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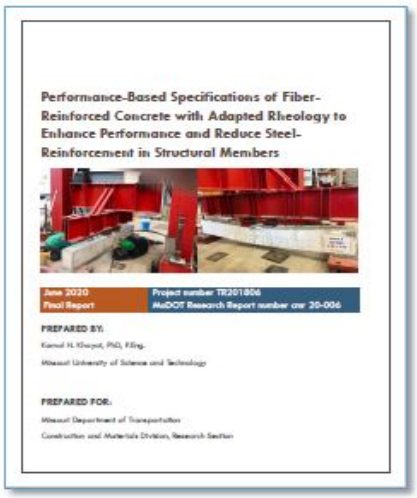
Research Summary

Performance-Based Specifications of Fiber-Reinforced Concrete with Adapted Rheology to Enhance Performance and Reduce Steel-Reinforcement in Structural Members


Performance-Based Specifications of Fiber-Reinforced Concrete with Adapted Rheology to Enhance Performance and Reduce Steel-Reinforcement in Structural Members

June 2020
Final Report

Project number TR201806
MoDOT Research Report number cmr 20-006

PREPARED BY:

PREPARED FOR:

The main objective of this research is to propose novel materials for the construction and retrofitting of bridges, including Economical Crack-Free High-Performance Concrete (Eco-Bridge-Crete, or EBC) and Fiber-Reinforced Super-Workable Concrete (FR-SWC). The project seeks to optimize the coupled effect of fiber characteristics, expansive agent (EA), saturated lightweight sand (LWS), and external moist curing on mechanical properties, shrinkage, and corrosion resistance of such classes of high-performance concrete. The project also aims to replace steel reinforcement in flexural members with steel fibers partially.

"The project seeks to optimize the coupled effect of fiber characteristics…"

In Task I, Eco-Bridge-Crete mixture design was optimized to reduce drying and restrained expansion and secure high mechanical properties. Eco-Bridge-Crete mixtures were optimized using various shrinkage mitigating strategies, including the use of different contents of CaO-based EA, LWS, and steel fibers as well as different moist curing conditions. The study revealed some synergistic effects among the EA, LWS, and fiber contents and external curing that led to lower shrinkage and restrained expansion and greater strength. The combined use of EA, along with LWS, was shown to reduce concrete conductivity and improve corrosion resistance. Overall, the use of synthetic fibers, EA along with LWS, increased moist curing duration, and concrete cover depth was identified as suitable strategies for improving the corrosion resistance of Eco-Bridge-Crete mixtures.

Figure 1: Field implementation of flowable FRC with adapted rheology for construction of a bridge deck near Taos, Missouri

In Task II, the structural performance of reinforced concrete beams cast with FR-SWC mixtures made with different fiber types and reinforcing steel densities was evaluated. The testing involved the casting of beam elements with different steel reinforcement densities (0.4 to 0.8 in.2 of steel area in the tension zone).

Figure 2: Beams testing and crack monitoring

Project Information

PROJECT NAME: TR201806—Performance-Based Specifications of Fiber-Reinforced Concrete with Adapted Rheology to Enhance Performance and Reduce Steel-Reinforcement in Structural Members

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REPORT NAME: Performance-Based Specifications of Fiber-Reinforced Concrete with Adapted Rheology to Enhance Performance and Reduce Steel-Reinforcement in Structural Members

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