Bowman Road Bridge over Shem Creek

Lightweight concrete makes heavy impact

by Adam Lansing, KCI Technologies

Side view of Bowman Road Bridge over Shem Creek (U.S. Route 17 Overpass in background). All Photos: Adam Lansing.

One of the benefits of design-build contracting is that engineers and contractors can react to unforeseen circumstances more effectively because they are partnered together through the project's life cycle. As part of the $84 million U.S. Route 17 (Johnnie Dodds Boulevard) widening and improvement project in Mt. Pleasant, S.C., that partnership had a substantial impact when the contractor encountered problems driving piles to replace the existing structure carrying Bowman Road over Shem Creek.

The new 90-ft-long, 78-ft-wide, three-span, flat-slab Bowman Road Bridge over Shem Creek, which carries the roadway across a tidal marsh, had many design challenges. These challenges included its low profile to the waterline, as well as road tie-ins in close proximity to both ends of the structure. Additionally, the Bowman Road Bridge over Shem Creek sits within the Lower Coastal Plain Physiological Province, a region of high seismic risk, which has sedimentary deposits exceeding 1000 ft thick. During an earthquake, these deposits can amplify seismic waves, which generate large ground accelerations and increase force demand on the structure. Also, geotechnical analysis indicated that liquefiable soils were present at the site along with corrosive salt water.

The design developed by the engineer specified a prestressed concrete pile foundation using 24-in.-square piles for each of four bents. However, when driven to the anticipated tip elevation, the piles in the interior bent did not attain the required resistance. The project team concluded that adding length to the piles by splicing so they could be driven farther and achieve the required resistance would not be acceptable because the splice would be located in a region with high flexural demand. After Pile Dynamic Analyzer and statnamic testing was conducted, engineers determined that the piles would meet all requirements if the superstructure design was modified to use lightweight concrete. They then worked with the lightweight aggregate and concrete suppliers to quickly obtain approval for the mixture proportions.

Although generally a more expensive material, the lightweight concrete provided additional value in this case not only by decreasing the bridge weight, which quickly solved the foundation concerns and minimized further schedule delays, but also by reducing permeability (improved resistance to chlorides), and increasing durability via enhanced internal curing provided by the pre-wetted, porous lightweight aggregate.

Through the design-build process, the team was able to bring the necessary resources together to deliver workable solutions that resulted in the Bowman Road Bridge over Shem Creek that will serve Mt. Pleasant residents and their guests for many years to come through increased vehicle capacity, enhanced safety, durability, and pedestrian accessibility.

Old Bowman Road Bridge prior to demolition.

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EDITOR'S NOTE

For further information on lightweight concrete, visit the website for the Expanded Shale, Clay and Slate Institute: www.escsi.org.