**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 #**<br>*TPF-5(468)* | **Transportation Pooled Fund Program - Report Period:**<br>☐Quarter 1 (January 1 – March 31)<br>◘Quarter 2 (April 1 – June 30)<br>☐Quarter 3 (July 1 – September 30)<br>☐Quarter 4 (October 1 – December 31) |
|---|---|
| **Project Title:**<br>Structural Behavior of Ultra-High Performance Concrete | |

| **Name of Project Manager(s):**<br>Ben Graybeal | **Phone Number:**<br>202-493-3122 | **E-Mail:**<br>benjamin.graybeal@dot.gov |
|---|---|---|
| **Lead Agency Project ID:**<br>TPF-5(468) | **Other Project ID (i.e., contract #):**<br>n/a | **Project Start Date:**<br>January 2021 |
| **Original Project End Date:**<br>December 2025 | **Current Project End Date:**<br>December 2025 | **Number of Extensions:**<br>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 | $80,000 | 10% |

***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 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.):**

- Continued to support the efforts of AASHTO Committee on Materials and Pavements (COMP) to publish a “Standard Method of Test for Uniaxial Tensile Response of Ultra-High Performance Concrete”. The test method was originally drafted by FHWA before it was picked up by a newly formed task force group formed by members of AASHTO COMP Subcommittee TS3c. The test method has passed Subcommittee TS3c ballot and is now being forwarded to AASHTO COMP main committee for balloting and adoption.
- Continued to work on the development of visual aids to support users in the execution of the direct tension tests and the analysis of the results.
- Continued to work on the development of a design example of a modified MN54 UHPC bridge girder acting compositely with conventional concrete deck and spanning 150 ft. The design example will highlight the structural design steps outlined in the “Guide Specification for Structural Design with Ultra-High Performance Concrete” proposed by FHWA; which is being considered for adoption as an AASHTO Guide Specification by AASHTO Committee on Bridges and Structures (CBS) Subcommittee T-10 on Structural Concrete.
- Verified the use of non-hydraulically operated loading frames in performing direct tension tests of UHPC specimens. This verification was performed by comparing the direct tension test results of identical specimens cast from the same UHPC mix and tested using hydraulically and non-hydraulically operated loading frames. The comparison shows a good agreement and opens avenues to potential savings in equipment needs for the direct tension test method.
- Continued to work on exploring the effects of various input material, geometrical, and design parameters on the behavior of UHPC bridge girders through a parametric study. The study aims at providing designers with best practices that fully utilize UHPC improved material behaviors in the design of highway bridges.
- Reviewed existing literature on the development length of reinforcing steel bars and prestressing strands embedded in UHPC. Worked on developing a testing program to further explore the development length of prestressing strands in UHPC.

**Anticipated work next quarter**:

- Continue to work on the parametric study to investigate the effects of various input material, geometrical, and design characteristics on UHPC bridge girder behavior and the development of design aids for designing UHPC bridges spanning over short and long distances.
- Work on a pilot testing program focused on the development length of 0.7 in. diameter prestressing strands embedded in UHPC.
- Explore the fatigue behavior of UHPC subjected to tension stresses.
- Continue to work on design examples for prestressed and non-prestressed UHPC girders.

**Significant Results:**

- The "Standard Method of Test for Uniaxial Tensile Response of Ultra-High Performance Concrete" has passed AASHTO COMP Subcommittee TS3c and is now being considered by AASHTO COMP main committee for adoption as a standard method of test.
- Non-hydraulically operated loading frames can be utilized to perform direct tension tests of UHPC specimens. It opens avenues to potential savings in equipment needs for the direct tension test method.

**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.