Florida Department of Transportation Research

Synthesis Study Quantifying the Effect of UHPC Fiber Dispersion and Orientation in Structural Members

October 2023

Project Number
BDV30-977-34

Project Manager
Christina Freeman
Research Center

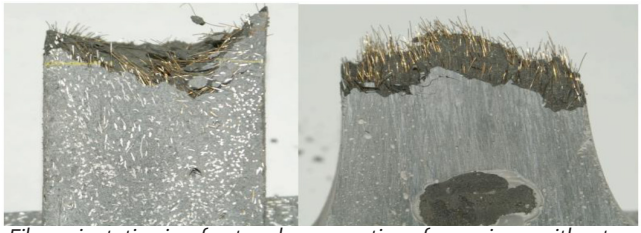
Principal Investigator
Dr. Qian Zhang
FAMU-FSU College of Engineering

Current Situation

Since 2000, global standards organizations have developed guidelines and standards for the materials, methods of construction, and structural design of ultra-high-performance concrete (UHPC). Due to its superior structural and durability performance, UHPC has been researched and implemented in Florida.

However, FDOT does not currently consider fiber orientation factors for the structural design of UHPC. These factors, adjust design capacity based on the direction in which fibers are arranged in the UHPC. That is important because fiber orientation influences the tensile strength of the concrete.

If FDOT knew the applicable fiber orientation factors and the background behind them, it would be better informed to implement reliable design and select appropriate casting procedures for UHPC members to achieve adequate structural performance.



Fiber orientation in a fractured cross-section of a specimen without any strain hardening (left) and with distinct strain-hardening (right).

Research Objectives

The objectives of this research were to synthesize decades of research and practicum surrounding fiber orientation factors for UHPC and analyze the rationale behind the standards set for UHPC design by several countries that have implemented guidelines for its use.

Project Activities

For this synthesis, the research team at the Florida A&M University-Florida State University College of Engineering conducted a two-part review of existing literature on UHPC materials, methods of construction, and structural design from several countries across Europe, Asia, and North America.

The first part of the literature review included design guidelines, recommendations, and codes on UHPC with a focus on methods and design factors to address fiber dispersion and orientation. The second part covered all other existing literature regarding the effect of UHPC casting procedures on fiber dispersion, orientation, and mechanical performance.

Following the literature review, the team made recommendations to address knowledge gaps about UHPC at FDOT and placed emphasis on an urgent need for quantification of fiber orientation in large-scale structures to ensure reliable design in future construction.

Project Conclusions and Benefits

FDOT now has current information on UHPC fiber orientation and dispersion quantification and therefore can consider adopting guidelines that will lead to procedures that achieve adequate structural performance of UHPC in future construction projects.

For more information, please see fdot.gov/research.