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 #	**Transportation Pooled Fund Program - Report Period:**
TPF-5(392)	☒ Quarter 1 (January 1 – March 31) 2020 ☐ 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	$111,316.52	40%

Quarterly Project Statistics:

Total Project Expenses This Quarter	**Total Amount of Funds Expended This Quarter**	**Percentage of Work Completed This Quarter**
$23,645.68	$23,645.68	7%

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.

Kansas Department of Transportation (KDOT) has identified one internally cured bridge deck for construction in 2020. Another is expected. The bridge deck is located on Montana Rd. over I-35 near Ottawa, KS. The most recent specifications for low-cracking high-performance concrete (LC-HPC) will be used for the construction of this bridge deck. KU researchers suggested a discussion with KDOT officials and the contractor regarding some provisions of the specifications.

In addition to the LC-HPC bridge decks in Kansas, the Minnesota Department of Transportation (MnDOT) has identified two internally cured bridge decks for construction in 2020. They are located in New Hartford Township, MN. KU researchers will work with the concrete suppliers to determine the lightweight aggregate (LWA) properties and share viewpoints on internally cured concrete projects.

50% COMPLETE

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

A series of concrete mixtures are being evaluated at KU lab for shrinkage, freeze-thaw durability, scaling, compressive strength, and permeability. These mixtures have different binder compositions (either 100% portland cement or a ternary binder composition including slag cement and silica fume) and different nominal quantities of internal curing (IC) water provided by pre-wetted lightweight aggregate (LWA) equal to 0, 7, and 9% by weight of binder. An additional ternary series is being tested to evaluate the effects of total internal water (TW) provided by all aggregates (not just LWA) on the durability of concrete.

The mixtures are being evaluated for free shrinkage in accordance with ASTM C157, scaling resistance in accordance with ASTM C672, freeze-thaw durability in accordance with ASTM C666 (Procedure A), rapid chloride permeability in accordance with ASTM C1202, surface resistivity results obtained per AASHTO TP-95 and Louisiana Department of Transportation and Development (LA DOTD TR 233-11), and compressive strength in accordance with ASTM C39.

33% 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.

MnDOT has identified a series of monolithic bridge decks in Minnesota for crack surveys this summer. This study aims, among other things, to investigate the effectiveness of nonmetallic fibers in reducing bridge deck cracks. A total of 21 monolithic decks were constructed between 2015 and 2018, including 10 bridge decks constructed with nonmetallic fibers and 11 with no fibers.

Additional surveys as part of the construction of LC-HPC bridge decks incorporating internal curing technology will be conducted in the summer of 2020 in Minnesota and Kansas. The bridge decks in Minnesota include one internally cured bridge deck (Mackubin St. over I-94) along with a control deck (Grotto St. over I-94) located in St. Paul; one internally cured bridge deck (TH 52 SB over Cannon River) along with a control deck (TH 52 NB over Cannon River) located in Cannon Falls; one internally cured bridge deck (TH 58 over TH 52) near Zumbrota; two internally cured bridge decks (38th St. and 40th St. over I-35W, respectively) in Minneapolis, and one internally cured bridge deck (Pokegama Lake Rd. over I-35) near Pine City. The single bridge deck constructed in Kansas with internal curing (Sunflower Rd. over I-35) in Edgerton will also be surveyed.

Scaling tests are complete on the ternary mixtures containing 0 to 9 lb/cwt of IC water. Results show the addition of IC water did not negatively affect the scaling resistance of concrete mixtures. The mixtures with and without quantities of IC water showed a visual rating of (1) (corresponding to very slight scaling) by the end of 50 freeze-thaw cycles. However, the ternary mixture with no IC water exhibited the highest mass loss (0.22 lb/ft^2) comparing to the mixtures with nominal quantities of 7 and 9 lb/cwt of IC water by the end of 50 freeze-thaw cycles. Scaling results for the mixtures with 100% portland cement will be provided in the next quarter.

Rapid chloride permeability (RCP) and surface resistivity (SR) tests are being evaluated. As an overall observation, to date, results show the mixtures containing a ternary binder composition improved transport properties of concrete compared to the respective mixtures with 100% portland cement as the binder. The average charge passed in the RCP test at 56 days for mixtures with 100% portland cement was 2980 coulombs (well above 1500 Coulombs as the maximum limit stated in the KDOT specifications at 56 days), while the value for the mixtures with ternary binder compositions was 690 coulombs. The use of IC water in the mixtures did not affect the RCP values. The ternary mixtures on average showed higher SR values than the mixtures with 100% portland cement (24.3 kΩ-cm vs. 10.1 kΩ-cm). Similar to the RCP results, the addition of IC water in the mixtures did not affect the SR values.

An additional ternary series is being tested to evaluate the effects of total internal water (provided by all aggregates) on the durability of concrete. These mixtures contain the same volume replacement of coarse aggregates with either granite (with 0.7% absorption, OD basis) or two different limestone coarse aggregates (with 0.8 and 2% absorptions, OD basis), with and without LWA. Results for free shrinkage, freeze-thaw, scaling, RCP, and SR tests will be provided in the next quarter.

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).

COVID-19 has resulted in a reduction of work in the laboratory. Existing specimens continue to be evaluated, but work on new mixtures has been temporarily halted. The effect of COVID-19 on work in the next quarter is uncertain.