Semi-Annual Progress Report

TIDC Transportation Infrastructure Durability Center AT THE UNIVERSITY OF MAINE

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): *NA*
Reporting Period: *First semi-annual report*
Date: *March 28, 2019*

Overview:

The overall goal of this project is to develop an autogenous fiber prestressing system for high performance concretes that increases the durability and strength of highway structures. This project is in its initial stages. The bulk of the activity to date has been to meet with potential collaborators, potential student researchers and to further develop the research plan. The primary potential collaborator identified so far is in the UVM Chemistry Department, Assistant Professor Severin Schneebeli. Dr. Schneebeli is an expert in synthesizing custom polymers. He may be able to synthesize nitrogen-based polymers that are similar to the natural material chitosan but have superior performance capabilities. These polymers would shrink with high-pH as does the chitosan, but would be easier to manipulate for manufacture, stiffness and cement-binding proclivities. At the moment, no graduate students have started to work on this project. A new MS student and an upcoming senior Honors College student have verbally committed to working on this project, with the graduate student possibly starting in May 2019 and undergraduate September 2019.

The context of these activities is that the novel nitrogen-based polymers have the potential to provide a superior solution for polymer-based shrinking fibers and the recruiting of talented student researchers is vital to accomplishing the project goals.

This project is just starting, in addition to the recruiting of collaborators and students described above, the primary accomplishment has been further refinement of concepts for steel-based autogenous prestressing fibers through the use of fibers in coiled shapes that are preloaded by enteric polymers that dissolve in high pH.

No significant training/professional development activities occurred.

The only research dissemination activity of note was that a paper describing the use of shrinking fibers for increasing the performance of fiberglass composites appeared in press. The underlying work for this paper predated the start of this project. The paper describes techniques that have the potential for pre-stressing fiber reinforced polymer composites that could be used as reinforcing layers on concrete structural elements, Figure 1 and Figure 2. The paper is:

Kim E, Huston D, Lee PC. (2019) “Interlaminar Prestressing Reinforcement of Epoxy/Glass Fiber Composites" Smart Mater. Struct. 28, 025006, doi:10.1088/1361-665X/aaefcd

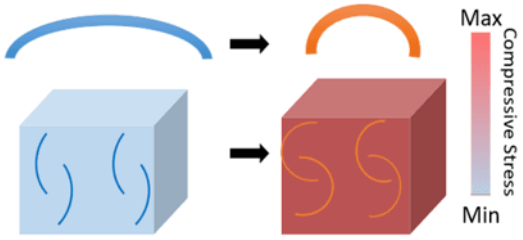

Figure 1. Hypotheses of the stronger composite reinforced with in situ shrinking fibers. Due to internal compressive stresses, the composite can withstand higher external stresses before failure.

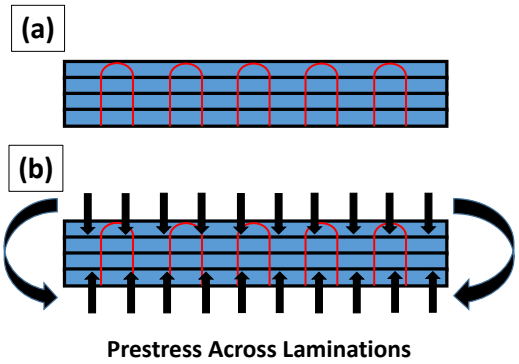

Figure 2. Hypothesis of an interlaminar strengthening effect of heat-activated shrinking fibers; (a) undamaged laminate fiber-reinforced composite structure, and (b) shrinking behavior of heat-activated shrinking fibers introduces transverse prestress that withstands delamination.

Participants and Collaborators:

PI Dryver Huston worked on this project. He met with several potential collaborators and student researchers as described above, but none of them have yet started on the project officially.

Changes:

No changes to date.

Planned Activities:

The planned activities over the next months are to hire a graduate student and possibly an undergraduate student to work on the project during the summer 2019 months. These students will work on experiments to further develop the shrinking fiber for concrete and to begin numerical studies of the mechanics of interactions of prestressed fibers and concrete.