U.S. Department of Transportation
Office of the Secretary of Transportation

UTC Spotlight

University Transportation Centers Program

Florida International University

Quarterly
Issue 2
April 2025

How U.S. DOT-Sponsored University Transportation Center Is Reinventing Bridge Repairs with UHPC

Innovative Bridge Technologies/Accelerated Bridge Construction-University Transportation Center (IBT/ABC-UTC) at Florida International University (FIU) has developed a game-changing pneumatic spray technology. This innovative technology offers an economical solution for retrofitting/upgrading deficient bridges and/or their elements at a fraction of the cost of replacing them—while minimizing traffic disruptions and helping people maintain their daily routines. Additionally, the finished product can be stronger and more durable than the original structure. IBT/ABC-UTC successfully deployed this exciting technology for the first time in the United States in August 2024, on a bridge near Washington D.C. (https://www.fhwa.dot.gov/innovation/everydaycounts/edcnews/20250206.cfm).

This technology involves using an advanced material called Ultra-High-Performance Concrete (UHPC) in spray form. UHPC is a dense, durable material made from Portland cement, silica fume, fine sand, steel fibers, and a low water content. Its unique composition gives it four to six times the strength of conventional concrete, along with superior resistance to cracking under tension forces, moisture, and extreme conditions—making it ideal for long-lasting infrastructure repairs. Pneumatically Sprayed UHPC can strengthen deficient bridge elements and prevent further corrosion.

The unit cost of commercially available pre-bagged UHPC is relatively high. The good news is that the IBT/ABC-UTC at FIU, along with some other partner universities, have developed an open-source UHPC mix at a fraction of the cost of commercial versions. IBT/ABC-UTC has further modified this formulation and developed sprayable UHPC, along with specialized equipment, application methods, and curing techniques to enable its effective use in the field.

In August 2024, in cooperation with the Virginia Department of Transportation (VDOT), IBT/ABC-UTC deployed its sprayable UHPC technology to repair portions of two abutments of a bridge located at the intersection of I-495 (Capitol Beltway) and Route 50 in Fairfax, Virginia. This first real-world application of sprayable UHPC in the United States has attracted interest from many State DOTs and bridge owners, as it provides an economical and long-lasting solution that is not easily achievable with most other materials.

The first successful application of sprayable UHPC in August 2024, provided lessons for facilitating future field applications. These lessons have been communicated through several webinars and other IBT/ABC-UTC's technology transfer activities with stakeholders.

Figure 1 shows photos of the two abutments near Washington D.C. that were partially repaired using sprayable UHPC. The abutment on the left was used as a practice case on Monday, August 19, 2024 while the primary repair work was carried out on the abutment on the right on Wednesday, August 21, 2024.

Figure 1. Two abutments partially repaired using Sprayable UHPC.

Prior to the arrival of the IBT/ABC-UTC team, VDOT removed the contaminated concrete and prepared the abutment surfaces for the spray process. VDOT decided not to place additional steel reinforcement over the

abutments before spraying. Figure 2 shows the condition of both abutments as they were ready for UHPC spray application.

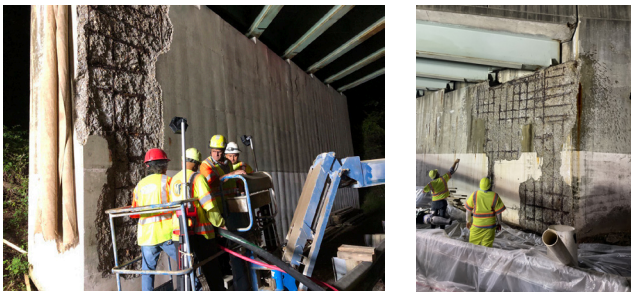

Figure 2. Condition of both abutments ready for spray process.

Figure 3 shows the left abutment in Figure 1 being sprayed in August 2024, and the condition of the same abutment in January 2025. It should be noted that the demonstration was limited by the mixer capacity and the amount of material transported to the field; therefore, only a portion of spalled area of the right abutment shown in Figure 2, was sprayed with UHPC. However, a larger area is certainly achievable, and greater build thickness can be attained by applying additional layers.

Figure 3. One of the abutments repaired using sprayable UHPC during spray procoss and the same abutment about four months after spray.

Spray application of UHPC to repair deficient bridge elements is typically achieved by spraying the UHPC in layers of about ¼-inch thick. Each layer should be allowed to dry for about three minutes before applying the next layer. For the abutment shown in Figure 3, each layer took less than two to three minutes to apply. Thicknesses larger than even two inches can be achieved by building up successive layers. Standard tests such as the ASTM C1202, Rapid Chloride Permeability Test (RCPT), can be used to determine the necessary thickness to meet specific durability targets. Experimental studies conducted at IBT/ABC-UTC indicate excellent bonding between sprayed UHPC and substrate normal strength concrete. In addition, freeze/thaw tests confirmed that the bond in between sprayed UHPC and substrate normal strength concrete remained unaffected by numerous cycles of freeze/thaw exposure.

Currently, IBT/ABC-UTC is conducting work to extend the application sprayable UHPC to repair steel culverts, as shown in Figure 4.

Figure 4. Work to extend the application of sprayable UHPC to Repair/Upgrade capacity of existing deficient steel culverts

Future plans include building a deployment trailer equipped with all necessary equipment for on-site removal of the contaminated concrete and UHPC spray application. The plan also includes establishing a spinoff company to offer sprayable UHPC services to the bridge community, as well as conducting training workshops, to train contractors interested in adopting the technology. Training workshops are expected to start in late 2025. Interested parties are encouraged to contact Dr. Atorod Azizinamini, Director of IBT/ABC-UTC, at aazizina@fiu.edu.

About This Project

This project is led by Dr. Atorod Azizinamini at Florida International University through the U.S. DOT-funded Innovative Bridge Technologies/Accelerated Bridge Construction University Transportation Center (IBT/ABC-UTC). Since 2013, IBT/ABC-UTC research has focused on developing generations of Accelerated Bridge Construction (ABC), affordable UHPC materials, pneumatic spraying systems, and other innovative technologies to improve the construction, repair, and durability of bridges. The work combines automation and advanced materials to address critical infrastructure challenges.