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: Jose F Munoz Campos	**Lead Agency Phone Number:** 202 493 3159	**Lead Agency E-Mail** Jose.munoz.campos@dot.gov
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	$56,454	31.2%

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 1: Selection of Aggregates and characterization using TFHRC toolkit tests

During this quarter, the TPF Team continued to measure the combined alkali thresholds (AT_{Mx}) of various concrete mixes. The team measured 10 AT_{Mx} values for five mixes from North Carolina, two mixes from Arkansas, two mixes from Pennsylvania, and one mix from Massachusetts. Table 1 summarizes the binder content and AT_{Mx} values of the 10 mixes. The team prepared experiments to measure the AT_{Mx} of six mixes from South Dakota and one more mix from North Carolina.

Table 1. Concrete Mix Design to Measure AT_{Mx}.

Mix ID	Coarse Agg ID #1	Coarse Agg ID # 2	Coarse Agg ID # 3	Fine Agg ID	Binder Content (kg/m^3)	AT_{Mx} (kg Na_2O_{eq}/m^3)
NCMix CA176MD2	NC-CA4-57	NC-CA4-78	N/A	NC-FA1	419	3.6
NCMix CA176MD3	NC-CA4-57	NC-CA4-78	N/A	NC-FA1	424	2.6
NCMix CA64MD1	NC-CA2-57	NC-CA2-67	NC-CA2-78	NC-FA1	367	2.8
NCMix CA64MD2	NC-CA2-57	NC-CA2-67	NC-CA2-78	NC-FA1	419	4.2
NCMix CA64MD3	NC-CA2-57	NC-CA2-67	NC-CA2-78	NC-FA1	424	3
ARMix BB	AR-CA1	N/A	N/A	AR-FA1	334	2.2
ARMix CA	AR-CA2	N/A	N/A	AR-FA2	368	1.7
PAMix GTC15	PA-CA1	N/A	N/A	PA-FA1	348	1.1
PAMix GTC25	PA-CA1	N/A	N/A	PA-FA2	362	1.1
MAMix CB7	MA-CA1	N/A	N/A	MA-FA1	420	1.5

N/A = not applicable

In addition to the concrete mixes in Table 1, the team explored the option of expanding the sample pool by incorporating more Class 1 aggregates. The criteria that define aggregate as Class 1 include a field history of over 15 years, the availability of accelerated physical expansion data, original mix design information, and well-documented ASR field performance. The team focused on reviewing published data from four field cases in Arkansas and four long-term exposure blocks located in Texas and Kingston, Canada.

Task 2. Characterization of supplementary cementitious materials (SCM)
The team worked on the SCM characterization task by evaluating the optimal area required to capture enough SCM particles for representative analysis. They determined this optimal area by performing Raman imaging on different millimeter-scale sections of slag, ground glass, and class F fly ash. After this optimization work, the team completed Raman imaging of five distinct 1.5x1.5 mm areas in the polished epoxy embedded SCM samples.

Task 3: Prepare Concrete Samples
The TPF team collected 12-month samples from two concrete mixes in Pennsylvania for microstructural analysis using a scanning electron microscope (SEM).

The team developed a research plan to explore the potential use of embedded resistivity sensors for monitoring pore solution concentrations. The team aimed to investigate how two materials, nanosilica and BCSA cement, affect the concrete pore solution with these embedded resistivity sensors. The team met with the Alaska Department of Transportation and Public Facilities State Quality Engineer, as well as with manufacturers of embedded concrete durability sensors, to discuss the potential of these sensors in monitoring pore solution concentrations for ASR-related research. The information gathered from the sensors will be compared with the analysis of concrete pore solutions. The data generated from these experiments will be used to create two concrete batches with tailored ASR risk for evaluating aggregates from Alaska.

Anticipated work next quarter:

- Complete the AT_{Mx} evaluation by measuring one concrete mix design from North Carolina and six from South Dakota.
- Conduct the pore solution study of pastes containing nanosilica and BCSA cement.
- Select the binders based on the AT_{Mx} of the aggregate combinations and pore solution experiments for the Alaska aggregates.
- Batch two concrete mixes using the Alaska aggregates.
- Prepare SEM samples from two Pennsylvania concrete mixes that are 12 months old for analysis.

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