TRANSPORTATION POOLED FUND PROGRAM
QUARTERLY PROGRESS REPORT

Lead Agency (FHWA or State DOT): ____Kansas DOT_____

INSTRUCTIONS:

Project Managers and/or research project investigators should complete a quarterly progress report for each calendar quarter during which the projects are active. Please provide a project schedule status of the research activities tied to each task that is defined in the proposal; a percentage completion of each task; a concise discussion (2 or 3 sentences) of the current status, including accomplishments and problems encountered, if any. List all tasks, even if no work was done during this period.

Transportation Pooled Fund Program Project # *TPF-5(392)*	**Transportation Pooled Fund Program - Report Period:** ☐Quarter 1 (January 1 – March 31) 2019 ☐Quarter 2 (April 1 – June 30) ✕Quarter 3 (July 1 – September 30) ☐Quarter 4 (October 1 – December 31)

Project Title: Construction of Low-Cracking High-Performance Bridge Decks Incorporating New Technology		
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Lead Agency Project ID:	**Other Project ID (i.e., contract #):**	**Project Start Date:** **January 1, 2019**
Original Project End Date: **December 31, 2021**	**Current Project End Date:** **December 31, 2021**	**Number of Extensions:** 0

Project schedule status:

✕On schedule ☐ On revised schedule ☐ Ahead of schedule ☐ Behind schedule

Overall Project Statistics:

Total Project Budget	Total Cost to Date for Project	Total Percentage of Work Completed
$270,000	$61,994.74	24%

Quarterly Project Statistics:

Total Project Expenses This Quarter	Total Amount of Funds Expended This Quarter	Percentage of Work Completed This Quarter
$29,779.93	$29,779.93	12%

Project Description:

Bridge decks constructed using low-cracking high-performance concrete (LC-HPC) have performed exceedingly well when compared with bridge decks constructed using conventional procedures. LC-HPC decks constructed prior to 2016 have included only portland cement as a cementitious material. Four LC-HPC decks were constructed between 2016 and 2018 and include a partial replacement of portland cement with slag cement along with internal curing through a pre-wetted fine lightweight aggregate. All LC-HPC projects used concrete with low cement paste contents and lower concrete slumps, along with controlled concrete temperature, minimum finishing, and the early initiation of extended curing. Methods to further minimize cracking–such as shrinkage-reducing admixtures, shrinkage-compensating admixtures, and fibers–have yet to be applied in conjunction with the LC-HPC approach to bridge-deck construction. Laboratory research and limited field applications have demonstrated that the use of two new technologies, (1) internal curing provided through the use of pre-wetted fine lightweight aggregate in combination with slag cement, with or without small quantities of silica fume, and (2) shrinkage compensating admixtures, can reduce cracking below values obtained using current LC-HPC specifications. The goal of this project is to apply these technologies to new bridge deck construction in Kansas and Minnesota and establish their effectiveness in practice.

The purpose of this study is to implement new technologies in conjunction with LC-HPC specifications to improve bridge deck life through reduction of cracking. The work involves cooperation between state departments of transportation (DOTs), material suppliers, contractors, and designers. The following tasks will be performed to achieve this objective.

Progress this Quarter (includes meetings, work plan status, contract status, significant progress, etc.):

TASK 1: Work with state DOTs on specifications for LC-HPC bridge decks to be constructed over the three-year period of performance of this project.

KU researchers are finalizing the Kansas LC-HPC specifications with KDOT. For the upcoming KDOT LC-HPC project, KU researchers and a KDOT representative held a meeting with the concrete supplier to discuss the mixture proportions, trial batches, and trial placement dates. The construction of this bridge has been delayed until late October. KU researchers will continue working with KDOT and the concrete supplier on determining the lightweight aggregate properties at the ready-mix plant before construction.

Based on experience in placing internally-cured LC-HPC bridge decks in Minnesota, KU researchers had a discussion with MnDOT about the possible adjustments in original mixture proportions based on the lightweight aggregate properties (namely absorption) of the material on-hand at the ready-mix plant to provide the intended amount of internal curing water. For the two decks placed this quarter, arrangements were made between KU, MnDOT, and the concrete suppliers to update mixture proportions based on higher fine lightweight aggregate absorptions than those listed in previously approved mixture proportions.

25% COMPLETE

TASK 2: Provide laboratory support prior to construction and on-site guidance during construction of the LC-HPC bridge decks.

Two internally cured LC-HPC bridge decks were placed in Minnesota this quarter. KU researchers traveled to the concrete ready-mix plants prior to construction to test the lightweight aggregate and provide modifications in the mixture proportions to maintain the desired amount of internal curing water. For both decks, adjustments were made to mixture proportions based on the absorption and specific gravity of the pre-wetted lightweight aggregate. The concrete properties at the construction site for both of the bridges were within MnDOT specifications for slump and air content.

