

Queens Midtown Tunnel Rehabilitation

By Ashley Cruz

The Queens Midtown Tunnel (QMT) is a twin-tube, tolled, four-lane highway that serves over 90,000 vehicles each day. With a height of 12 ft-1 in. (3.7 m), it measures 6414 ft (1955 m) in the north tube, and 6272 ft (1912 m) in the south tube. This critical thoroughfare was designed by Ole Singstad in 1921, with groundbreaking in 1936, and opened to traffic in 1940. This was the first roadway to go under the East River, connecting the east side of Midtown Manhattan to Queens and Long Island.

On October 29, 2012, the area of the Mid-Atlantic coastline, stretching from the Jersey Shore through the south shore of Long Island, was hit by the catastrophic hurricane, Superstorm Sandy. The floodwaters inundated large sections of New York City's shoreline with water surges of over 10 ft (3 m), devastating much of New York City's infrastructure.

The hurricane flooded the QMT with 12,000,000 gal. (45,000 kl) of contaminated saltwater, forcing the tunnels to close for 10 days and damaging the majority of traffic, mechanical, electrical, plumbing, and safety systems in the 1.2 mile (1.9 km) commuter tunnel.

After the immediate emergency repairs allowed the tunnel to be placed back into service, MTA Bridges and Tunnels expedited the damage assessment and remediation program for long term permanent repairs and upgrades. The *Superstorm Sandy Repair and Capital Improvement Project* QM-40S at the QMT was announced and awarded to Judlau Contracting-OHL North America (Judlau) on April 23, 2015. The project was completed on May 11, 2018, with a cost of

\$265,000,000. It included a new fireproof ceiling with new wall tiles, duct banks, curbs and gutters, LED lighting, traffic signals, and improved evacuation signage.

Repair and restoration work included replacing all the major systems in the tunnel, including electrical, lighting, communications, monitoring, and control systems. Restoration and mitigation efforts included new submersible pumps at the mid-river pump room.

SIGNIFICANCE OF SHOTCRETE

Shotcrete's use in this project stems from Cruz Concrete & Guniting Repair Inc. (Cruz) being awarded a subcontract from Judlau. Cruz's contract scope included repair of all concrete spalls throughout the fresh-air and exhaust-air ducts of both tubes, drainage chase repairs, and the encasement of the new fire standpipes.

As a seasoned contractor in shotcrete construction, as well as having experience working on many large transit infrastructure projects in the Tri-State Area, Cruz saw an opportunity in the project to save time, money, and resources, all while doing what they are great at—shotcrete. Cruz proposed to use shotcrete for the standpipe encasement, and spall repairs as Cruz provided a similar application on past successful projects at the QMT. All parties involved agreed to use this method, with the only caveat being a troweled finish.

Many in the shotcrete industry are familiar with the fact that this sector of construction is susceptible to setbacks and delays, often the result of workflow delays with tasks

