2018 Outstanding Underground Project

Tiber Creek Sewer Rehabilitation

Old structural improvements are replaced safely while maintaining integrity

By John Becker and Randle Emmrich

As part of the DC Clean Rivers Project – Division 1 Main Pumping Station Diversions, the Tiber Creek trunk sewer was designated to receive a new structural liner in a 122 ft (37 m) section near the intersection of New Jersey Ave. and Tingey St. in southeast Washington, DC. The rehabilitation involved creating new supporting arch structures using the shotcrete placement method between previously installed steel bents. Once the shotcrete arches reached the required strength, the steel bents were removed, a new mat of reinforcing steel was installed, and the entire length of repair was fitted with a new continuous 6 in. (150 mm) shotcrete liner.

ACCESSING THE PROJECT SITE

Throughout the planning and construction processes, site access was a major concern and hurdle to overcome. First, entry into the project site was limited to two 36 in. (900 mm) manholes, and the normal sewer flow could not be redirected during a rain event. The ability to place concrete using the shotcrete method lent itself well to the situation, given it could be installed quickly and efficiently in all positions with minimal footprint in the sewer. Shotcrete also allowed the use of a rapid-set accelerator which could achieve initial set within an hour, ensuring no damage from potential storm water flow should there be rain or failure in the flow diversion systems. Also, the shape of the sewer, with one big line diverting into two smaller ones, would have made the formwork to support a form-and-pour concrete method complicated, expensive, and interfered with the flow during a rain event.

Site access was also a consideration in the selection of the concrete repair material. The material availability needed to synchronize with the availability of work in the sewer. Concrete trucks were not considered a viable option due to past negative experiences trying to get relatively small quantities of concrete delivered on time and still meet the required specification through Washington, DC's notoriously foul traffic. The project site was in the middle of high-end residential and commercial buildings, so the dust creation associated with dry-mix placement methods was also a concern. Ultimately, prepackaged shotcrete material was mixed on site and placed with a combination concrete mixer-pump. King Packaging Materials MS-W1, a silica fume-enhanced, prepackaged shotcrete mixture designed for wet-mix placement, was selected for its superior consistency and excellent pumpability, though limited storage space on site necessitated a careful control of material lead times and delivery schedules. The concrete was ordered in bulk bags and loaded into the hopper of a volumetric

Fig. 1: Installing first shotcrete layer

Fig. 2: Removing preexisting bents

Fig. 3: Installing second mat of steel

Fig. 4: Single bore prepared to receive second mat of steel

concrete mixer truck that fed the mixer on the pump. Mixing the material in smaller batches helped maintain stricter quality standards because the amount of water added to the mixture and the mixing time were both closely monitored. The staging area required for the entire shotcrete operation was small and mobile. The only equipment needed on the project were a volumetric mixer, concrete mixer-pump, and air compressor. On a busy, crowded construction site, this small footprint and setup flexibility was appreciated as the surrounding construction continued and the site setup needs evolved. If the traditional form-and-pour method was used, a significantly larger staging area would be needed to accommodate all the equipment.

SHOTCRETE PLACEMENT

Not only was shotcrete a viable option for restricted access reasons, but it also reduced the labor required to complete the rehabilitation work because there was no earthwork or formwork needed. The shotcrete was placed on existing prepared surfaces, which greatly reduced the overall cost of both the labor and material.

The original plans called for the use of wire mesh reinforcement to be installed during each phase of construction. However, because all materials had to be brought into the tunnel via a 36 in. manhole, it was determined to substitute a mat of No. 3 reinforcing bar, which could be more easily handled and manipulated into place given the restricted access and complicated shape of the sewer. The small diameter of the reinforcing bar made it easy and quick to cut and bend on site as needed.

Coastal Gunite convinced the Owner and Engineer to allow us to shoot in multiple layers as opposed to full-thickness applications. This is possible because properly prepared and placed shotcrete in layers structurally acts as monolithic concrete. This was a faster and more efficient method for placing the material and allowed for easier removal of the existing steel supports between the shotcrete arches. Sika Sigunit L72 AF liquid accelerator was introduced at the nozzle allowing a rapid initial set and the shotcrete to be installed in thicker layers (8 to 10 in. [200 to 250 mm]) than otherwise would have been possible. It also allowed the concrete to be pumped with a greater slump, reducing the risk of plugged delivery lines and reduced stress on the shotcrete pump. The rapid strength gain and high compressive strength value allowed for more production during short working periods. The shotcrete was placed overhead in an underground arched sewer, which added complexity to the project, but it was easily overcome with good-quality, wet-mix shotcrete and a qualified contractor with an ACI-certified nozzleman.

