

Fort McHenry Tunnel Miscellaneous Structural Repairs

By John Becker

At the time of its construction, the widest underwater tunnel in the world, the Fort McHenry Tunnel in Baltimore, MD, was opened to traffic in 1985. It houses Interstate Route 95 as it travels under the Baltimore Harbor and is operated and maintained by the Maryland Transportation Authority. In 2011, Coastal Guniting Company was given the task of repairing spalled and delaminated concrete areas of the two southbound bores on the underside of the road deck and other areas in the fresh air duct that runs beneath the roadway (Fig. 1 and 2).

Minimizing exposure of the ventilation fans to dust was a prime concern during the execution of these repairs. The bulk of the concrete was removed using hydrodemolition by Rampart Hydro Services with a rig specially designed to maneuver and work in the small space of the duct. The repair areas ranged in depth from 1 to 6 in. (25 to 150 mm) depending on the extent of the deterioration and corrosion present. The hydrodemolition process also roughened the existing concrete surface sufficiently such that no additional roughening was required.

As another way to minimize dust, the damaged concrete of the structure was replaced by Coastal

Guniting using the wet-mix shotcrete method. The shotcrete needed to maintain a minimum of 2 in. (50 mm) cover over the reinforcing steel, necessitating that it be built out past the surface of the existing concrete sections in most places. It was given a fine brush finish. Because of the inconsistent and limited access times for construction, a preblended, dry material bag mixture provided by US Concrete Products was batched on site. Batching on site also allowed Coastal Guniting to accurately optimize the water-cement ratio (w/c) for the placement needs.

Because of the high volume of material and short working time available, the debris generated from the hydrodemolition and shotcrete activities had to be handled and removed using small equipment and a great deal of labor through the few available manholes (Fig. 3 and 4). Wastewater generated by the hydrodemolition and shotcrete activities had to be collected and properly treated to prevent negative environmental impact.

The Maryland Transportation Authority provided traffic control for the project. All work was done at night and required the closing of one bore of the tunnel at a time. Because the tunnel is such a vital traffic artery, the entire repair



Fig. 1: Mobile shotcrete equipment in tunnel (work is underneath road deck)

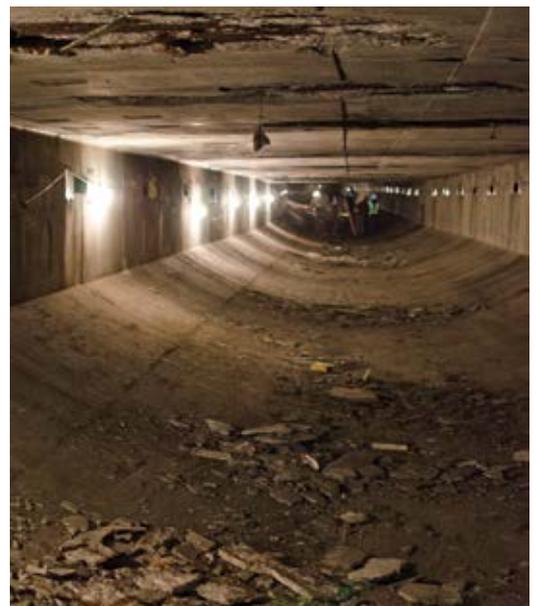


Fig. 2: Underside of road deck prior to rehabilitation activities



Fig. 3: Hydrodemolition robot in action removing overhead concrete



Fig. 4: Areas after hydrodemolition and hand chipping behind reinforcing steel ready for shotcrete



Fig. 5: Placing overhead wet-mix shotcrete



Fig. 6: Completed ceiling and wall rehabilitation

operation had to be designed so that, if necessary, the job site could be vacated and the bore reopened within 30 minutes. To accommodate this requirement, all necessary equipment and materials mobilized in the roadway were mounted to and used from trailers or vehicles, enabling them to be removed quickly. All equipment left in the air duct had to be fully secured as well. Liquid accelerator was used in the shotcrete mixture to guarantee that the repair material would reach initial set before traffic resumed in the bore.

An unanticipated difficulty arose, as it was found that the water piping and electrical utilities encased in the concrete walls on both sides of the fresh air duct were heavily corroded. Removal of the deteriorated and corroded materials without causing further damage to the equipment while it was in use required delicate use of hand tools. Much of the replacement reinforcing steel used on the project went into these areas, as total corrosion of the existing reinforcement was common (Fig. 5 and 6).

The extent of necessary repairs significantly increased from the initial estimates the contract for the project was based on, requiring substantial additional work in some areas. Thus, the decision was made to exhaust the original funding designated for the project and leave the work

unfinished. Ultimately, after we completed the first phase, two additional phases were added to complete the project. The third phase has not yet been completed. By placing the 23,600 ft³ (668 m³) of concrete using the wet-mix shotcrete method, the repairs were completed much faster and more efficiently than possible with other methods. This construction efficiency and flexibility convinced the Maryland Transportation Authority that shotcrete was the method of choice for the rest of the needed repairs in the tunnel.



John Becker is an ACI Certified Nozzleman who, for the last 5 years, has worked in many capacities—most recently as Project Manager—for Coastal Gunitex Construction Company based in Cambridge, MD. In addition to the Fort McHenry

Tunnel, he has been involved with many shotcrete projects large and small, including the \$15 million Bonner Bridge Rehabilitation Project in Nags Head, NC, and the \$5 million Old Mill Creek Sewer Rehabilitation Project in St. Louis, MO.