2025 Outstanding Underground Project

New York City Grand Central Station New Passageway

By Louis Falco

INTRODUCTION

The prestigious Grand Central Station is located in a major hub center of New York City bound by East 42nd Street (south), Lexington Avenue (east), East 51st Street (north), and Madison Avenue (west). As one of the major hub centers, it serves over 25 million customers a year using multiple lines with the New York City Transit Subway Lines 4, 5, 6, Flushing Line #7, Shuttle to Times Square on 42nd Street, the Long Island Railroad (LIRR), Metro North Railroad, and New York City Transit (NYCT) entering and exiting the Grand Central Terminal.

The underground area showed signs of congestion and patron queueing issues. With an anticipation of increasing ridership as well, the Metropolitan Transportation Authority Construction and Development (MTA C&D) team planned to implement solutions to address these issues, plus improve passenger circulation, access, and egress within the Grand Central Station area. The Circulation Improvements at Grand Central Station consisted of various construction projects aimed at improving access and egress for Lexington and Flushing Line commuters at the 42nd Street – Grand Central Station location. It should be noted that the project site was located at the intersection of East 42nd Street and Lexington Avenue in the midst of important and historic landmarks such as the Mobil Building (southeast corner), Chrysler Building (northeast corner), Chanin Building (southwest corner), and the Hyatt Hotel and MTA building on the northwest corner.

Fig. 1: NYC Grand Central Station/Terminal area; project site located at the bottom of the picture

This article will discuss the project's construction of the Grand Central Station New Passageway involving the extension to the existing Flushing Line Passageway and installing an additional staircase to the Flushing Line Platform required to improve passenger relief along with innovative approaches such as pneumatically applied concrete to placing the final concrete liner.

The MTA C&D contracted a Design-Build (DB) team comprising of the Designer of Record (DOR), STV Inc, and the contractor, Skanska USA Civil, to perform this work. The DB selected the option to install an access shaft at the street level, followed by an access drift tunnel and finally the New Passageway.

The New Passageway consists of an East-West passageway tunnel, which is parallel to the existing subway Flushing Line platform #7 train that connects to the existing Flushing Passageway located on the Mezzanine level of the station. The North-South Passageway tunnel connects to the existing Flushing platform #7 train cavern at a predetermined location. This included the installation of an additional staircase providing passengers with an additional access point to the Flushing Line #7 train platform.

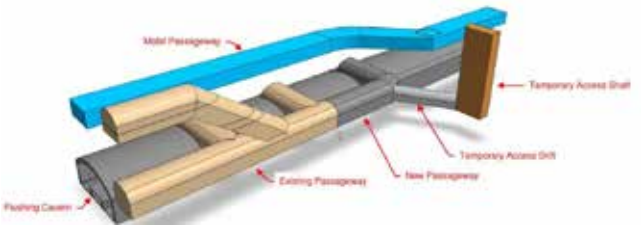

Figure 2: 3-D Rendition of the New Passageway with Existing Subway Structure; shows the project location underground in relation to the mentioned connection points within the existing subway structures

NEW PASSAGEWAY PROJECT CONTRACTUAL OBLIGATIONS

The MTA C&D team selected the following companies to perform preplanning and preparations of the procurement documents for the New Passageway at Grand Central Station: Naik Consulting Group, P.C. (project construction manager), Gall Zeidler Consultants (subconsultant tunnel engineer for station connection), Mueser Rutledge Consulting Engineers (geotechnical services), Sowinski Sullivan (architectural services), and Parsons (prime engineer).

Each entity provided their expertise and specialty, and contributed toward the project's conception, preplanning, preliminary design, procurement, and construction oversight. Subsequently, the procurement and delivery method selected for this project was design-build.

