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:

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 AASHTO Committee on Bridges and Structures (CBS) subcommittee T-10 on Structural Concrete to evaluate FHWA proposed draft of an “AASHTO Guide Specification for Structural Design with Ultra-High Performance Concrete” for possible adoption. The guide was submitted to AASHTO CBS T-10 on June 30, 2021. The research team at FHWA has begun to received comments from members and is working on addressing them.

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 the FHWA research team and was then raised to the attention of AASHTO COMP Subcommittee TS3c. The test method has passed Subcommittee TS3c ballot and is now being balloted by the AASHTO COMP main committee.

Continued the development of visual aids to assist users in performing the “Standard Method of Test for Uniaxial Tensile Response of Ultra-High Performance Concrete”. The portion of the video detailing the preparation of the specimen for testing has been completed.

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 based on the structural design steps outlined in FHWA proposed draft “AASHTO Guide Specification for Structural Design with Ultra-High Performance Concrete”. The design of the composite section has been finalized and is being drafted. Work has started on developing a second design example showing the analysis of non-prestressed rectangular UHPC beam reinforced with conventional concrete bars. This example will focus on determining the flexure and shear capacities of the beam.

Developed the work plan for a pilot testing program focused on the development length of 0.7 in. diameter prestressing strands embedded in UHPC. The experimental test setup is being erected, which involves pulling a strand out of a UHPC block in a configuration such that the stress field and strand confinement are comparable to a beam subjected to flexural loading.

Worked on evaluating the tensile stress-strain relationship of UHPC based on ASTM C1609 flexural test. Investigating pitfalls and misconceptions that can arise from inappropriately interpreting the results of flexural tests

to obtain the key tensile parameters. These parameters are critical to the appropriate design of UHPC structural members.

Anticipated work next quarter:

Finalize two design examples: prestressed and non-prestressed UHPC beams.
Work on developing version 1.1 of the "AASHTO Guide Specification for Structural Design with Ultra-High Performance Concrete" based on comments received from the members of AASHTO CBS T-10 and other interested parties.
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. The study aims to provide designers with support to enable the appropriate use of UHPC's improved material behaviors in the design of highway bridges.
Perform additional direct tension tests with the goal of verifying and documenting the applicability of non-servo-hydraulic operated loading frames in performing direct tension tests of UHPC specimens.
Execute experimental tests on the pilot test specimens for the development length project; the results will be used to verify the test method for evaluating the development length of various strand diameters in UHPC-class materials.

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.
AASHTO CBS T-10 is evaluating the draft of "AASHTO Guide Specification for Structural Design with Ultra-High Performance Concrete", proposed by FHWA, for structural design with UHPC; FHWA is assisting the committee in managing the comments and editing the document.
The test setup for evaluating the development length of strands embedded in UHPC is being erected; testing will start in the next report period.

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.