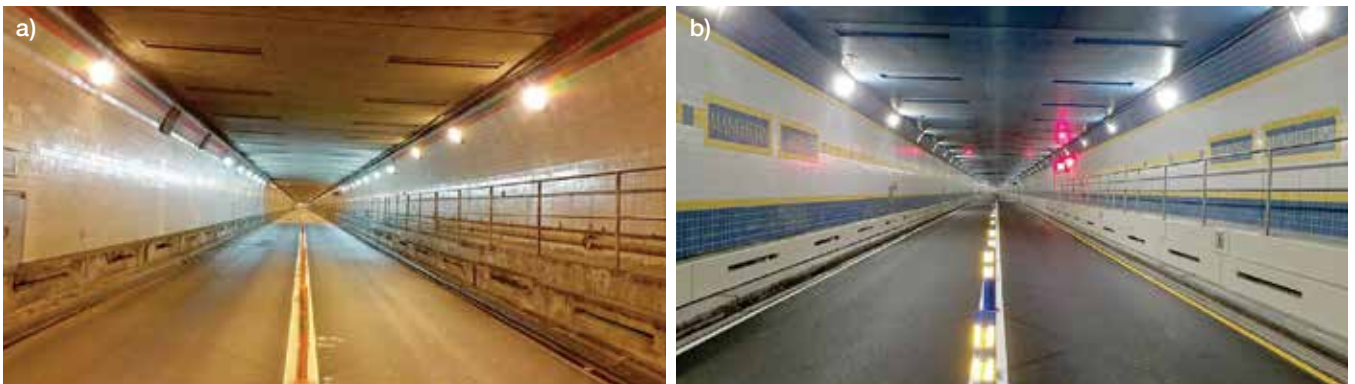


Fig. 1: (a) Before; and (b) after images of QMT
(Photo courtesy of Metropolitan Transportation Agency)



Fig. 2: Preconstruction, highlighting the light trenches ready for wet-mix shotcrete (top left), hollow wall niches (right wall) and exposed ceiling for patch repair (Photo courtesy of Judlau)

needing completion by other disciplines first. One example was parging of the light trench followed by the installation of LED light fixtures. The light fixtures and other subsequent work activities hinged on the timely placement of the finished concrete in the light trench. Cruz recognized an opportunity to perform the parging work with shotcrete. It would result in an accelerated critical path, with a more sustainable product. Cruz completed an in-place mockup and was awarded the work in the North Tube (the first scheduled tube to be rehabilitated), zone by zone. With the promised schedule accelerations realized, the work proceeded to the South Tube and included filling the nearly 1000 hollow wall niches throughout both tubes with shotcrete.

This work established Cruz as an integral part of the project team and the “critical path” subcontractor, where they used maximum production rates and were able to accelerate the project schedule. This sequence allowed Judlau to commission the zonal light systems, meeting its milestones, and contributing to the early completion of the project.

Cruz’s shotcrete methodology on the project, in place of the traditional form-and-pour, made shotcrete the main method of structural strengthening, as well as vertical, overhead, and large leak repairs. Shotcrete provided quicker and more cost-effective production than originally anticipated, while maintaining the required quality of work stipulated in the specifications. Cruz’s workmanship increased the sustainability of this project, saving resources, time, and money while extending the service life of these integral concrete repairs.

CHALLENGES LEAD TO INNOVATION

Time is of the Essence

Due to the high traffic volume of the QMT, traffic control restricted reconstruction to one tube at a time, limiting closure only for overnight work. This posed a challenge to Cruz as the available work hours not only included the



Fig. 3: During construction, repair of the drainage chases (Photo courtesy of Cruz)



Fig. 4: Post-construction image of shotcrete, light trenches have been repaired (top left), the drainage chases have been chipped out and replaced (vertical lines) and ceiling has been patched and encased with fireproof panels (Photo courtesy of Judlau)

work to be performed in the contract but also required daily mobilization and demobilization within the tube. Shotcrete, as opposed to the traditional method of form-and-pour concrete, allowed the crew to get off the road quickly while providing accelerated production during the short window of overnight hours, adding cost savings and increasing efficiency.

PROJECT QUANTITIES

Parging
12,902 ft² (1199 m²)

Fireline
10,133 ft² (941 m²)

Light trench
25,395 linear ft (7740 m)

Roadway soffit
2963 ft² (275 m²)

Drainage chase
4185 linear ft (1275 m)

Deep concrete repairs
6748 ft² (626 m²)

Shallow concrete repairs
1197 ft² (111 m²)

About the Product

Both dry- and wet-mix shotcrete were used in this project in innovative and sustainable ways. To provide increased production, Cruz used a 5000 psi (35 MPa) wet-mix shotcrete for the fire standpipe encasement. The velocity of the shotcrete eliminated the risk of poor bond strength and is a stronger product because of the low water-cementitious materials ratio (*w/cm*).