Along with the standard bidding documents, such as invitation to bidders, design-build agreement, general provisions and project requirements, design criteria, as-built/utility/survey/standard drawings, geotechnical data report, and geotechnical baseline report, the MTA's project requirement design criteria (PRDC) had to be met. The MTA's PRDC included the numerous mandatory requirements such as — scope of work, applicable codes, design and testing standards, design loads and load combinations, structure design life, pre-construction and post-construction surveys, permanent materials, concrete specifications, durability, mined tunnel excavation, initial ground support systems, initial shotcrete lining, tunnels and underground structures, subsurface investigation, ground characterization, geotechnical parameters, monitoring of instrumentation, settlement, vibration and noise, watertightness in tunnel, waterproofing system, and final concrete lining.

The successful DB team noted above was responsible for developing and providing site-specific specifications in accordance with the MTA's PRDC, enabling them to formulate and establish their final design concept and perform both the temporary and permanent works.

PLANNING THE PROJECT

The construction of a tunnel of any size in an urban environment is a task, let alone in a cosmopolitan location such as New York City. There are many variables that need to be considered — underground utilities, pedestrians, vehicular traffic, lane detours, abutters, surrounding buildings, landmark buildings, emergency access, shaft location, muck disposal, overhead crane location, and construction vehicular access to the project site.

The DB team had selected the construction site location to include the shaft point of entry, access drift tunnel, and ultimately the final location and configuration. The team preferred to use the southeast corner of Lexington Avenue and East 42nd Street to locate the access shaft (See Fig. 3).

The DB opted to install a shaft access on the southeast corner of the East 42nd Street and Lexington Avenue intersection, and the planning phase began. The project

Fig. 3: Looking southeast at the access shaft adjacent to the intersection of East 42nd Street & Lexington Avenue

shaft location is in one of busiest intersections in New York City, originally having two entrances to the MTA subway for Grand Central Station, located at the Hyatt Building and the Mobil Building Passageway.

Due to the restrictive nature of the congested urban area, Skanska was limited to a small access shaft footprint of 25 ft by 10 ft (7.6 m x 3 m) opening, of which only 125 ft^2 (12 m^2) were useable for shaft and tunnel work. The access shaft was located adjacent to the Mobil Building. The support of excavation was designed with mini piles filled with grout and rebar reinforcement, W10x112 steel walers, with 4 in. (100 mm) lagging (See Fig. 4).

EXECUTING THE PROJECT

During the planning phase, the DB determined the need to temporarily close the Mobil Passageway to subway commuters over the course of construction. The DB was only able to excavate an access shaft in a trapezoidal shape at the corner of East 42nd Street and Lexington Avenue. This shaft was constructed by conventional means of installing piles, walers and lagging to a depth of approximately 52.5 ft (16 m). The clear opening of the shaft is only 7.25 ft (2.2 m) wide by 17.5 ft (5.3 m) long, providing approximately an opening of 127 ft^2 (12 m^2) to excavate the temporary shaft, access drift tunnel followed by the full-scale excavation of the East-West and North-South Passageways (See Figs. 4 and 5).

Comparatively speaking, the surface area of the shaft opening is smaller than that of a ready-mix concrete truck. All excavation equipment, excavated muck, supplies, materials, and tunnel workers entered and exited from this relatively small opening. As the DB proceeded with tunnel excavation, they prepared themselves for the challenge of dealing with the Manhattan geology consisting of interlayered schist, gneiss, granofels, and amphibolite of the Hartland Formation with RQD values ranging from 77% - 100% with REC values from 91% - 100%.

The cross section of access drift was 11 ft (3.4 m) wide, 10 ft (3 m) high, and 39 ft (12 m) in length, and was

Fig. 4: Access Shaft Opening

excavated utilizing demolition equipment such as the Brokk with hammering tool, jack hammers, jack legs, and rock splitters. The access drift was excavated as a full-face tunnel and excavated volume was approximately 160 yd^3 (122 m^3). Installation of a lattice girder was required at both ends of the access drift, and the ground support also included an initial steel-reinforced shotcrete lining thickness of 6 in. (150 mm).

