TIDC Transportation Infrastructure Durability Center AT THE UNIVERSITY OF MAINE

DEPARTMENT OF TRANSPORTATION UNITED STATES GOVERNMENT

High Performance Concrete with Post-Tensioning Shrinking Fibers

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Introduction

Concrete failure is often catastrophic due to the high compression strength but brittle nature of the material. Nature is one of the biggest of opponents of the material as well. Freeze/thaw cycles and salt degrade concrete and expand cracks weakening structures and supports.

The goal of this research is to develop high performance concrete using post-cure active prestressing fibers. Research proving the feasibility of these methods has been done in the past. The current focus is on steel rings and springs. Chitosan fibers and yarns are the focus of the next phase. Chitosan shrinks in high pH environments like concrete so chitosan fibers are a great candidate for shrinking. Chitosan is made from processed crab and crustacean shells making it sustainable option.

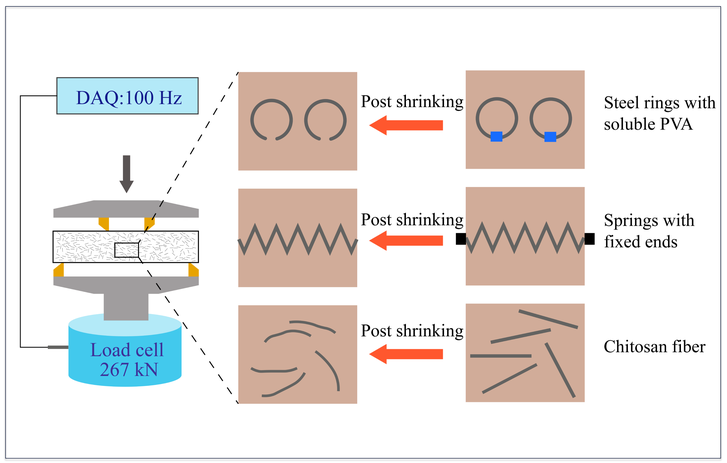

Figure 1: Different prestressing strategies with post shrinking fibers

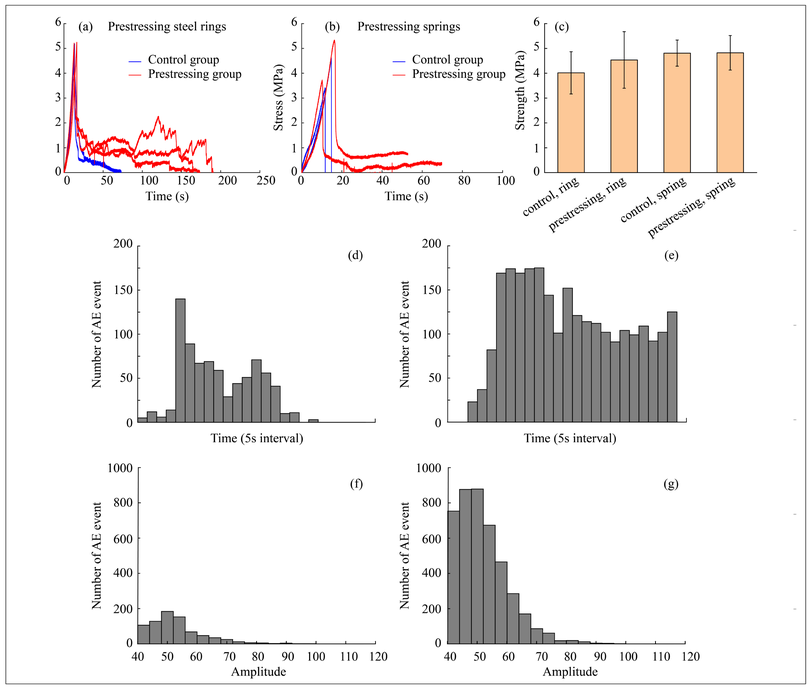

Figure 2: **(a)** Concrete with rings stress curve. **(b)** Concrete with springs stress curve. **(c)** Rings and springs strength bar graph. **(d)** AE events time histogram for control, ring test. **(e)** AE events time histogram for prestressed, ring test. **(f)** AE events amplitude histogram for control, ring test. **(g)** AE events amplitude histogram for prestressed, ring test.

Results and Conclusions

Control rings were rings added to the concrete without the PVA insert and control springs were springs not pre-stretched.

Steel rings increased increased flexural strength by an average of .5 MPa and increased post failure ductility.

Steel springs showed no change in flexural strength but showed increased post failure ductility.

Current work is being done on chitosan fibers which shrink in high pH environments. We are currently setting blocks to test the effect of these novel shrinking fibers.

Experimental Design and Data Collection

Four-point bending tests with a loading span of 66 mm, and supporting span of 200 mm.

Steel ring volume ratios used were 0.5% and 1.0%.

Each test used two constant displacement rates (0.03 in/min and 0.15 in/min), a 100 Hz sampling rate and acoustic emission monitoring.

Steel rings are prestressed with water soluble 3-D printing filament (PVA) and then added to concrete mix which is poured into molds. Steel springs are pre-tensioned in a mold with concrete poured around.

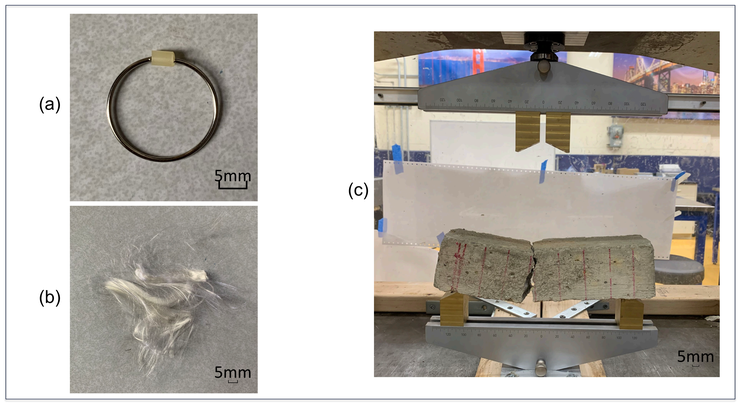

Figure 3: **(a)** Rings pre-stressed with PVA. **(b)** Citosan fibers used for next phase. **(c)** Concrete block post failure.

Zhang Liu assisted in testing and concrete specimen preparation.

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