Fig. 5: First layer of shotcrete installed with preexisting support bents still in place

Fig. 6: Second mat of steel installed

ON-SITE DUST CONTROL

Due to the new OSHA silica regulations, the worksite was constantly being vacuumed and dust producers were wet-down to prevent any excess dust. All employees were also fitted with the appropriate respirators to comply with the new regulations and the confined space environment. Airborne silica was also of great concern as the work was being performed in a busy pedestrian area; containment and filtering systems were key to ensuring their safety. Because the site was also an active sanitary sewer, after every rain event, the site had to be cleaned again before work could be safely performed. Strict decontamination procedures were required for all people and equipment after removal from the line to prevent the potential spread of disease to workers and the surrounding public in close proximity.

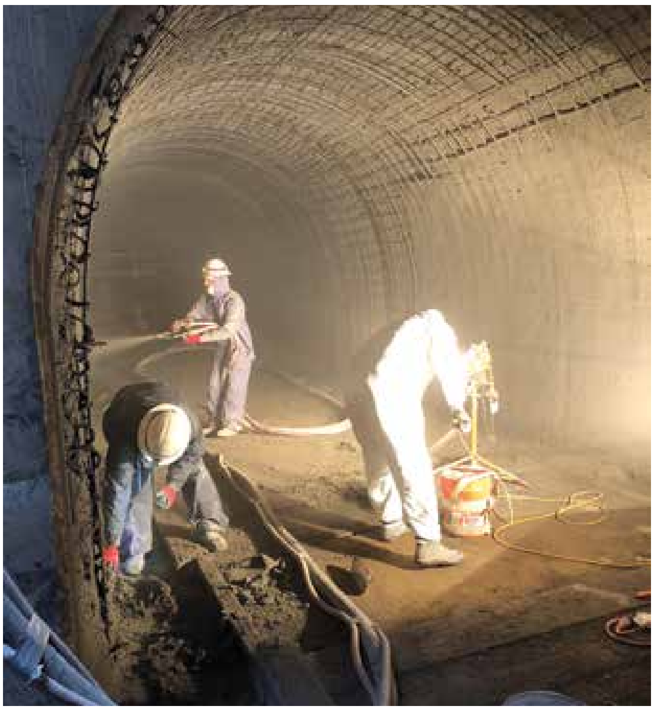

Fig. 7: Placement of second layer of shotcrete

COLD WEATHER OPERATIONS

Measures were taken so that the project could continue to progress efficiently even during cold weather. A propane tankless water heater was plumbed into the concrete mixing system to raise the concrete material temperatures to meet the specified requirements. The sewer also had to remain both ventilated and warm, so the fresh air supply was also heated using a vented propane heater. The work area itself was separated from the rest of the sewer as the natural airflow was too cold for work to be performed.

MONITORING OF WATER LEVELS

The main flow of the sewer line was diverted because, even under normal flow conditions, the flow would have been a serious hazard to our workers. Water level monitors connected to alarms were installed on both ends of the work area to alert workers of rising water. A strict lock-out tag-out procedure was also implemented in conjunction with DC Water to protect against the accidental release of the diverted flow into the work area. Due to variables including weather and normal water treatment repair and maintenance operations, access to the sewer was highly variable and nearly impossible to predict with any accuracy. Fortunately, another project also performed by Coastal Gunite at DC Water's nearby water treatment plant allowed our out-of-state workers to remain productive and kept the manpower

