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) 2022 ☐ 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, 2023**	**Number of Extensions:** 1

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
$390,000.00	$378,994.82	88%

Quarterly Project Statistics:

Total Project Expenses This Quarter	Total Amount of Funds Expended This Quarter	Percentage of Work Completed This Quarter
$12,062.51	$12,062.51	3%

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.

In 2020, the current study was expanded to perform crack surveys on an additional 20 bridge decks per year for two years in Minnesota to correlate the cracking on those decks with environmental and site conditions, construction techniques, design specifications, and material properties, and compare them with results obtained from previously studied conventional and LC-HPC bridge decks, as is currently being done for the newly constructed decks. The results of this expanded effort will be documented in project reports. MnDOT will select the bridges and provide plans and specifications, dates of construction, concrete mixture proportions, material test reports, and observations recorded during construction, if any, as well as traffic control during bridge deck crack surveys.

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.

One more internally-cured bridge deck is planned for Kansas. Construction is anticipated in Spring 2022. This bridge is located on K-33 over BNSF Rail Road.

95% 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 were cast to evaluate the effects of total internal moisture (TIM) provided by all aggregates (not just LWA), ranging from 3 to 16% by the weight of binder, on the durability of concrete. The mixtures have different binder compositions (either 100% portland cement or 30% replacement of portland cement with slag cement) and contain either limestone or granite as coarse aggregate. The mixtures have a paste content of 24.2% and a water-to-cementitious material (*w/cm*) ratio of 0.43.

The mixtures are being evaluated for freeze-thaw durability following the regime specified in Kansas Department of Transportation (KDOT) Test Method KTMR-22, *Resistance of Concrete to Rapid Freezing and Thawing*, exposed to rapid freeze-thaw cycles as specified in ASTM C666 (Procedure B), scaling in accordance with a modified version of BNQ NQ 2621-900 (with minor changes to temperature), and compressive strength in accordance with ASTM C39.
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92% 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.

Seven internally-cured bridge decks in Minnesota (38th and 40th St. over I-35W in Minneapolis, Dale St. over I-94 and Mackubin St. over I-94 in St. Paul; Pokegama Lake Rd. over I-35 in Pine City; two bridge decks in Winona), one control

deck in Minnesota (Grotto St. over I-94 in St. Paul), and the bridge decks constructed in Kansas with internal curing (Sunflower Rd. over I-35; Montana Rd.; 199th St. over I-35) will be surveyed in summer 2022.

90% 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.

KU researchers are working on drafting a report on the cracking performance of twenty monolithic bridge decks with or without incorporating nonmetallic fibers, as well as nineteen bridge decks with either low slump or silica fume overlays, with or without nonmetallic fibers and monolithic decks with or without nonmetallic fibers surveyed in Minnesota during summers 2020 and 2021.

50% COMPLETE

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

55% COMPLETE

Anticipated work next quarter:

Future meetings and conference calls will be held. Pre-construction meetings will be held with representatives from KU, KDOT, and the contractors to discuss the details of mixture proportions and construction procedures.

Additional IC mixtures will be cast.

Laboratory testing of concrete mixtures with different quantities of internal curing water and total internal moisture will continue to be evaluated for scaling and freeze-thaw durability.

Significant Results this quarter:

KU researchers and MnDOT held an online meeting on 1/6/2022 to discuss the cracking performance of nineteen bridge decks surveyed during the summer of 2021, with either low slump or silica fume overlays, with or without nonmetallic fibers and monolithic decks with or without nonmetallic fibers in Minnesota. During the meeting, the effects of paste content on the cracking performance of bridge decks were addressed. Additionally, KU researchers presented a comparison between the results obtained by KU and results obtained by aerial images taken by drones at different altitudes on some of the bridge decks. KU and MnDOT agreed that the detection of crack defects, sealant detection, and the ability to distinguish sealed cracks from defects are potential challenges that drone inspection may face.

Scaling resistance is being evaluated in accordance with a modified version of BNQ NQ 2621-900 with a failure limit of 0.1 lb/ft^2 of mass loss by the end of 56 freeze-thaw cycles. Although still undergoing testing, as an overall observation, mixtures containing 100% portland cement as the only binder with or without IC, exhibit lower mass losses (higher scaling resistance) than a mixture containing 30% replacement of portland cement with slag cement (by weight) and no IC. For the mixture with 100% portland cement as the only binder and no IC, the 7-day and 21-day mass losses were 0.001 and 0.003 lb/ft^2, respectively, and for the mixture with 100% portland cement as the only binder and 7% IC (by the weight of binder) the 7-day mass loss was 0.002 lb/ft^2, well below the failure limit of 0.1 lb/ft^2. For the mixture with 30% replacement of portland cement with slag cement (by weight) and no IC, the 7-day mass loss was 0.01 lb/ft^2, higher than the paired mixture with 100% portland cement at the same freezing-thawing cycle.

The mixtures will continue to be evaluated for scaling and freeze-thaw durability. The results 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).

None.