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).

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 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 inter-
rupted 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 shot-
crete 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
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 appli-
cation (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 4 years. Townsend is an active member of ACI Committee 506, Shotcreting; a member of ASA; and currently serves on the ASA Board of Directors. 2015 ENR top 20 under 40.

The Outstanding Underground Project

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 (MTACC)

Material Supplier/Manufacturer
Ferrara Brothers Building Material
5000 PSI Mix

Project Owner
Metropolitan Transportation Authority

*Corporate Member of the American Shotcrete Association

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