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	$46,449	29%

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 completed the characterization of the aggregate samples under AASHTO TP 144 (T-FAST) and the measurement of the individual alkali threshold (AT_{Ag}) under AASHTO T 416 (ATT). Tables 1 and 2 summarize the T-FAST and ATT results for coarse and fine aggregate samples.

Table 1. T-FAST and ATT results of coarse aggregates.

Sample ID	T-FAST Classification	AT_{Ag} (kg/m^3)
NC-CA1-57	MR/HR	4.4
NC-CA1-78	HR	3.4
NC-CA2-78	SR	3.8
NC-CA2-67	MR	3.9
NC-CA2-57	MR/HR	4.6
NC-CA3	HR	3.6
NC-CA4-57	HR	2.5
NC-CA4-78	HR	3.8
NC-CA5	MR	6.5
CT-CA1	MR	2.8
SD-CA1	MR/HR	3.4
SD-CA2	MR/HR	3.8
MA-CA1	MR	4.2
PA-CA1	MR/HR	4.5
AR-CA1	HR	2.8
AR-CA2	SR	4.6
VA-CA1	SR	6.5
VA-CA2	HR	2.2
AK-CA1	HR	2.2

Table 2: T-FAST and ATT results of fine aggregates.

Sample ID	T-FAST Classification	AT_{Ag} (kg Na2Oeq/m^3)
NC-FA1	NR	6.5
NC-FA2	SR	6.5
NC-FA3	NR	6.5
CT-FA1	NR/SR	6.5
SD-FA1	MR	4.4
SD-FA2	MR	2.6
SD-FA3	MR	5.2
MA-FA1	NR	6.5
PA-FA1	MR/HR	1.8
AR-FA1	MR/HR	2.1
AR-FA2	HR	2.7
VA-FA1	NR/SR	6.5
AK-FA1	MR/HR	3.8

The TPF Team continued to measure the combined alkali thresholds (AT_{Mx}) of different concrete mixes. The team measured 12 AT_{Mx} values for 2 mixes from Virginia, 3 mixes from Alaska, 4 mixes from Connecticut, and 3 mixes from North Carolina. Table 3 summarizes the binder content and AT_{Mx} values of the 12 mixes.

Table 3. Concrete Mix Design Containing Virginia Aggregates to Measure AT_{Mx}.

Mix ID	Coarse Agg ID	Fine Agg ID	Cement (kg/m^3)	AT_{Mx} (kg Na2Oeq/m^3)
A3aPav Mix1	VA-CA1	VA-FA1	334	6.1
A3aPav Mix2	VA-CA2	VA-FA1	334	2.5
AK Mix CP835	AK-CA1	AK-FA1	495	1.4
AK Mix CP740	AK-CA1	AK-FA1	439	1.7
AK Mix CAA620	AK-CA1	AK-FA1	367	1.3
CT Mix PCC340	CT-CA1	CT-FA1	364	1.4
CT Mix PCC483	CT-CA1	CT-FA1	418	1.8
CT Mix PCC460	CT-CA1	CT-FA1	390	1.6
CT Mix PCC360	CT-CA1	CT-FA1	334	1.4
NC Mix CA9CMD	NC-CA5	NC-FA3	424	5.1
NC Mix CA10CMD	NC-CA1-57, NC-CA1-78	NC-FA1	367	3.0
NC Mix CA17CMD1	NC-CA4-57, NC-CA4-78	NC-FA1	367	2.6

Task 2. Characterization of supplementary cementitious materials (SCM)

The TPF team completed the XRF analysis of all the SCM samples. Two SCM samples were embedded in resin, lapped and polished for Raman characterization.

Task 3: Prepare Concrete Samples

The TPF team collected 6-month samples from the two Pennsylvania concrete mixes for microstructural analysis under the scanning electron microscope (SEM). Additionally, the team established a protocol for preparing concrete samples for SEM analysis. The protocol includes cutting, embedding in epoxy resin, lapping and polishing of the samples.

The team selected two I/II cements with alkali contents of 0.3% and 0.57% of Na_2O_{eq} as binders for preparing the Alaska concrete mixes.

Anticipated work next quarter:

- Evaluate the AT_{Mx} of 6 concrete mix designs from North Carolina, 6 from South Dakota, 2 from Arkansas, 2 from Pennsylvania, and one from Massachusetts.
- Select the binders based on AT_{Mx} of the aggregate combinations for NC and VA.
- Preparation of SEM samples from the two Pennsylvania concrete mixes of 0, 3 and 6 months for analysis.
- Plan the two concrete mixes from Alaska.
- Evaluate the influence two additives, a nanosilica admixture and a BCSA cement, on the alkali content of the concrete pore solution of one Alaska concrete mix.

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