Transportation Consortium of South Central States

Toward Corrosion-Free and Highly Sustainable Structural Members by using Emerging Ultra-High-Performance Materials for Transportation Infrastructure

Key Points

Project Number:
18STUTA01

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University of Texas at Arlington

Funds Requested to UTC:
$70,000

Funding Source(s):
Tran-SET
University of Texas at Arlington

Total Project Cost:
$140,000

Brief Project Description

This study aims to develop next-generation highly corrosion-resistant and sustainable structural members by utilizing the high durability, compressive ductility, crack resistance and shear strength of ultra-high-performance fiber-reinforced concrete (UHP-FRC). The primary objective is to develop a design procedure for the new durable structural members through large-scale beam testing

Problem Statement

Ultra-high-performance fiber-reinforced concrete (UHP-FRC) is a new generation of fiber reinforced concrete which has ultra-high compressive strength and ductility. A concrete with only ultra-high compressive strength is not suitable for structural application, even reinforced with mild reinforcing steel, as the very brittle nature can cause potential issues such as abrupt unpredictable failures and a minimum capability of stress redistribution. UHP-FRC was developed by changing the porous nature of conventional concrete through reducing dimensions of microcracking (or defects) in the concrete. This is achieved in UHP-FRC through a very low water to cementitious materials ratio (0.18 to 0.25) and a dense particle packing, which leads to almost no shrinkage or creep, making it very suitable for concrete members under long-term compression. The consequences of a very dense microstructure and low-water ratio results in enhanced compressive strength. Furthermore, combining very ductile UHP-FRC with brittle but high strength FRP bars can provide corrosion-free characteristics needed for future concrete infrastructure.

Objectives

The research objective is to develop highly sustainable and efficient reinforced concrete structural members for future infrastructure by utilizing emerging high-performance materials. These materials include ultra-high-performance fiber-reinforced concrete (UHP-FRC) and corrosion resistant high-strength fiber-reinforced polymer (FRP) bars.

The primary parameters to be investigated include: (1) type of FRP bars (glass fiber, carbon fiber or basalt fiber); (2) fiber types of UHP-FRC (high-strength micro steel fibers and ultrahigh- molecular-weight polyethylene fibers), and (3) shear reinforcement (steel, FRP, or none).

Intended Implementation of Research

An important component of the implementation process will be the dissemination of findings through conferences that will present the findings and discuss their significance to the transportation agencies and related committees. The research team will report the results to ACI Committee 239 – Ultra-High Performance Concrete in their committee meeting. The ACI Committee 239 is currently developing a structural design guide for members using UHP-FRC. The research team will discuss the research findings with the committee and implement the proposed design procedure in the design guideline of the committee.

Anticipated Impacts/Benefits of Implementation

Region 6 is facing deterioration of bridge and transportation infrastructure due to deterioration of concrete and corrosion of steel. This study will develop a new type of RC structural members which have very high-strength, ductility, cracking and damage resistance, corrosion resistance, and superior durability. Using high-strength materials and eliminating shear reinforcement also leads to simple design and construction. Life-cycle costs of the new RC members are expected to be much lower than conventional RC members.

Weblinks:

- Tran-SET's website (http://transet.lsu.edu/research-in-progress/)
- TRB's Research in Progress (RIP) database (https://rip.trb.org/View/1505461)