Shotcrete Rehabilitation of the Noblestown Road Bridge

By Ted W. Sofis

The Noblestown Road Bridge is located in Allegheny County just outside of Pittsburgh, PA, in Pennsylvania Department of Transportation's (Penn DOT) District 11. The Noblestown Road Bridge piers were badly deteriorated for a structure of its age and the deterioration in many places looked as if the concrete had eroded away like a mud embankment.

In concrete rehabilitation, certain things remain constant. To get a good repair, all unsound or deteriorated concrete needs to be removed because the shotcrete is only as good as the material to which it adheres. Whenever possible, it is important to get behind the outer layer of reinforcing bars. This secures the shotcrete to the surface better than any anchors or dowels. In past years this was often ignored and many repairs were treated as merely cosmetic surface treatments that had little structural value. On installations over the years where the extra time was taken to get behind the reinforcing bars, however, much better results have been achieved.

Sofis Company Inc. bid and won the project working with Thornbury Inc., the general contractor. The sequence of operations dictated that only one half of the bridge could be worked on at a time. Thornbury set up a traffic pattern diverting all traffic to the two westbound lanes with one lane in each direction taking the entire load off of the two eastbound lanes. Towers were erected at Piers 1, 3, and 5; and the bridge was jacked up to support the structure during removal of concrete on the bridge piers. The concrete removal work began in early August. Due to structural concerns, removal of concrete from both sides of the piers' hammerheads at the same time was not permitted. Therefore, the concrete had to be removed, the surfaces prepared, and the one side gunned and given time to cure before beginning removal and replacement on the other side. After work was completed on the piers supporting the two eastbound lanes, the traffic was diverted to the two westbound

A badly deteriorated bridge pier

Concrete removal and surface preparation prior to the shotcrete placement

lanes and work was allowed to begin on the tops of the other piers.

The method of repair chosen was the dry-mix shotcrete process. This choice was made for several reasons. With the dry-mix process, both the overhead and vertical areas could be shot to the full depth of the repair without using any accelerators. A full-depth monolithic repair is preferable to shooting in layers because it eliminates laminations that can sometimes prove to be points of failure. Also, with scattered repair areas, work could stop and start more easily without concern about wet material in the hoses, as is the case with the wet-mix shotcrete process. The dry-mix process allows the nozzleman to make the adjustments in water content at the nozzle and allows the material to be placed with a much lower water content. So the material being installed is essentially a zero-slump pneumatically-placed concrete. As the shotcrete contractor, Sofis Company was responsible for saw-cutting the perimeter of the repair areas, tearing out the deteriorated concrete, sand-blasting the reinforcing bars, adding new reinforcing bars where needed, installing the mesh, drilling and installing epoxy anchor bars, and placing shotcrete to restore the concrete piers to their original contours.

The material chosen for the repair was Quikrete Shotcrete MS with a Cortec migrating corrosion inhibiter added. By using Shotcrete MS, a premixed material, the need for on-site mixing was eliminated, which provided better quality control for the shotcrete mixture. Premixed materials are blended in a more controlled environment and the ratios are uniform and certified by the manufacturer. The cement and aggregates are kiln dried and the material can be predampened on site to achieve the optimal moisture content. Often with on-site mixing, ratios can vary and sand may be too wet, which can create production problems, plugged hoses, and a slug feed that causes surging. On this project, the premixed material was predampened with an auger-type predamper and the Shotcrete MS was shot with a rotary Ridley C-10 gunite machine manufactured by Airplaco. Both the auger-type predamper and the rotary gunite machine are continuous feed devices, so as the premixed material is predampened, it is immediately conveyed into the gun and through the hose. The moist material is not allowed to sit and is only dampened moments before being fed into the gunite machine and discharged. Therefore, there is no concern with truck time as with ready mixed concrete or with the moist sand reacting with the cement in large holding hoppers in some of the older batch-type mixing rigs.

Overhead dry-mix shotcrete application to a pier hammerhead

A completed shotcreted section of a pier hammerhead

A shotcreted section of a bridge pier

A completed shotcrete repair of a pier

Projects of this nature require good cooperation between the general contractor and the subcontractors. In this case, there was work on the piers where both parties had to do repair work. Thornbury personnel had areas of Class AA concrete repair and Sofis had the shotcrete, so work had to be coordinated for both contractors to properly sequence their repair work.

A material hopper with the material being predampened and fed into a rotary gunite machine during shotcrete placement

In the 1960s and 1970s, Sofis Company did a lot of shotcrete rehabilitation work for the Penn DOT in the Pittsburgh area. In the 1980s, Penn DOT's District 11 began to specify that its spall repair work be done with cast-in-place concrete, due largely to a lack of suitable technical information, poor practices, and mixed results with shotcrete. This is now changing, however, in part due to the efforts of the American Shotcrete Association (ASA). Engineers, contractors, and suppliers are now better informed about the advantages of using shotcrete. ASA has done an outstanding job of educating those in the industry regarding proper practice and procedures, furnishing technical data, and promoting nozzleman certification, along with the American Concrete Institute, to establish and regulate the quality of shotcrete workmanship. Shotcrete has been around for a century and it has long been a excellent method for the repair of concrete structures. Hopefully, in the twenty-first century, with support provided by ASA, we will continue to develop and to make use of its advantages.

Ted W. Sofis *and his brother, William J. Sofis, Jr., are principal owners of Sofis Company, Inc. After graduating from Muskingum College, New Concord, OH, with a BA in 1975, he began working full time as a shotcrete nozzleman and operator servicing the steel industry. He began managing Sofis Company in 1984, and has over 34 years of experience in the shotcrete industry. He is an ASA-approved Shotcrete Nozzleman Educator, serves on the Board of Directors of the American Shotcrete Association (ASA), and is a member of the ASA Publications and Education Committees. Over the years, Sofis Company has been involved in bridge, dam, and slope projects using shotcrete, as well as refractory installations in power plants and steel mills. Sofis Company is a member of the Pittsburgh Section of the American Society of Highway Engineers (ASHE) and ASA.*