Quarterly Progress Report:
Project Number and Title: 2.7 High Performance Concrete with Post-Tensioning Shrinking Fibers
Research Area: Thrust 3 Use new materials and systems to build longer-lasting bridges and accelerate construction
PI: Dryver Huston, University of Vermont
Co-PI(s): Ting Tan, University of Vermont
Reporting Period: 1/1/20 – 3/31/20
Submission Date: March 31, 2020

Overview:

The graduate student that was working on the project moved onto a different project and was largely unavailable to work on this project. Another graduate student has been identified and will probably start full time on the project in May 2020.

Task 1: *Shrinking Fiber Development and Manufacture*. Efforts were made to develop additional configurations for metal fibers including larger rings and the possibility of using nitinol.

Task 2: *Laboratory Performance Testing*. Laboratory testing was minimal during this quarter. The intent was to ramp up during the later half of March, but the laboratories shut down and the tests were postponed.

Task 3: *Mechanical Modeling*. The modeling of the mechanics of shrinking fibers began with a study of the various techniques used on non-shrinking fibers and the techniques used to model prestressing. Many of the non-shrinking fiber models use custom numerical techniques, while prestress concrete models often use ad hoc procedures implemented in commercial codes. The peridynamics technique also looks promising. It was decided to build on existing experience modelling prestress in concrete with the commercial Ansys code as the first step.

Table 1: Task Progress

Task Number	Start Date	End Date	Percent Complete
Task 1: Shrinking Fiber Development and Manufacture	6/1/19	5/30/21	35%
Task 2: Laboratory Performance Testing	6/1/19	5/30/21	30%
Task 3: Mechanical Modeling	6/1/19	5/30/21	20%

Table 2: Budget Progress

Entire Project Budget	Spend Amount	Spend Percentage to Date
$220,000		

Opportunities for training/professional development

Graduate student Zhuang Liu visited the FHWA Mobile Concrete Research Laboratory while it was at the VTrans Material Test Laboratories in October 2019.

Activities involving the dissemination of research results

Table 3: Presentations at Conferences, Workshops, Seminars, and Other Events				
Title	**Event**	**Type**	**Location**	**Date(s)**
N/A				

Table 4: Publications and Submitted Papers and Reports				
Type	**Title**	**Citation**	**Date**	**Status**
Peer-reviewed journal	Avalanches During Flexure of Early-Age Steel-Fiber Reinforced Concrete Beams	Cement and Concrete Research	12/19/19	under review

Participants and Collaborators:

Table 5: Active Principal Investigators, faculty, administrators, and Management Team Members			
Individual Name	**Email Address**	**Department**	**Role in Research**
Dryver Huston	dryver.huston@uvm.edu	Mechanical Engineering	PI
Ting Tan	Ting.Tan@uvm.edu	Civil and Environmental Engineering	Co-PI

Table 6: Student Participants during the reporting period				
Student Name	**Email Address**	**Class**	**Major**	**Role in research**
Diarmuid Gregory		M.S./Senior	Mechanical Engineering	Just began at end of quarter

Table 7: Student Graduates			
Student Name	**Role in Research**	**Degree**	**Graduation Date**
N/A			

Use the table below to list organizations have been involved as partners on this project and their contribution to the project.

Table 8: Research Project Collaborators during the reporting period						
Organization	**Location**	**Contribution to the Project**				
		Financial Support	**In-Kind Support**	**Facilities**	**Collaborative Research**	**Personnel Exchanges**
N/A						

List all other outputs, outcomes, and impacts here (i.e. patent applications, technologies, techniques, licenses issued, and/or website addresses used to disseminate research findings). Please be sure to provide detailed information about each item as with the tables above. N/A

Have other collaborators or contacts been involved? If so, who and how? (This would include collaborations with others within the lead or partner universities; especially interdepartmental or interdisciplinary collaborations. N/A

Changes:

The focus continued on metallic fibers and numerical modelling. The graduate student that planned to conduct the research moved onto a different project and efforts were undertaken to get a new one. These efforts were successful with the addition of a student enrolled in the accelerated Masters program. The plan is for him to engage in the project full time following the end of the spring semester, with a focus on numerical modeling if the laboratories remain closed.

Planned Activities:

The planned activities during the coming months depend on the availability of laboratory testing facilities. While the labs are closed, the focus will be on numerical methods of modeling the mechanics of fiber pretensioned concrete. Topics to be looked into include developing effective tools that capture the microscale behavior of the fibers, including debonding, versus fiber stiffness and the effect on macroscale properties. When the labs become available, testing will continue on mechanical methods of post-cure tensioning of fibers and determining what features improve strength measures and durability measures, such as hydraulic permeability and microcracking.