

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: 1/1/21 – 3/31/21

Submission Date: March 29, 2021

Overview: (Please answer each question individually)

Much of the activity this semester focused on developing better shrinking fibers using high pH activation of chitosan fibers, Figure 1. The results have been successful for hand mixed chitosan fibers. The fibers were placed in an alkaline bath, then taken out and allowed to dry. After drying, the fibers shrank to 50% of their original length, Figure 2. These results are seen with three different types of chitosan powder: high molecular weight, ≥ 75 deacetylated, and practical grade. Shrinkage happens fairly quickly and fibers are fully dried and shrunk after 2-3 hours at 40% relative humidity. A shrinkage test will be run in a higher humidity environment $\geq 85\%$ relative humidity to mimic the humidity of cured/curing concrete. The shrinkage rate is an important but not crucial factor to increase the strength of the concrete.

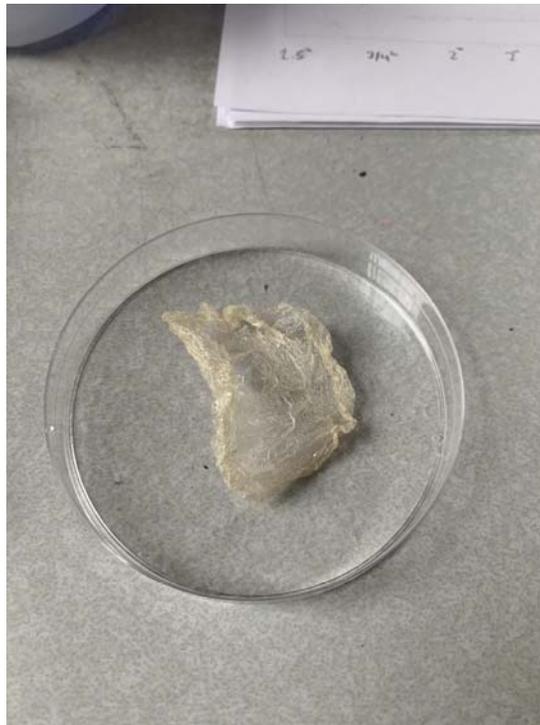


Figure 1. Shrank chitosan flake originally the area of its container (~70% shrinkage)



Figure 2. Chitosan fibers shrunk 50% in length with alkaline soak followed by drying.

Table 1: Task Progress			
Task Number	Start Date	End Date	% Complete
Task 1: Shrinking Fiber Development and Manufacture	6/1/19	12/31/21	60%
Task 2: Laboratory Performance Testing	6/1/19	5/30/21	35%
Task 3: Mechanical Modeling	6/1/19	5/30/21	47.5%
Overall Project:	6/1/19	5/30/21	47.5%

Table 2: Budget Progress		
Project Budget	Spend – Project to Date	% Project to Date*
\$220,000	\$142,623.69 – 27/21/21	77.79 %

Table 3: Presentations at Conferences, Workshops, Seminars, and Other Events				
Title	Event	Type	Location	Date(s)
Self-Prestressing Concrete with Shrinking Fibers	TIDC Research Showcase presentation	Student presentation scheduled	TIDC, U Maine	April 21, 2021 to be presented

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:

A no cost extension has been granted on this project with the new end date of 12/31/21. There are no anticipated changes in the overall technical plan for the research.

Planned Activities:

The planned activities in the next quarter are:

1. Scale up production of improved shrinking chitosan fibers.
2. Use shrinking fibers in laboratory tests of performance on small cylinders and more standard sized beams and cylinders.
3. Examine the viability of a method of synthesizing fibers with more aggressive and tunable shrinking properties. A concept based on increase amine addition to cellulose and similar molecules has been formulated based on conversations with Severin Schneebelli of the UVM Chemistry Department on methods.
4. Based on success with the above steps, interaction with VTrans Technical Champion Jim Wild to formulate a plan on moving the concept of self-prestressing concrete into a more durable high performance material that finds use in transportation structures.