as shrinkage rate, will be examined.

STATUS AND COMPLETION DATE

Percentage of work completed to date for total project is: 55%

__X__ on schedule _____ behind schedule, explain:

Expected Completion Date: March 31, 2008