Florida Department of Transportation Research

Requirements for Use of Field-Cast, Proprietary Ultra-High-Performance Concrete in Florida

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Current Situation

Standard concrete is, at minimum, a combination of the portland cement, limestone aggregate, sand, and water. Additives such as supplementary cementitious materials (SCMs) like fly ash and water reducers enhance the strength and durability of concrete, and the exact proportions of these materials that produce desired results have been the subjects of much research. Further additives like reactive powders, fibers, and finely ground quartz or limestone have also been used to increase the strength and durability of concrete. The resulting product is called ultra-high performance concrete (UHPC), which can be five or more times a strong as standard concrete. When UHPC is used in structural designs, it is important to verify that it performs as expected. This is easier for precast materials, but when UHPC is cast in the field, reliable tests are needed.

A worker conducts a slump test of freshly made UHPC. This simple test helps verify the consistency of a batch of concrete.

Research Objectives

University of Florida researchers developed a method to measure the UHPC tensile stress-strain relationship. They also developed a specification for material acceptance of field-cast UHPC.

Project Activities

The researchers documented the state of the art on UHPC materials and construction by conducting a thorough literature review. This included review of project reports, journal articles, recent conference papers, and proprietary material data sheets and literature. The review covered a wide variety of topics related to materials, theoretical models, preparation of concrete, and testing methods. A comparison of sections of building codes and specifications for UHPC used by other countries was also performed. A survey of departments of transportation was conducted to determine current UHPC use and specification best practices.

To develop a draft Florida Test Method for UHPC tensile strength, a comparison of potential methods was performed at the University of Florida and Florida Department of Transportation (FDOT) State Materials Office (SMO). Flexural testing was compared with direct tension testing. The researchers used computed tomography to examine samples of UHPC placed at the center of the mold and the end of the mold to determine whether fiber direction was affected. No difference in overall fiber direction was seen, but in both cases, fibers tended to align parallel to the walls of the mold near the edges. This wall effect can alter results of tensions tests, so the researchers devised a correction.

Based on the project results, the researchers proposed revisions to the FDOT specification for UHPC. Their recommended changes to the specification were accompanied by extensive annotations giving the research basis for the recommendations.

Project Benefits

Improved specifications and performance verification will allow designers to use UHPC more widely and take advantage of its benefits in Florida transportation construction projects.

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