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: 7/1/20 – 9/30/20
Submission Date: September 30, 2020

Overview: (Please answer each question individually)

Laboratory studies resumed in August following a pandemic related shutdown.

- The laboratory experiments included the fabrication and testing of concrete beam specimens that contain steel rings that shrink post cure to induce a prestress in the concrete. The results of the failure tests indicated an increase post-fracture strength for the prestressed rings versus controls, along with an increased post-cracking acoustic emission behavior. This activity advanced Task 1 and Task 2. Figure 1 shows the shrinking fiber techniques presently under investigation.

- Located sources of chitosan fiber that has the potential for serving as a polymer-based shrinking fiber. A small (1 kg) batch of sisal-type fibers has been acquired, Figure 2. Preliminary tests of shrinking performance have been started. This activity advanced Task 1.

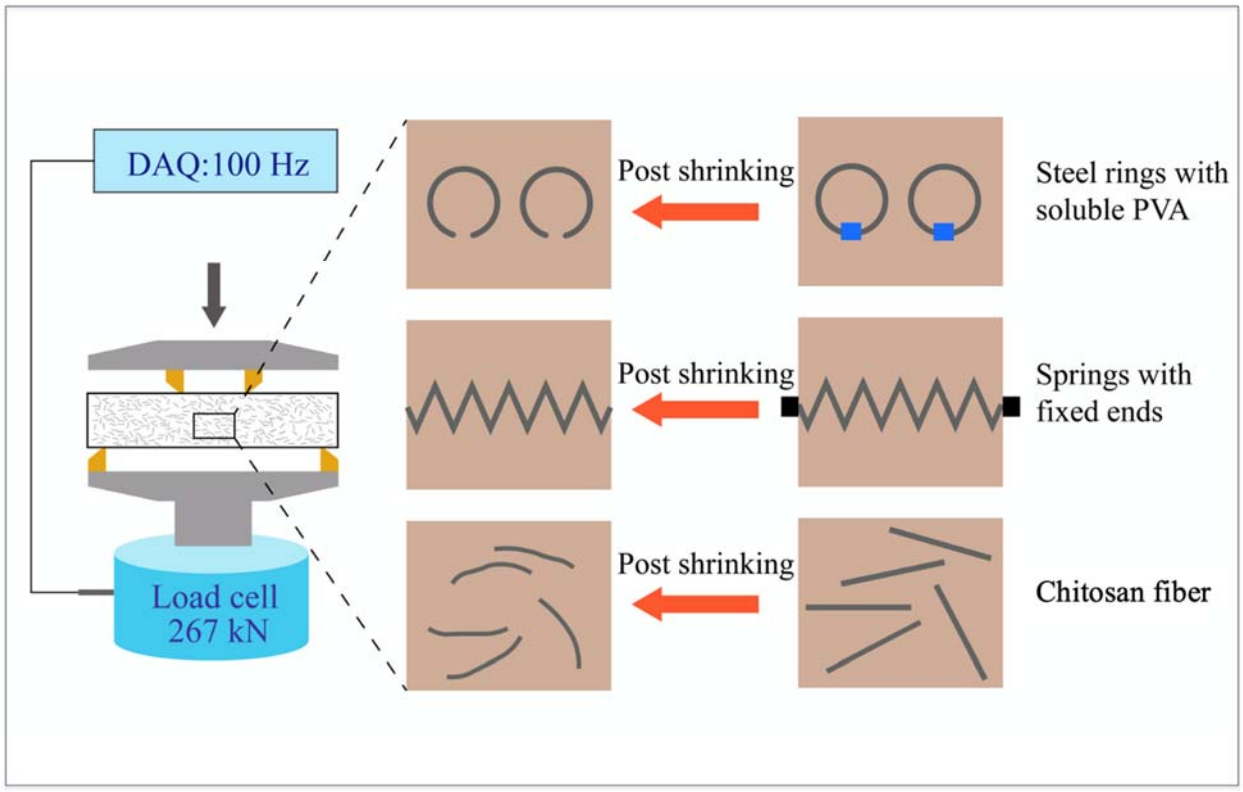

Figure 1 Shrinking fiber testing techniques under investigation

Figure 2 Sisal type chitosan fiber

Table 1: Task Progress			
Task Number	**Start Date**	**End Date**	**% Complete**
Task 1: Shrinking Fiber Development and Manufacture	6/1/19	5/30/21	45%
Task 2: Laboratory Performance Testing	6/1/19	5/30/21	35%
Task 3: Mechanical Modeling	6/1/19	5/30/21	35%
Overall Project:	6/1/19	5/30/21	38.3%

Table 2: Budget Progress		
Project Budget	**Spend – Project to Date**	**% Project to Date***
$220,000	$117,865.29 – 09/28/20	53.58%

Training/professional development – Graduate student Diarmuid Gregory attended FHWA Advanced Sensing Technology (FAST) NDE Lab Webinar Series - FHWA Mobile Concrete Laboratory - July 27, 2020

Table 3: Presentations at Conferences, Workshops, Seminars, and Other Events				
Title	**Event**	**Type**	**Location**	**Date(s)**
High Performance Concrete with Post-Tensioning Shrinking Fibers	2020 TIDC Annual Student Poster Contest	Student Poster Contest	TIDC	2020
High Performance Concrete with Post-Tensioning Shrinking Fibers	33rd Rhode Island Transportation Forum	Forum	Rhode Island	Abstract submitted and accepted for presentation October 30, 2020

Table 4: Publications and Submitted Papers and Reports				
Type	**Title**	**Citation**	**Date**	**Status**
NA				

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	Graduate research assistant

Table 7: Student Graduates			
Student Name	**Role in Research**	**Degree**	**Graduation Date**
NA			

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**
NA						

Table 9: Other Collaborators			
Collaborator Name and Title	**Contact Information**	**Organization and Department**	**Contribution to Research**
James Wild	Vermont Agency of Transportation	Materials	Technical Champion

Who is the Technical Champion for this project?
Name: James Wild
Title: Concrete Materials Manager
Organization: Vermont Agency of Transportation
Location (City & State): Montpelier, VT
Email Address: Jim.Wild@vermont.gov

Changes:

Due to the pandemic-related shutdown of experimental facilities at the UVM campus, the research pivoted to numerical modeling of concrete with embedded shrinking fiber elements in the Spring of 2020. Following a partial reopening of research laboratories at UVM during mid-summer 2020, project focus switched back to experimental testing of concrete

beams with prestressing fibers. Tests included beams with shrinking steel rings. Two sources of chitosan fiber have been identified. A 1 kg sample has been obtained from one of the sources. If these fibers perform as hoped, the use of them has the potential to accelerate progress on the project by bypassing the chitosan fiber manufacture process at UVM. Previous work at UVM has produced chitosan fibers with uncertain geometries, but effective shrinking capabilities, in a labor-intensive process. These new fibers have favorable geometry, but the shrinking performance remains to be determined. Due the laboratory shutdown, the original proposed completion date of 5/31/21 may be difficult to achieve and may necessitate consideration of no-cost extension.

Planned Activities:

The planned activities in the next quarter will focus on laboratory testing of concrete formulations with various shrinking fiber constituents. Assuming modest success with the efforts, we then plan to engage more closely with our Technical Champion (Jim Wild) at VTrans to see how this technique can be made practical for use as a potential performance concrete in transportation structures.