The first bridge deck (Br. 27700) is a pedestrian bridge along 40th St. over I-35W in Minneapolis and was placed on 7/23/2019. The average absorption and the specific gravity of the lightweight aggregate were 27.6% and 1.30, respectively, which differed from the values indicated in original mixture proportions (30.2% and 1.27, respectively). No significant issues arose in concrete placement. The deck was consolidated with a single spud vibrator and was finished with a vibrating screed. Because of the finishing techniques, construction personnel walking through consolidated concrete on the bridge deck prior to finishing. Long delays (up to 2 hours) between finishing, and the application of curing compound occurred. This was due to slow setting of the concrete (caused by the use of a set retarder), which caused the delays in bullfloating, brooming, and applying the curing compound. Based on the trip tickets, the average amount of internal curing water provided was approximately 7.9 lb/cwt. The average water-to-cementitious material ratio (*w/cm*) was 0.41, and paste contents ranged from 25.2% to 25.5%, with an average of 25.3%.

The second bridge deck (Br. 58826) is over I-35 near Pine City and was placed on 9/19/2019. The average values for the absorption and the specific gravity of the lightweight aggregate were 32.9% and 1.20, respectively, which differed from the values provided by the concrete supplier for the original mixture design (27.2% and 1.56, respectively). No significant issues arose during concrete pumping placement or finishing. Based on the trip tickets, the average amount of internal curing water provided by the lightweight aggregate was approximately 7.45 lb/cwt. The average water-to-cementitious materials ratio (*w/cm*) was 0.41 and paste contents ranged from 24.8% to 25.4%, with an average of 25.2%.

25% COMPLETE

TASK 3: Perform detailed crack surveys on the bridge decks. If desired, DOT personal will be trained in the survey techniques and may assist in the surveys, as appropriate.

Crack surveys of bridge decks were conducted on 9/16/2019 on three internally cured LC-HPC and one control bridge deck placed in Minnesota. This was the fourth survey for the bridge decks placed in 2016 and the first survey for decks placed in 2018 and 2019. The crack density for the 2018 deck was 0.005 m/m^2, 16 months after construction, and only included a few short, narrow cracks. The 2016 LC-HPC and control deck were surveyed again to provide results near 36 months after placement and include three summers of drying. No changes in cracking patterns or densities from the June 2019 surveys were observed during the September surveys. A two-month survey on the pedestrian bridge deck in Minneapolis placed this quarter was performed with no cracks found.

25% COMPLETE

TASK 4: Correlate the cracking measured under Objective 3 with environmental and site conditions, construction techniques, design specifications, and material properties, and compare with results obtained on earlier conventional and LC-HPC bridge decks.

0% COMPLETE

TASK 5: Document the results of the study. Provide recommendations for changes in specifications.

0% COMPLETE

Anticipated work next quarter:

KU researchers are planning to be present for the trial placement for the upcoming LC-HPC deck in Kansas. Bridge deck placement is currently scheduled for late-October 2019.

Mixtures using materials from the 2019 Kansas LC-HPC deck, including replications of mixture proportions of the deck will be cast for shrinkage, durability, and permeability testing.

Significant Results this quarter:

Two internally-cured LC-HPC bridge decks were successfully constructed in Minnesota this quarter. The lightweight aggregate used in both bridge decks was from the same supplier as the previous four internally-cured LC-HPC bridge decks in Minnesota; however, material properties (absorption and specific gravity) of stockpiles at the ready-mix plants have shown to be highly variable between projects. Mixture proportions were updated for both decks placed this quarter to maintain the design amount of internal curing water (7 or 8% by total weight of binder). Failure to correctly account for the lightweight aggregate absorption and specific gravity can result in unintended addition or withholding of mix water, which can lead to placement issues on top of a different amount of internal curing water in the concrete.

Materials being used for the upcoming LC-HPC deck in Kansas were obtained and are being tested in the laboratory. Absorption and specific gravity values for the coarse and fine aggregates were within 0.1% of the values provided by the concrete supplier; however, the values for the lightweight aggregate (based on a 72-hour soak time) obtained by KU researchers differed from the concrete supplier. KU researchers found an absorption and specific gravity of 11.4% and 1.62, respectively, whereas the concrete supplier provided values of 13.5% and 1.55.

Crack surveys completed this quarter showed a low crack density for the LC-HPC deck placed in 2018. The pedestrian bridge placed this quarter was surveyed approximately 2 months after placement with no cracks observed during the survey.
Circumstances affecting project or budget. (Please describe any challenges encountered or anticipated that might affect the completion of the project within the time, scope and fiscal constraints set forth in the agreement, along with recommended solutions to those problems). None.