VERMONT
AGENCY OF TRANSPORTATION

FACT SHEET

2019 Research Showcase & STIC Annual Meeting

High Performance Concrete with Post-Tensioning Shrinking Fibers

PROJECT TITLE

Title: High Performance Concrete with Post-Tensioning Shrinking Fibers

STUDY TIMELINE

June 2019 – May 2020

INVESTIGATORS

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Fact sheets can be found for additional projects featured at the 2019 Symposium at http://vtrans.vermont.gov/planning/research/2019showcase

Additional information about the VTrans Research Program can be found at http://vtrans.vermont.gov/planning/research

Additional information about the VTrans STIC Program can be found at http://vtrans.vermont.gov/boards-councils/stic

Additional information on this project can be found at http://www.tidc-utc.org

Introduction

The goal is to create a superior class of high-performance concrete using prestressing fibers. Steel-fiber reinforced concrete (SFRC) has been an excellent composite material that improves the brittle feature of conventional concrete. Adding a proper amount of steel fibers in concrete significantly increases compressive and flexural strength before and after cracking, enhancing the ductility and improving post-cracking behavior. Chitosan polymer fibers with pre-stressing have demonstrated concrete strengthening beyond non-stressing fibers. Studies are in progress to extend the prestressing technique to steel fibers by investigating the effect of fiber shape and different fiber reinforcing strategies, including pre-stressing, on the mechanical properties of concrete with load and acoustic emission testing.

Fig. 1 Bending test and AE

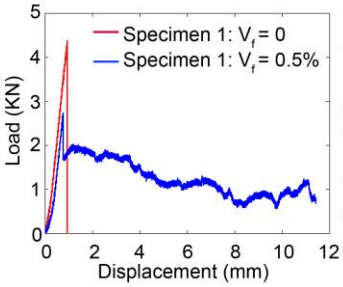

Fig. 2 Load curve

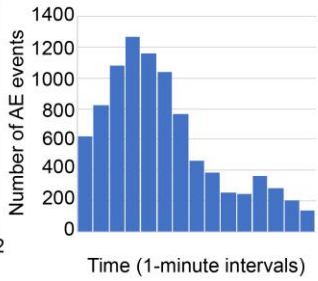

Fig. 3 AE events distribution

Methodology

Four-point bending tests loaded to failure fiber-reinforced beams with a loading span of 80 mm, and supporting span of 240 mm. Each test used a constant loading rate of 0.03 in/min, a 100 Hz sampling rate to record the load versus displacement data and acoustic emission monitoring to record elastic waves due to cracking.

Conclusions and Future steps

Flexural strength of SFRC specimen decreased when compared with the control specimen because steel fibers provide much more sources of stress concentrations. However, SFRC specimen exhibited significant improvement in ductility. Planned future work includes testing of the spiral steel-fiber reinforced concrete specimens and pre-stressed steel fibers. We will also test the beam specimens with different fiber volume ratios.

Potential Impacts and VTrans Benefits

This study investigates the overall flexural performance of SFRC with respect to fiber volume ratios, fiber types and pre-stressed steel fibers, in which AE was used to monitor the crack propagations. If successful, the technique could be extended to enhancing flexural strength and ductility of concrete structures. The long-term impact is the potential for increased serviceability values for structures by using steel fibers reinforced and pre-stressed concrete elements.