Period Covered: October 1 through December 31, 2008 (Quarterly Report)

KSDOT Progress Report
for the

State Planning and Research Program

PROJECT TITLE: Construction of Crack-Free Concrete Bridge Decks, Phase II		
PROJECT MANAGER: Richard L. McReynolds, P.E.	Project No: TPF-5(174)	Project is: ____ PLANNING ___X__ RESEARCH & DEVELOPMENT
Annual Budget	**Multi Year Project Budget** $975,000	

PROGRESS:

LAB ACTIVITIES:

Work continues in the concrete lab. The effect of long-term curing on free shrinkage specimens containing different types of fly ash is ongoing. Mixes to evaluate these effects include a control mix (with cement only), a mix with a 40% Class F fly ash (volume) replacement of cement (Phase I) and a mix with a 40% Class C fly ash replacement of cement. A new series of free shrinkage specimens were cast this quarter to investigate the combined effect of Class F fly ash and shrinkage reducing admixture (SRA). The new series includes a control batch (cement content of 540 lb/yd^3 and a water-cement ratio of 0.44) and batches that have a 40% Class F fly ash replacement of cement (by volume) with SRA dosages of 0%, 0.5 % and 1% (by weight of cement). All batches have the same paste content on a volume basis as the control batch and a water-cementitious material ratio of 0.44. All specimens were cured for 14 days. The results will be compared with the SRA series cast last quarter, which contained cement and SRA dosages of 0.5% and 1% (by weight of cement).

Tests using restrained shrinkage (ring) specimens with a concrete thickness of 1.125 in. finished this quarter. New restrained ring test specimens with a concrete thickness of 2 in. were cast with high and low-paste content mixes to investigate the sensitivity of the test to thickness. The data acquisition system was modified to be more sensitive to strain changes in the steel rings.

Methods for vacuum saturating lightweight aggregates to obtain high absorption were investigated. The preparation of the lightweight aggregates for mixing was also explored.

LAB RESULTS:

Preliminary results (90-day old specimens) for the Class C fly ash series evaluating the effect of long-term curing show a reduction in concrete shrinkage. The specimens cured for 56 days had the least amount of shrinkage, followed, in turn, by those cured for 28, 14, and 7 days. When the specimens were cured for 7 days or 14 days, the fly ash mixtures shrank more than corresponding control mixtures. This is consistent with the results from Phase I. When the specimens were cured for 28 days, the concrete containing fly ash had slightly more shrinkage than the corresponding control batch, but shrank less than the control batches which were cured for 7 days and 14 days. When the curing time was increased to 56 days, the fly ash batch had slightly less shrinkage than the control batch cured for 56 days.

The free shrinkage series cast this quarter to evaluate the combined effects of Class F fly ash and an SRA have been monitored for approximately 30 days. The concrete was cured for 14 days. To date, the SRA has reduced shrinkage for the mix containing fly ash. The batch with both fly ash and an SRA shrank less than the control batch (540 lb/yd^3 cement content, 0.44 water-cement ratio), while the batch with only fly ash shrank more than the control batch.

Eight ring specimens with 1.125-in. concrete thickness were cast last quarter and seven of the eight have cracked. Small cracks were visually observed, while no obvious changes in strain gage readings were noted. Seven of the eight ring specimens (2-in. concrete thickness) cast this quarter have also cracked. The batch with high cement content (729 lb/yd^3) cracked earlier than the LC-HPC batch (535 lb/yd^3 cement content). Cracks were both visually observed and monitored by a modified data acquisition system for the high cement content batch. Only one crack was identified using strain gages for the LC-HPC specimens, although other cracks were noted visually.

The air void system tests of the SRA series described in the last quarterly report have concluded. Using ASTM C457, "Test Method for Microscopical Determination of Parameters of Air-Void System in Hardened Concrete," the Kansas Department of Transportation Materials Research Lab observed that all specimens met the air void spacing factor parameter requirement (less than 10 mils or 0.254 mm).

ACTIVITIES PLANNED FOR NEXT QUARTER

Free shrinkage and strength specimens containing lightweight aggregates will be cast. Mixes will include an SSD Granite control, SSD Limestone, and SSD Granite mixes with three levels of aggregate replacement by lightweight fine aggregate (13%, 18%, and 23% by volume). The lightweight aggregate replacement levels were selected to provide 75%, 100%, and 125%, respectively, of the calculated optimum quantity of water needed for internal curing. Additional aggregate will be delivered this quarter (two sizes of aggregate from the same source) to cast new free shrinkage specimens to investigate the effect of lightweight aggregate size on internal curing. Following the series to determine the proper replacement level for internal curing, a series investigating the effects of adding lightweight aggregate to mixes with slag will be cast and compared with mixes containing limestone and slag.

A series of scaling specimens to evaluate the combined effects of Class F fly ash and SRA on concrete durability will be cast. Samples of the hardened concrete from the fly ash with an SRA scaling tests will be analyzed for air void system by the Kansas Department of Transportation according to ASTM C457.

Project personnel will be contacting KDOT and other state transportation departments to discuss potential bridges for inclusion in the Phase II program.

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

STATUS AND COMPLETION DATE

Percentage of work completed to date for total project is: 10%

__X__ on schedule _____ behind schedule, explain:

Expected Completion Date: June 30, 2013