The contractor was not allowed to use explosives in New York City. Through negotiations and meetings with the Fire Department of New York City (FDNY), however, Skanska was permitted to utilize a product called NxBurst (non-electric initiation type) on a trial basis. Nxburst is a non-detonating propellant-based cartridge that can be used in locations where vibration, air-blast overpressure, and environmental sensitivities prohibit the use of explosives. The specifications were strict, with peak particle velocities limits of 1 in. per second (25 mm per second) in any of the transverse, vertical, or longitudinal directions due to close proximity of major historic buildings and public safety.

The contractor's first attempt in the access drift was deemed unsuccessful: The 4 ft round did not 'pull' the expected theoretical volume. Skanska did not see it as a failure, though, but rather as a "lesson learned" for the next time. The contractor continued to excavate the access drift using mechanical demolishing tools until reaching the new passageway location at the elbow area.

Fig. 5: Access Drift Tunnel

The contractor began entering the new passageway through the elbow area (north-south and east-west directions). Skanska divided the tunnel excavation process into four identities: The drift extensions from the access drift, elbow area, followed by the east-west, and north-south directions (See Fig. 6).

All of these areas were performed in the traditional format: Top heading, followed by benching. The total length of the combined directions was approximately 100 ft (30 m). Upon completing the excavation for the drift extensions, Skanska proceeded to open up two concurrent top headings in the east-west and north-south directions. The project required two full-face horseshoe-shaped cross-sections. The nominal excavation cross section in the elbow area was 18.5 ft (5.6 m) wide by 15.7 ft (4.8 m) high, whereas the E-W, N-S direction was 17.2 ft (5.2 m) wide by 15.7 ft high.

The total length of the combined directions was approximately 100 ft with 975 yd^3 (745 m^3) of 'Manhattan Schist' to be removed. The specifications required ground support at 3 ft (0.9 m) or 4 ft (1.2 m) rounds with the installation of lattice girders, and twenty #9 (#29M) rebar spiles in the crown area for each lattice girder. They were also required to provide 10 in. (250 mm) of initial steel fiber

Fig. 6: Excavation of East-West Passageway (left) and North-South Passageway (right)

reinforced shotcrete to finalize the ground support system. Through mechanical means, Skanska also opted to use the Nxburst product to accelerate and improve the rock deflagration. There were three seismographs placed at different locations along the wall of the active Flushing Line #7 cavern, to verify the peak particle velocity events.

Upon completing the excavation, a 2 in. (50mm) smoothing layer of non-reinforced shotcrete was applied prior to the installation of the PVC membrane waterproofing system. The waterproofing system was comprised of geotextile fabric, PVC membrane, water barriers, and regroutable and contact grouting hoses, covering an approximate area of 4900 ft² (455 m²). This was followed with the installation of typical reinforcement using #7 (#22M) rebar (See Fig. 7).

The final concrete lining was scheduled to be cast-in-place with traditional formwork, but through innovative and collaborative meetings with the MTA C&D group, PMC, and

Fig. 7: Picture shows GCS East – West New Passageway with installed PVC membrane system and reinforcement

Fig. 8: The mockup installation with the PVC membrane systems and reinforcing

Fig. 9: The progress of shotcreting through the second layer of reinforcing in the wall and arch

Skanska-STV, the shotcrete placement option was selected.

To move forward with the shotcrete option, the contractor and subcontractor were required to verify the process to ensure a quality end product. Skanska provided an important component of the process — the mockup system. The mockup system allowed Skanska to show the MTA C&D and PMC group all steps involved, such as PVC membrane installation, reinforcing bar installation, actual shotcreting placement, and quality control measures to be instituted during the shotcrete operation in the tunnel. Figs. 8 and 9 show how the PVC membrane and reinforcement would be installed, and Fig. 10 shows the results of a successful shotcreting operation. Additionally, the contractor elected to sawcut the mockup panel into multiple pieces to ensure no voids occurred during shotcreting.

