TRANSPORTATION POOLED FUND PROGRAM
QUARTERLY PROGRESS REPORT

Lead Agency (FHWA or State DOT): FHWA

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(468)*	**Transportation Pooled Fund Program - Report Period:** ☒ Quarter 1 (January 1 – March 31) ☐ Quarter 2 (April 1 – June 30) ☐ Quarter 3 (July 1 – September 30) ☐ Quarter 4 (October 1 – December 31)
Project Title: Structural Behavior of Ultra-High Performance Concrete	

Name of Project Manager(s): Ben Graybeal	**Phone Number:** 202-493-3122	**E-Mail:** benjamin.graybeal@dot.gov
Lead Agency Project ID: TPF-5(468)	**Other Project ID (i.e., contract #):** n/a	**Project Start Date:** January 2021
Original Project End Date: December 2025	**Current Project End Date:** December 2025	**Number of Extensions:** 0

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	Percentage of Work Completed to Date
$800,000	$40,000	5%

Quarterly Project Statistics:

Total Project Expenses and Percentage This Quarter	Total Amount of Funds Expended This Quarter	Total Percentage of Time Used to Date
$*40,000 and 5%*	$40,000	5%

Project Description:

Ultra-high performance concrete (UHPC) is the next generation of concrete, a concrete whose mechanical and durability properties far exceed those of conventional concretes. UHPC combines together a set of advancements in concrete technology from recent decades to create a concrete with compressive strengths at or greater than approximately 20 ksi, sustained post-cracking tensile strength at or greater than 750 psi, and a discontinuous pore structure that reduces permeability by an order of magnitude. During the past 10 years, UHPC has found significant usage in the US bridge sector as a field-cast grout cast between prefabricated bridge elements; effectively, UHPC enabled novel accelerated bridge construction methods to flourish. As the awareness of UHPC capabilities as grown, interest has turned toward using UHPC for primary structural elements in bridges. The handful of primary structural component deployments in the US so far (e.g., a few pretensioned girders, a few precast bridge decks, a few piles) have been completed as experimental deployments by innovative departments of transportation. Mainstreaming of this technology will require a broader knowledge base and greater standardization of engineering practices. Researchers at the FHWA Turner-Fairbank Highway Research Center (TFHRC) have been leaders in advancing UHPC technology for the bridge sector for nearly two decades. The proposed project will allow them to broaden the scope of their efforts and thus provide more substantial input to the AASHTO community as formal guidance for the design of UHPC components is developed. The objective of the TPF project is to develop knowledge pertinent to the structural performance of UHPC. This knowledge will be of significant value as the AASHTO Committee on Bridges and Structures considers the use of UHPC-class materials in highway bridges and structures. The proposed project is focused on the design, fabrication, performance, and analysis of UHPC components. It is anticipated that various UHPC components will be designed, fabricated, and tested. The test results will be analyzed and used to inform proposed structural design guidance for UHPC components. Results will also be used to support usage of UHPC by interested departments of transportation. It is anticipated that bridge superstructure components (e.g., pretensioned girders) will be a significant part of this study, with behaviors related to flexure, shear, and end zones being investigated. Other components may be investigated based on available resources and the interest of participating partners.

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

- Held a kickoff meeting for the project with all the contributing states on February 1, 2021. States in attendance were Michigan, Minnesota, Mississippi, New Jersey, New York, Pennsylvania, Texas. Georgia and Florida joined the pooled fund project during the weeks after the kickoff meeting.
- Provided support for AASHTO COMP TS5c to publish a provisional standard test method on uniaxial tensile response of UHPC.
- Performed experimental work to diversify the equipment that is required for UHPC direct tension tests by: 1) exploring manual techniques to grip the specimen in the loading frame, and 2) investigating the use of a non-hydraulically operated loading frame to execute the test.
- Worked on visualizations including drawings, phots and video clips to support users in the preparation and execution of direct tension tests as well as the analysis of the results.
- Worked on the development of optimized cross-sectional shapes for UHPC bridge girders with utilizing the existing formworks and without necessitating excessive capital investments. Initial investigations were focused on a design example for a modified MN54 girder with the span of up to 160 ft, considering it acts compositely with the conventional concrete deck.
- Worked on the development of UHPC bridge design examples tailored to the needs of the contributing states. The design examples will highlight the key steps of design with UHPC members following the design recommendations that is currently being drafted by the research group at FHWA TFHRC.
- Explored the effects of various input material, geometrical, and design parameters on the behavior of UHPC bridge girders through a parametric study. The aim is to support the UHPC design recommendation developed by FHWA, as well as provide designers with best practices to fully utilize the improved material behaviors of UHPC in the design of highway bridges.

Anticipated work next quarter:

- Continue the parametric study to explore the effects of various input material, geometrical, and design parameters on the behavior of UHPC bridge girders.
- Work on the optimization of existing cross-sectional shapes of conventional concrete girder for UHPC over various bridge span lengths.
- Work on providing more guidance and diversifying the equipment needs for UHPC direct tension tests.

Significant Results:

- Developed an optimized shape for an MN54 bridge girder with the span of up to 160 ft when it is designed to act compositely with the conventional concrete deck.

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:

The study team is actively engaging the nine contributing State DOTs to solicit their feedback and to ensure that the results are applicable. In short, the study team in partnering with the contributors to continually adjust the direction of the project into the most beneficial direction. It is anticipated that this method of project scoping and management will ensure that the project results are implementable by at least many of the contributing DOTs.