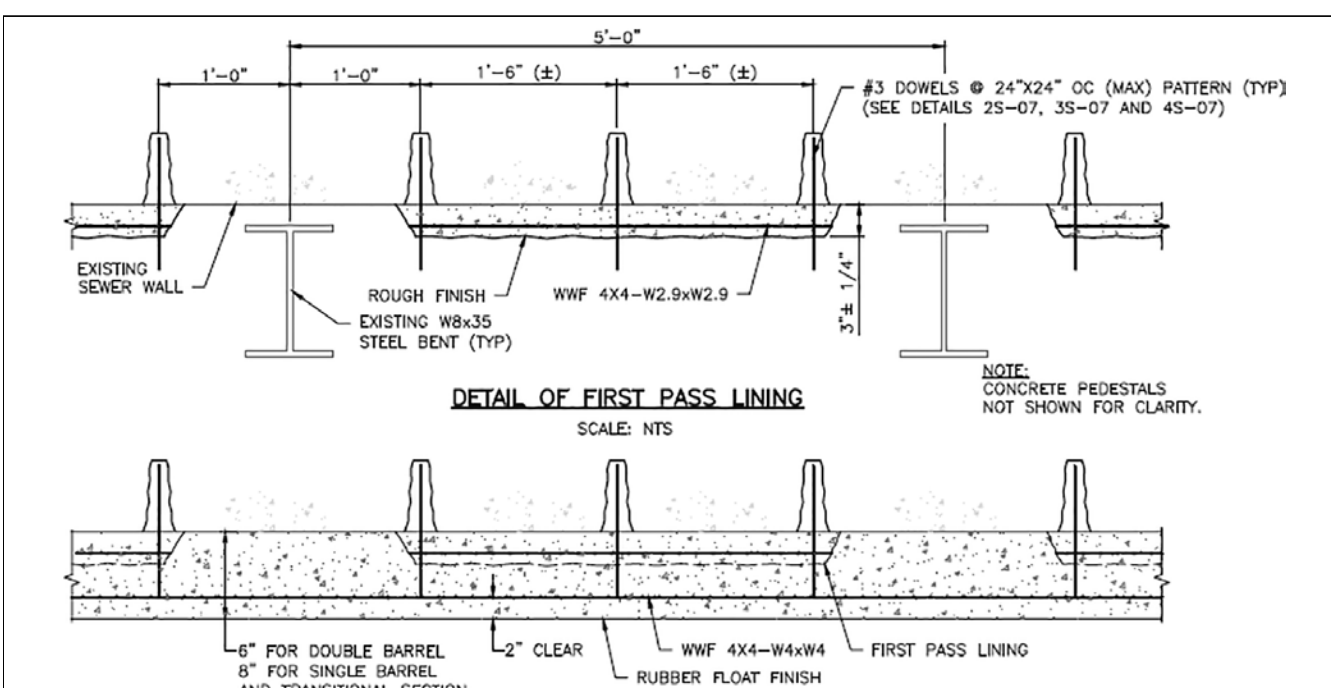

Fig. 8: Sequencing of shotcrete installation in two phases

available for the Tiber Creek Sewer project when access was permitted.

Conclusions

Shotcrete placement for rehabilitating the sewer allowed traffic to continue uninterrupted and the sanitary sewer could remain in active service throughout the project. Even though access to the sewer for work was often limited due to regular rain events and other on-site construction activities, shotcrete's flexibility made for maximum efficiency and productivity when the sewer was accessible.

In summary, a heavily traveled street in downtown Washington, DC, plus an active sanitary sewer that needed to remain fully functional with only a standard manhole available to access the work meant that shotcrete was THE option to complete the rehabilitation of this large-diameter sewer.

Fig. 9: Placement of second layer of shotcrete

Fig. 10: One barrel of double barrel section completed

John Becker *is an ACI-Certified Nozzleman who for over a decade has worked in many capacities, most recently as Project Manager for Coastal Gunite Construction Company based in Cambridge, MD. He has been involved with many shotcrete projects including the $15 million Bonner Bridge Rehabilitation Project in Nags Head, NC; the $5 million Old Mill Creek Sewer Rehabilitation Project in St. Louis, MO; and the $19 million Fort McHenry Tunnel Rehabilitation in Baltimore, MD.*

Randle Emmrich *is Vice President for Coastal Gunite Construction Company, Bradenton, FL. She received her BS in civil engineering from Bucknell University, Lewisburg, PA. In her 20 years in the shotcrete business, she has overseen many projects, including the rehabilitation of bridges, piers, manholes, aqueducts, and sewers. Her projects have served various clients, such as the U.S. Army Corps of Engineers, ESSO Inter-America, the Maryland Transportation Authority, the Virginia Department of Transportation, the City of Atlanta, and the City of Indianapolis. Emmrich serves as Secretary of the ASA Membership Committee. She is also a member of ASCE; Chair of ACI Committee C660, Shotcrete Nozzleman Certification; and ACI Subcommittee C601-I, Shotcrete Inspector Certification; and a member of ACI Committee 506, Shotcreting.*

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Project Name
Tiber Creek Sewer Rehabilitation

Project Location
Washington, DC

Shotcrete Contractor
Coastal Gunite Construction Company*

Architect/Engineer
Greeley & Hansen/Jacobs Associates

Material Supplier/Manufacturer
King Packaged Materials*

Equipment Manufacturer
Putzmeister*, Cemen Tech*

General Contractor
Corman Construction

Project Owner
DC Water and Sewer Authority

*Corporate Member of the American Shotcrete Association