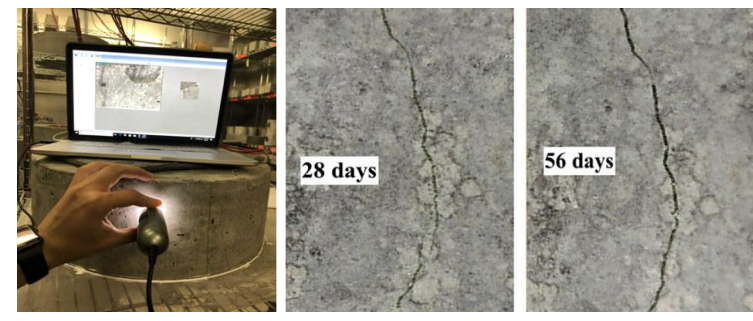




Crimped steel fiber, Macro polypropylene, Micro polypropylene

Microscope was used for specifying the crack width and length



Control of Shrinkage Cracks in Bridge Decks by Using Hybrid Fiber Reinforced High Performance Concrete

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Introduction

Concrete bridge decks are very susceptible to transverse shrinkage cracks. A case study was done in New Jersey by implementing macro polypropylene fibers in the mix design for bridge decks at 0.32% concentration. It reduced the crack density by 33.3%. However, the cracking resistance could be improved by implementing hybrid fibers into the mix design.

Objectives

The main objective is to implement a hybrid combination of fibers Steel and Macrofiber and Microfiber in high-performance concrete and determine in which combinations of hybrid fibers will reduce its cracking frequency under restrained shrinkage conditions. As well as enhance the mechanical performance of high-performance concrete produced by a single type of fiber.

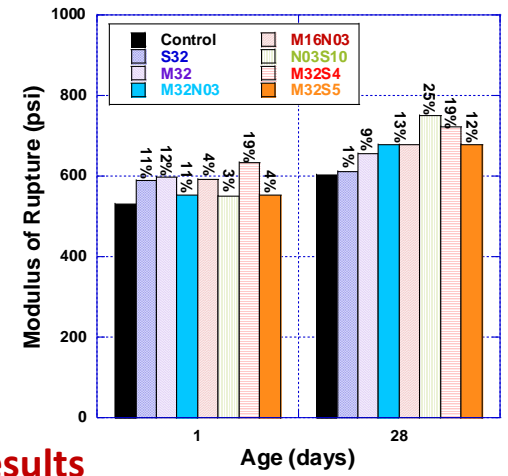
Fibers and Mix Design

Mix Notation	Macro Fiber	Micro Fiber	Steel Fiber	Total Content
Control	0	0	0	0
S32	0	0	0.32	0.32
M32	0.32	0	0	0.32
M16N03	0.16	0.03	0	0.19
M32N03	0.32	0.03	0	0.35
N3S10	0	0.03	0.1	0.13
M32S4	0.32	0	0.04	0.36
M32S5	0.32	0	0.05	0.37

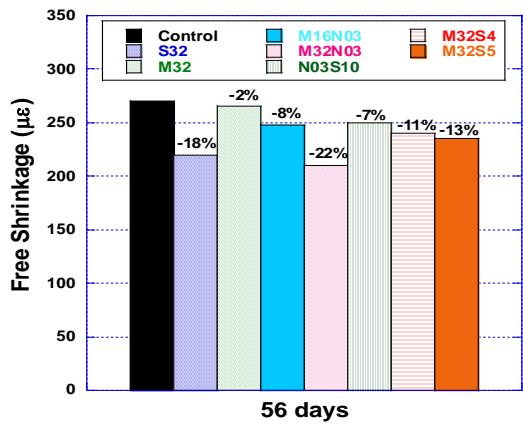
Mechanical Test Results

Strength Properties

No Significant change in Compressive and Splitting Tensile Strength
Modulus of Rupture Increased by up to 24.5% (steel and micro hybrid fibers)



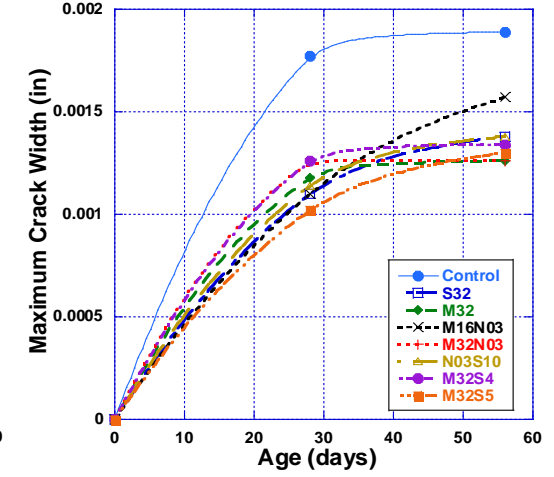
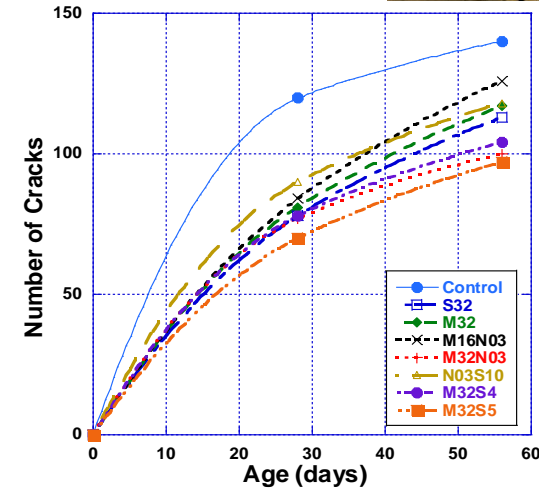
Free Shrinkage Test Results



All mixtures produced with fibers tend to reduce free shrinkage **up to 22%** compared to the control mix

Restrained Shrinkage Test Results

AASHTO ring test was the primary test which utilized to measure cracking frequency properties



Avg. Crack Width: Hybrid fibers did not show significant improvement in reducing crack width.

Max. Crack Width: Hybrid reduced the max. crack width up to 33% compared to control

No. of Cracks: Hybrid fibers helped reducing the No. of cracks up to 30% compared to control

Conclusions

Adding hybrid fibers

1. Reduce free shrinkage strain and number of cracks by 21% and 17%, respectively.
2. Reduce the maximum crack width by 33%.

Hybrid fiber mix is recommended for bridge deck for its role in enhancing the mechanical performance of high performance concrete and increasing its shrinkage cracking resistance. Other combination of hybrid fibers in high-performance concrete needs more investigations(update)

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