Northern Boulevard Crossing Tunnel CQ039

By Frank Townsend

The Northern Boulevard Crossing tunnel is a crucial link for the East Side Access Program linking Long Island Rail Road trains to Grand Central Station, New York City. It is a 125 ft (38 m) long sequentially excavated (SEM) tunnel. The tunnel is situated approximately 55 ft (17 m) below the groundwater table and was mined through glacial deposits. The tunnel alignment also crossed beneath a pile-supported, elevated railway line; a six-lane street; and an active below-grade subway structure (refer to Fig. 1 and 2).

Fig. 1: East Side Access overall project scope

Fig. 2: CQ39 Excavation

Contaminated plumes in the area also dictated the installation of a protective frozen arch above the tunnel alignment, extending to bedrock for complete groundwater cutoff. The freezing of the ground costs the New York Metropolitan Transportation Authority (MTA) $11,000 per day. Every day the liner completion could be accelerated, the more savings to the MTA. A value-engineered approach was given to the MTA to shotcrete this liner in lieu of traditional cast-in-place. This offered both savings in time and construction cost. Without the shotcrete alternative approach, an elaborate, costly, and time-consuming tunnel form system would have to be engineered, delivered, and assembled in the tunnel for traditional formed cast-in-place concrete. The contractor estimates that close to 2 months were saved using the shotcrete alternative.

Superior Gunite's scope was to expeditiously shoot the structural liner of this tunnel to then allow quickly unfreezing the ground and transfer the load from the aboveground structures. Coordination with the contractor allowed Superior Gunite crews to use the same scaffolding system used by the lathers installing the reinforcing bars, again saving time and money (refer to Fig. 3 and 4).

Challenges

Preparation of a plan and logistics were critical to the success of the project. Through a very tight relationship with our concrete supplier, Ferrara, we mapped out trucking delivery routes to mitigate the New York City traffic to avoid lost time and waiting times on trucks. Ferrara had a Quality Control representative on site to work through any possible quality control and address issues on the spot, which fortunately were minimal.

Due to the site constraints, laydown area was limited. We installed our primary and backup pumps inline so if we had mechanical issues we could easily swap the line and deal with the pump on the off-shift. This system proved important, as

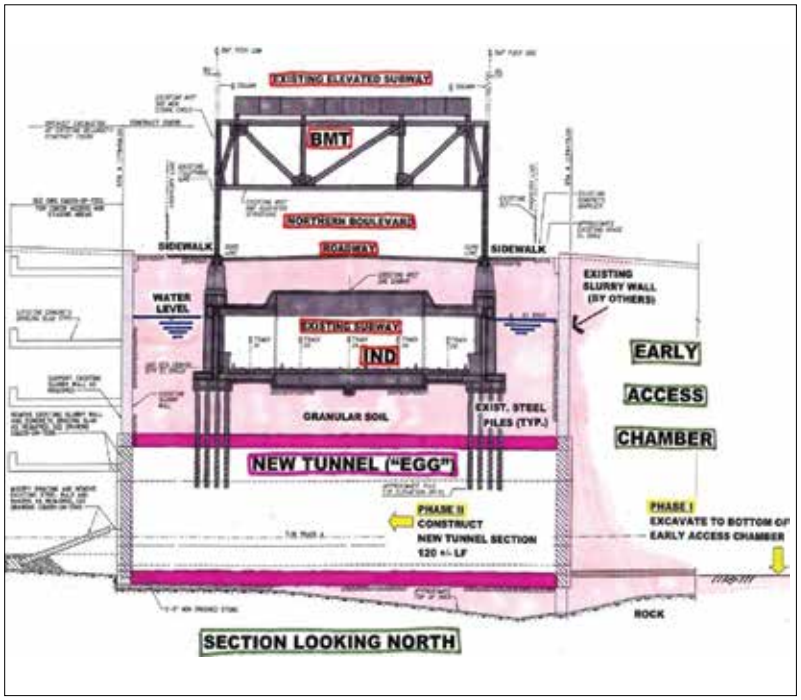

Fig. 3: Overhead load applied to the tunnel

Fig. 5: Mockup of ring girder shoot

Fig. 4: Waterproofing and ring girders being installed

Fig. 6: Shooting the mockup

three times we had to divert to an alternate pump. Because the pumps were inline, the conversion was accomplished with minimal down time.

Temporary support of the overhead structures, which had a pile foundation that would be interrupted by the tunnel, would eventually be replaced by steel tube ring girders installed to permanently carry the load of the overhead structures once the transfer occurred. The shotcrete encapsulation of the ring girders was the first issue and we proved our methods were accurately represented during the mockup for the project. Due to the size of the girders, we used a layering method and encapsulated the backs of ring girders ahead of the reinforcement being installed. We then shot the remaining thicknesses during a follow-on mobilization (refer to Fig. 5(a) and (b) and 6).

Another challenge, which was proven at the mockup stage, was the encapsulation of the No. 11 (#36M) reinforcing bar splices, which were lapped, leaving us only a 3.5 in. (90 mm) opening to shoot through.

The next challenge was shooting a 36 in. (0.9 m) thick structural liner from spring line to spring line, mostly in the overhead position and finishing the project in less than 5 days. We attacked the project by working two crews per shift and two long shifts per day, with a cleanup and maintenance shift in between, with the wall segments being installed first, then moving to shooting the overhead areas. Due to the thickness

Fig. 7: Nozzle in outer layer of reinforcement, encasing the back layer

Fig. 8: Cutting of guides and finishing

Fig. 9: Finished tunnel looking east to west under Northern Boulevard

of this liner, we used several methods to assist us in encapsulating all of the reinforcement. We placed the shotcrete with unique techniques developed by our team specifically for this application (refer to Fig. 7 and 8).

All in all, Superior shot 1463 yd^3 (1118 m^3) and finished the tunnel with two shifts to spare. From the complexity of the tunnel reinforcement system, the large thickness, and the overhead application, the coordinated teamwork from Schiavone/Kiewit JV and Superior Gunite's team made this a huge success. The freezing operation was turned off early and the load from the six-lane thoroughfare on top, with an overhead train line running 500 trains per day, continued. This was the first part of a much bigger project to bring the Long Island Railroad into a new terminal beneath Grand Central Station in Manhattan (refer to Fig. 9(a) and (b)).

Frank E. Townsend III *is the East Coast Region Manager for Superior Gunite. He is a civil engineering graduate of Worcester Polytechnic Institute, Worcester, MA, and received his master's degree from the University of Missouri, Columbia, MO. Townsend comes from the U.S. Army Corps of Engineers and has been running Superior's East Coast operations (predominantly New York, New Jersey, Connecticut, and Boston, MA) for 3 years now. Townsend is an active member of ASA and currently serves on the ASA Board of Directors.*

Protective Arch Liner

Project Name
Northern Boulevard Crossing Tunnel CQ039

Project Location
Queens, NY

Shotcrete Contractor
Superior Gunite

General Contractor
Schiavone/Kiewit JV

Architect/Engineer
New York Metropolitan Transportation Authority
Capital Construction

Material Supplier/Manufacturer
Ferrara Brothers Building Material
5000 PSI Mix