To enable this repair technique, the material should be strong both in tension and compression, should be able to be cast in tight spaces and formed into complex geometries, form a strong bond with steel through mechanical connections, and have superior durability characteristics," he explains. "UHPC is a material that fills all these needs; it has any other available option, like regular-strength concrete, lacks one or more than one of these fundamental characteristics."

The second feature of UHPC that it could be placed via a leadwood polyvinyl chloride (PVC) pipe distribution system that was sized and designed for the specific conditions of each girder end being repaired and accessed via the top of the deck. Because of this, the bridge owners had no choice but to shut down the work in place.

The university researchers worked with the Connecticut Department of Transportation (ConnDOT) and a number of stakeholders in the government and private sector on the method's development; ConnDOT is implementing the new technique in the field. "My research team has stayed involved in the implementation phase of the project to support a... transfer of research to practice and to perform short- and long-term monitoring of the performance of the repair method" in real life," Zaghly says.

Four of the modified beam ends will be equipped with 64 sensors (16 per beam end) to monitor their performance, including strain gauges, displacement transducers to measure movement, and thermocouples to measure temperature changes, among others. These sensors will be cast into the girders and will be monitored on-site. The gathered data will provide empirical evidence about the girders' performance and be used to revise the team's analytic models, according to Zaghly.

While UHPC is known as an expensive material, the fact that it does not need to be maintained once it has been cast in place on the girder ends makes it a viable alternative to the conventional repair method used for steel bridges, according to Zaghly. Typically, damaged regions of steel girders are fixed by welding or bolting new steel plates overaged, corroded areas. However, the new steel plates must be regularly maintained, inspected, and painted, and they will also likely corrode and need to be replaced. With UHPC, the beam end corrosion will not worsen and the initial UHPC repairs can remain in place until the bridge itself is replaced, according to Zaghly.

"Certainly, UHPC is not the one-size-fits-all solution for all repair projects, but we have a long way to go to fully utilize the unique characteristics offered by the material," Zaghly notes. Research into the use of UHPC in other projects is under way by Zaghly, Hain, and others and includes connections to enable accelerated bridge construction, overlays for bridge decks, and the construction of main structural elements such as girders. (For some examples of UHPC's use in bridges, see "Infrastructure Solutions: Bridges Move Forward," Civil Engineering, July/August 2018, pages 70-79.) Future UHPC projects on steel girders in ConnDOT bridges are also being planned.

—CATHERINE A. CARDINO, PH.D.

WASTEWATER

Learning from Hurricane Harvey, Pearland, Texas, to Construct New Treatment Facility

S PURRED by population growth and the desire to fortify its wastewater infrastructure against the risk of major flooding, the City of Pearland, Texas, is moving forward with the construction of a new, expanded version of its 3.1 mgd Barry Rose Water Reclamation Facility (WRF). This month, the city plans to begin construction on a new 1.3 mgd expansion and new rate structure management at-risk (GMR) to implement the project, which also entails the demolition of the city's Longwood 2 mgd water treatment facility and the construction of two new wet weather reuse complexes.

As an example of the work done by the City of Pearland in the wake of Hurricane Harvey, the city has a 100-year floodplain in which more than 25,000 homes were flooded through a new, approximately 25,000 linear foot long force main to the new Barry Rose WRFR. In essence, Pearland is combining the two service areas into one," says Robert Upton, PE, the city's director of engineering and capital projects.

"Stance, which has its headquarters in Bakersfield, Calif., is a leader in the recycling and reuse of wastewater," says Paul Sikes, the company's vice president for business development. "We have a number of projects that are in various stages of development, from concept to construction. We are currently working with the city of Bakersfield on a project to provide recycled water for agriculture and landscaping. We are also working with a number of other cities in California, Oregon, and Washington to provide recycled water for various applications, including irrigation and landscaping. Our goal is to provide a sustainable and ecologically friendly solution to the water scarcity problem facing many areas of the United States."