Transportation Consortium of South Central States

Use Ultra-High-Performance Fiber-Reinforced Concrete (UHP-FRC) for Fast and Sustainable Repair of Pavements

Key Points

Project Number:
17STUTA03

Start Date:
05/08/2017

End Date:
11/08/2018

Principal Investigator(s):
Dr. Shih-Ho Chao
University of Texas, Arlington
Email: shchao@uta.edu

Lead Institution:
University of Texas, Arlington

Funds Requested to UTC:
$55,000

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

Total Project Cost:
$110,071

Brief Project Description

This project offers a new methodology which will enable the use an advanced fiber-reinforced concrete material which will delay or prevent the deterioration of transportation infrastructure when subjected to traffic and environmental loadings. The major concern regarding concrete structures is the considerable deterioration and consequent repair work needed due to its brittleness and limited durability. The consequence of concrete deterioration and short service life requires frequent repair and eventual replacement, which consumes more natural resources. Ultra-high-performance fiber-reinforced concrete (UHP-FRC) introduces significant enhancement in the sustainability of concrete structures due to its dense microstructure and damage-tolerance characteristics. These characteristics can reduce the amount of repair-rehabilitation-maintenance work significantly and give transportation infrastructure a longer service life, all of which will eventually lower the environmental liability of concrete use. This research will address the strong need to develop fast and sustainable repair UHP-FRC materials for concrete pavement repair that can be easily cast on site without special treatments such as heat, pressure, and vacuum. This avoids any major changes to current concrete production practice to accelerate the use of UHP-FRC materials for pavement repair.

Problem Statement

Statistical data shows that in industrially developed countries about 50 percent of total construction costs are related to repair, replacement, and maintenance of existing structures that have been deteriorated or damaged by environmental stress, structural loading, or other effects. The durability issues of structures can lead to a significantly higher life-cycle cost in comparison to the initial construction cost. Fast transportation infrastructure deterioration can be caused by climate change, overloaded and increasing traffic, and other environmental loads. Recent statistics indicate that annual pavement maintenance and rehabilitation budget is estimated to increase by around 30% (considering both the influences of climate change and transport demand changes). Deficiencies in conventional concrete and its subsequent impact on the environment calls

for a much durable material that will last longer under environmental stress, thereby contributing to the conservation of natural resources and the protection of the ecosystem. Many solutions have been proposed for enhancing the sustainability of concrete, and the use of ultra-high performance fiber-reinforced concrete (UHP-FRC) is a promising one. UHP-FRC has recently attracted the attention of researchers and practitioners not only because of its high compressive strength but also because of its excellent environmental resistance. Its high-early strength and durability allow for fast reopen the traffic and less future repair.

Objective

The objective of this study is to offer a new methodology which will enable the use an advanced fiber-reinforced concrete material (UHP-FRC) which will delay or prevent the deterioration of transportation infrastructure when subjected to traffic and environmental loadings.

Intended Implementation of Research

A critical component of the implementation process will be the dissemination of findings through several seminars or webinars that will present the results and discuss their significance to the transportation agencies as well as local cities, consultants and DOTs. The use of the findings from this research will not require any additional resources or testing to be implemented by various transportation agencies.

Anticipated Impacts/Benefits of Implementation

In the concrete repair/rehabilitation of highway infrastructure, this technology will enable municipalities and local government entities to repair/rehabilitate their local infrastructure in an accelerated fashion by bringing it back into service in twenty-four hours, and without the additional need for conventional reinforcement. This technology will also help municipalities and DOTs to design thinner layers of concrete pavement due to its high tensile strength, which will reduce the cost of material and labor by 40% regarding the pavement rehabilitation process. The potential economic impact in construction will be evidently clear with this technology because the strength and ductility of this concrete will reduce the cost of reinforcement placement and reinforcement materials. Before implementation, proof-of-concept testing will be done with the collaboration with local cities because they are facing frequent repairing issues of their transportation infrastructure. New repairing materials can be directly used by local cities without going through building or bridge code approval, thereby leading to a fast implementation process.

Weblinks:

- Tran-SET's website (http://transet.lsu.edu/completed-research/)
- TRB's Research in Progress (RIP) database (https://rip.trb.org/view/1467525)