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) 2023 ✕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	$386,292.63	95%

Quarterly Project Statistics:

Total Project Expenses This Quarter	Total Amount of Funds Expended This Quarter	Percentage of Work Completed This Quarter
$134.40	$134.40	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.

Bridge (123) on K-33 bridge deck over a BNSF railroad line was placed on 06/22/2023. The bridge is 208 ft long and 52 ft-10 in. wide. The mixture included cement replacements of 30% slag and a 1.9 % silica fume, both by weight. The design paste content by volume and the water-to-cementitious material (*w/cm*) ratio were 24.2% and 0.44, respectively. The design quantity of internal curing water was 7% by the weight of binder; the contractor reached 6% to 7 % of internal curing water for this mix. The average absorption of the lightweight fine aggregate measured by KU and KDOT personnel was 37.5 %. The concrete properties were tested after pumping at the job site with an average air content and slump of 8.6% (between 8.4 and 9.1%) and 5.5 in. (between 3.75 and 7.25 in.), respectively. The free surface moisture measured by KU researchers and KDOT personnel was 5 % (on average), but the contractor used a value 8% for the first truck, 6% for the second truck, and 5% for the rest of the placement. KU personnel observed contractor personnel walking through the concrete after it was vibrated and before it was screeded. They mentioned this to contractor personnel, but no changes were made. During application of burlap, KU researchers saw small dry regions on the burlap for four occasions, indicating either lack of proper pre-saturation or drying after saturation. Approximately halfway through placement, a delay of about 25 minutes occurred due to the need to relocate the pump from the north side to the south side of bridge. Relocation was needed because the pump at the south side was inoperable. At the end of brooming in south side of the bridge (5 feet) KU and KDOT personnel saw workers use water as a finishing aid. The placement started at 4:30 am and ends at 12:20 pm. The air temperature ranged from 65 to 93 ºF; the wind speed and humidity varied between 1 and 4 mph and 39.9 % and 96 %, respectively. The contractor delayed placing the plastic sheets for curing until 6/23/2023.

100% COMPLETE

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

Work on this task has been completed. The final laboratory report has been completed and will be sent to the sponsors during the next quarter.

95% 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.

One internally-cured low-cracking high-performance (IC-LC-HPC) bridge deck (122) constructed in Kansas (Montana Rd. over I-35) was surveyed in April 2023. This was the third-year survey for this deck, which was placed in 2020. Crack surveys will be performed for two internally-cured low-cracking high-performance (IC-LC-HPC) bridge decks constructed in Kansas (Sunflower Rd. (423), 199th St. (441) over I-35), and an additional deck (147-98 KA-5240-01) with sandy LWA mix (K-147 over Cedar Bluff Spillway) in August. The crack survey for the bridge deck (123) on K-33 BNSF railroad line will be performed in summer 2024.

The Montana Rd. deck had a crack density of 0.006 m/m^2. Crack widths ranged from 0.002 to 0.020 in., with most of the cracks were observed near the abutments and the shoulders. Some scaling damage was observed in multiple locations on the surface of the deck.

92% 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 finalizing the report on crack surveys of 19 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 summer 2021. It will be submitted by next quarter.

75% COMPLETE

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

See items under Task 4.

75% COMPLETE

Anticipated work next quarter:

Crack surveys will be performed for two internally-cured low-cracking high-performance (IC-LC-HPC) bridge decks constructed in Kansas (Sunflower Rd., and 199th St. over I-35), and an additional deck with sandy LWA mix (K-147 over Cedar Bluff Spillway) in August.

Reports on laboratory study and crack surveys in Minnesota will be submitted.

Significant Results this quarter:

The third-year crack density of just 0.006 m/m^2 on the Montana Rd. bridge deck indicates that the internally-cured low-cracking high-performance concrete is doing exceptionally well, matching the best decks cast in Minnesota.

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.