Fig. 5: Working in the air ducts provided for tight work spaces for the entire crew. Cruz devised methods to ease human comfort while working in these situations. Crew chipping away deteriorated concrete
(Photo courtesy of Cruz)

Wet-mix shotcrete also proved useful to repair the random leak holes, some large enough to accommodate 0.5 yd³ (0.4 m³) of material, located under the roadway tunnel liner (soffit) throughout the fresh-air duct and exhaust-air plenum. Dry-mix shotcrete allowed Cruz to increase the speed of repair by 30 to 50%, keeping labor costs down and construction productivity up, on top of producing an extremely well-bonded repair. The prebagged, dry-mix product, with accelerator, fibers, and polymers, manufactured by USCP, exceeded the 5000 psi specification. The advantage of using a specifically designed concrete mixture for each situation added value to each man-hour and allowed for the timely and economical completion of the project.

Human Comfort

Cruz worked the night shift in the QMT for 3 consecutive years. The fire standpipe encasement of both tubes spanned a total distance of 1.2 miles, located about 5 ft (2 m) off the ground. The combination of the location and duration of the project caused Cruz to have concern for its crew in regard to occupational health and safety, and limited mobility. As a result, Cruz devised a mechanism that would support the hose and nozzle, with an adjustable height between 4 ft-5 in. and 12 ft (1.3 and 3.7 m) above the ground, as well as the ability to pivot side to side and up and down. This device was extremely mobile, being wheel-mounted, and boosted productivity by 15%, ultimately creating better



Fig. 6(a) and (b): A prepared fireline sits within the walls of the QMT (top). Cruz's device to reduce the stress of employees while ramping up productivity (lower)
(Photo courtesy of Cruz)

working conditions for the nozzleman and the assistant guiding the hose behind.

OVERALL PROJECT SUCCESS

The QMT Rehabilitation project was a success from both a financial and reputational standpoint for Judlau, as the project was finished on May 11, 2018, 11 months ahead of the original completion date of April 23, 2019. Cruz's experience, inputs, skills, and expertise played an important role in the early completion of the project. Cruz shotcreted hollow wall niches, the replacement of the PROMAT light trench, and the tiled wall. These were major work activities where Cruz delivered and contributed to the overall success of the project.

Overall, the experience and versatility in Cruz's shotcrete performance contributed to this multi-million-dollar Capital Improvement Project located in America's largest city to be completed on time and under budget.

ABOUT CRUZ CONCRETE & GUNITING REPAIR

Cruz Concrete & Guniting Repair, Inc. has been in business since 1984, incorporated in 1986. Cruz performs a wide range of concrete repair and rehabilitation work throughout the New York City and Tri-State Areas. Its services run the gamut from shotcrete roofs shot post-Sandy in Breezy Point, NY; "bathtub" walls in the new World Trade Center, after 9/11; retaining walls of manufacturing plants; sub-roadway repairs to the George Washington Bridge; to historic restoration projects.

Cruz has been a corporate member of the American Shotcrete Association since 2010. Working on this project were three ACI-certified nozzlemen; two certified in both wet- and dry-mix shotcrete and one certified in wet-mix shotcrete. They all worked on portions of this extensive

shotcrete contract and couldn't have done it without its team of finishers and laborers.



Ashley Cruz is the newest member to the family-owned and operated business. She joins the company with 10 years of experience in urban planning and landscape architecture. Cruz is the Director of Operations and aims to take Cruz Concrete to the next level in sustainability and blending of creative design decisions with quality construction.

2018 OUTSTANDING REPAIR & REHABILITATION PROJECT

Project Name
Queens Midtown Tunnel Rehabilitation – QM40S

Project Location
New York, NY

Shotcrete Contractor
Cruz Concrete & Guniting Repair, Inc.*

General Contractor
Judlau Contracting – OHL North America

Architect/Engineer
URS

Material Supplier
US Concrete Products*

Equipment Manufacturer
Putzmeister*

*Corporate Member of the American Shotcrete Association



Fig. 7: Cruz's collaborative nature helps to expedite workflow, delivering projects on time and within budget (Photo courtesy of Cruz)