TRANSPORTATION POOLED FUND PROGRAM
QUARTERLY PROGRESS REPORT

Lead Agency (FHWA or State DOT):
________FHWA_______________________________________

INSTRUCTIONS:
Lead Agency contacts 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:**
TPF5-(521)	☐ Quarter 1 (January 1 – March 31) ■ Quarter 2 (April 1 – June 30) ☐ Quarter 3 (July 1 – September 30) ☐ Quarter 4 (October 1 – December 31)

TPF Study Number and Title:
TPF5(521) New Performance Approach to Evaluate ASR in Concrete

Lead Agency Contact:	**Lead Agency Phone Number:**	**Lead Agency E-Mail**
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Lead Agency Project ID:	**Other Project ID (i.e., contract #):**	**Project Start Date:**
Original Project Start Date: 07/23/2023	**Original Project End Date:** 12/31/2028	**If Extension has been requested, updated project End Date:**

Project schedule status:

■ On schedule ☐ On revised schedule ☐ Ahead of schedule ☐ Behind schedule

Overall Project Statistics:

Total Project Budget	Total Funds Expended This Quarter	Percentage of Work Completed to Date
$315,000	$119,736	64%

Project Description:
The Turner-Fairbank Highway Research center has developed two new alkali–silica reaction (ASR) tests, the AASHTO TP-144-23 (T-FAST) and the AASHTO T 416-24 (ATT). The T-FAST is sensitive method capable of accurately detecting the presence of alkali–silica reactive phases in any type of aggregate. The ATT is a simple and reliable method to determine the alkali threshold (AT) of any aggregate combination. The AT is defined as the specific alkali level at which the ASR reaction is triggered in an aggregate. Knowing the AT of an aggregate combination is an important piece of

information that provides insight into the field behavior of the aggregates when used in a concrete of specific alkali loading.

A new performance and prescriptive approach have been proposed based on the information provided by the T-FAST and ATT to predict the alkali–silica susceptibility of any concrete mix design. The two newly proposed approaches are based in the widely accepted notion that any given combination of aggregates will develop ASR inside of a specific concrete only when the alkali loading (AL) of the concrete is higher than the AT of the aggregates. The AL of the concrete depends on the mix design proportions, type and content of the cement, and the presence of supplementary cementitious materials. While previous research supports the theory that ASR can be prevented by limiting AL below AT, there is a need to understand the extent of the influence played by available alkalis and aluminum released by SCM in the AL of the concrete and AT of the aggregates, respectively. Lastly, it is also necessary to expand T-FAST capabilities to evaluate ASR mitigation strategies. This is a requirement because it is not always possible to avoid the use of reactive aggregates due to lack of availability or other reasons.

The principal objective of the project is to evaluate a wide selection of concrete mix designs to validate the use of T-FAST and ATT methods in conjunction with mix design data, cement mill reports and SCM properties to determine the likelihood of ASR gel formation in concrete.

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

Task 2. Characterization of supplementary cementitious materials (SCM)
During the last quarter the research team's work mainly focused on completing the chemical and spectroscopic characterizations of the SCM. In particular the team completed:

- X-ray fluorescence analysis of SCMs to be used in the Task 3 mixes.
- Raman spectroscopy mapping of selected SCM samples, including fly ash and slag, for concrete mixes (CTMix_PCC04460 and SDMix_M1CMD1). This involved collecting Raman scans over a 250 x 250 µm area to determine the optimal scan dimensions for characterizing the phases present.

Task 3: Prepare Concrete Samples
The team worked on the potential automation of the Damage Rating Index (DRI) evaluation for Scanning Electron Microscope (SEM) samples. Preliminary imaging of two samples (GTC15F12M and AK Mix CA740LA) was completed to establish a protocol for quantifying ASR cracking using the DRI. Large-area maps of the entire 1" x 2" samples were collected, and a preliminary algorithm was developed to map and categorize cracks based on size and area. Although the algorithm successfully categorized cracks, it failed to distinguish those infilled with ASR gel products. To address this limitation, Non-negative Matrix Factorization (NMF) imaging was applied to Energy-Dispersive X-ray Spectroscopy (EDS) data collected from an ASR-damaged aggregate sample. This method successfully mapped the ASR gel regions and their corresponding EDS spectra. Consequently, it was concluded that Backscattered Electron (BSE) imaging alone is insufficient for a comprehensive DRI protocol.

The research team also cut samples of the 2-year PAMix GTC15 specimens and prepared epoxy-embedded samples for DRI analysis.

Lastly, the team initiated the freeze-thaw evaluation of two 2-year concrete mix specimens (PA Mix GTC15 and PA Mix GTC25). The objective of this experiment is to capture a potential reduction in freeze-thaw resistance resulting from the infilling of air voids with ASR gels.

Anticipated work next quarter:

- Collect high-magnification, large-area maps combining BSE images and EDS data to develop an integrated DRI protocol and apply the new protocol in the analysis of AK Mix CA835LA and AK Mix CA740LA samples.
- Complete the batching of three concrete mixes (AK Mix CA564LA, CTMix_PCC04460, and SDMix_M1CMD1).
- Complete the cutting of the 2-year PAMix GTC25 samples and prepare epoxy-embedded specimens.
- Measure the available alkali loading of selected SCMs.

Significant Results:

None

Circumstance 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

Potential Implementation:

None