Concrete Repairs of the Wright Memorial Bridge

By Michael LaPrade

The Wright Memorial Bridge has served as the gateway to the sunny beaches of the iconic Outer Banks of North Carolina for millions of vacationers since 1930. The bridge crosses roughly 3 miles (5 km) across the Albemarle Sound between the towns of Currituck and Kitty Hawk. The first bridge, completed in 1930, was an entirely wooden toll bridge, which replaced a ferry. As the Outer Banks gained in popularity and traffic flows increased, it became abundantly clear that an update was in order. In 1966, the "new" Wright Memorial Bridge was built and opened to traffic. This upgraded bridge allowed beachgoers to travel at speeds of 55 mph (89 km/h). A second bridge to serve westbound travelers was completed in 1995, resulting in two lanes of traffic in both directions. The older, now eastbound, bridge was determined to be in need of repairs by the North Carolina Department of Transportation (NCDOT). Flatiron Constructors Inc. won the bid for the project and brought in Coastal Gunite Construction to provide the substructure concrete repairs and the installation of cathodic protection on the bent caps.

SELECTING SHOTCRETE FOR THE REPAIR METHOD

Spalled concrete and damaged reinforcing steel were prevalent throughout the entire structure. Indeed, the need for repairs was far more extensive than originally determined. Coastal Gunite and the NCDOT agreed that shotcrete was a superior method of repair for all the damaged concrete including the prestressed girders that were originally specified to be repaired using form-and-pour methods. This change allowed for a more efficient and cost-effective high-quality repair.

US Concrete Products, operating out of Timonium, MD, provided a dry-process shotcrete mixture that was specifically designed to work with cathodic protection systems. A reduction in fly ash in its standard prebagged dry-mix shotcrete product allowed for increased permeability while maintaining an acceptable design strength. This mixture was used to repair the concrete of the bent caps prior to surface metalizing operations. The metalizing operations had a strict 10-day waiting period after a cap was shot, before molten

Fig. 1: The Wright Memorial Bridge

Fig. 2: Repair location on bent cap

Fig. 4: Coastal Gunite Construction Company and Inspector testing for continuity

Fig. 3: Nozzlemen shooting back damaged bent cap

Fig. 5: Preparing to apply zinc anode

zinc could be applied. This timetable, paired with numerous other subcontractor operations, created an environment that required detailed coordination and planning.

CATHODIC PROTECTION

The cathodic protection for the bent caps was installed in three phases after completion of the underlying concrete repairs. First, electrical continuity had to be established to each reinforcing bar in the bent cap. Using a reinforcing bar finder, every reinforcing bar was located, and a hole drilled through the concrete to it. An electrical multimeter was then used to determine if each bar was electrically continuous with the others in the cap. If not, the bars were connected by resistance welding steel wire between the individual members until continuity could be established throughout the cap reinforcement. To establish an electrical connection between the existing reinforcing steel and the zinc coating to be installed in the metalizing, threaded rods were tapped into selected reinforcing bars on each side of the cap and fitted with a metalized plate. These locations will also be used to test for electrical continuity and to observe the condition of the reinforcing steel in the future. The second phase consisted of applying a 16 to 18 mil (0.4 to 0.5 mm) coating of zinc using thermal spray equipment to project

Fig. 6: Finished application of zinc anode and testing plate

atomized zinc onto the surface where it cools in a uniform coating. The third and final phase was to apply a zinc silicate topcoat, applied with paint spraying equipment.

PROVIDING ACCESS TO THE PROJECT

Access to the underdeck, bent caps, and girders was achieved using a couple of Anderson Hydra-Platform trailer-mounted under-bridge access machines and working from the water as well. Coordinating with other contractors to perform the work on top of the bridge required Coastal Gunite to work from the water; equipment was staged on two 10 x 20 ft (3 x 6 m) barges that were married together. Rough water conditions were common, limiting the use of the barges as stable work platforms, so a swing stage was suspended from the parapet walls of the bridge to provide a suitable work access to the bent caps. Multiple scaffold hangers were installed when bridge deck access was limited so that the scaffolding sets themselves could be moved around from the water level. This system allowed the contractors on site to work efficiently and decrease the total duration of the project and limit inconvenience to travelers.

WEATHER CHALLENGES

Several severe weather events impacted the project. In the winter of 2018, record low temperatures caused the Albemarle Sound to completely freeze over, something no locals could recall happening before. This made work from the water impossible and stalled all but the concrete removal operations. The job was also plagued by two different tropical storms.

Hurricane Florence hit the Carolina coast in mid-September and caused storm surges and high winds at the Wright

Fig. 7: Anderson Hydra-Platform Bridge Access Machines in use

Memorial Bridge. Advanced warning systems allowed Coastal Gunite to properly secure and evacuate all personnel, equipment, and materials well in advance of the storm. Although Hurricane Florence had devastating impacts in North Carolina further south, the project was able to resume afterwards relatively unscathed. Hurricane Michael, which after crossing over land from the gulf coast, hit the project unexpectedly hard from the west resulting in far more equipment damage, cleanup, and delays. Scaffolding still staged under the bridge was especially hard hit despite it being secured before the storm.

CONCLUSIONS

Vacationers on the Outer Banks this season will enjoy safe access to the beaches unencumbered over a bridge which, thanks to the recent repairs, should enjoy a much longer service life. Due to the limited access and required coordination with other contractors, the flexible and nimble repairs that shotcrete enabled facilitated the swift execution of the project. The use of shotcrete in combination with thermal zinc spray cathodic protection systems provide a product that will sustain the bridge far into the future.

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Fig. 8: Barge system for metalizing operations

Fig. 9: Swing stage scaffolding