Fig. 10: Shows that the PVC membrane was not damaged, as well as full consolidation of the shotcreted concrete material

Fig. 11: Patriot Shotcrete — shotcrete placement on the East-West Passageway Wall

Fig. 12: Patriot Shotcrete employee shotcreting the East-West Passageway Arch/Roof

There were two areas of concern to be evaluated: Damage of the PVC membrane after shotcreting, and voids around the reinforcement. Upon reviewing the process exhibited during mockup system and observing the successful results, the project team proceeded with the shotcreting process in the New Passageway Tunnels with Skanska and their subcontractor Patriot Shotcrete, after they successfully alleviated these concerns. Figs. 11 and 12 show the shotcrete application of a typical wall and arch/roof, with the final opening of the Grand Central Station New Passageway in Fig. 13.

CONCLUSION

Construction of a tunnel is demanding, and adding the urban environment variable makes it an even more challenging endeavor. This project with its design-build format was fortunate to have forged a teamwork mentality from the onset of construction, with collaboration and determination. Many thanks to MTA C&D, design-builder STV-Skanska with Patriot Shotcrete, PMC team of Naik Group, subconsultants Parsons, and GZ Consultants. With this exemplary team, the project was a great success.

2025 OUTSTANDING UNDERGROUND PROJECT

Project:
NYC Grand Central Station New Passageway

Project Location:
New York City, NY

Shotcrete Contractor Company:
Patriot Shotcrete*

Engineer Company:
STV Incorporated

Materials Supplier Company:
Tec-Crete Transit Mix

General Contractor:
Skanska USA Civil Northeast

Additional Team Members:
Naik Consulting Group

Owner:
Metropolitan Transit Authority

**ASA Sustaining Corporate or Corporate Member*

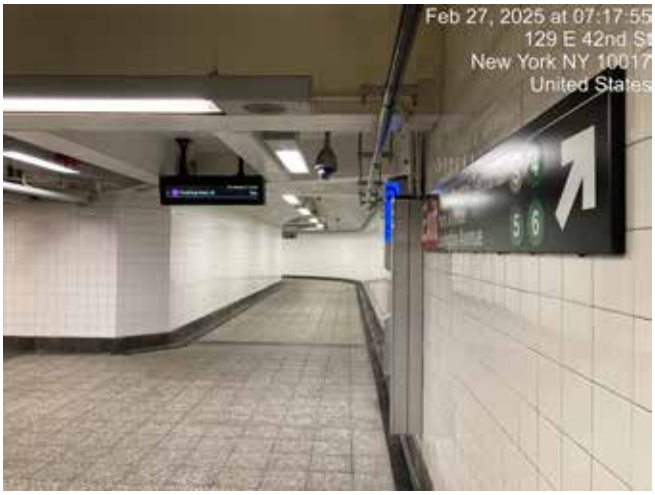

Fig. 13: A view of the finished East-West New Passageway in Grand Central Station

Louis Falco *is a Senior Tunnel Engineer, Senior Project Manager with Gall Zeidler Consultants, a global specialty tunneling and underground engineering firm. Louis graduated from Concordia University (Montreal, Canada) with a Bachelor of Engineering (Civil). With more than 45 years of experience, he has worked in various fields such as structural design, major falseworks (Place des Martyrs [Algiers]), concrete design, support of excavations, tunneling and underground engineering (eg. Montreal South Shore, Austin Govalle Tunnel, Boston Central Artery, Chicago TARP, Milwaukee MMSD, Cleveland NEORSD), manufacturing precast concrete segmental tunnel liners for major projects (e.g., CBBT, REM, NEORSD, RONDOUT, BSIT, LAX), and construction management with major contractors on various heavy construction projects both above ground and underground (SA Healy, Kiewit, Perini, Atlas, Impregilo, Kajima) in Canada, the U.S., and Africa. Louis is also a member of the GZ Subject Matter Expert team for the VTA BSVII project, recently completed the Grand Central Station New Passageway in New York City, and is now assigned to the PMC team on the Second Avenue Subway Phase 2 in New York City. Member of the American Society of Civil Engineers, Disputes Review Board Foundation, ITA Working Group 12 - Sprayed Concrete, Underground Construction Association (UCA of SME), and lead author contributing to the Handbook of Precast Segmental Tunnel Lining Systems. He is also the Vice Chair of the North American Tunneling Planning Committee.*