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Reuters Comes to Times Square

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REUTERS COMES TO TIMES SQUARE

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ABSTRACT

Times Square in New York City was chosen for the new Reuters Headquarters Building for its significance as the crossroads of the world. The headquarters consists of a 30-story office tower with a foundation footprint of 30,000 square feet including two subsurface levels nearly 40 feet deep for retail shops, parking and access to the Times Square subway station.

This paper describes the geotechnical challenges that were faced to minimize the effects of both the construction excavation, mainly in mica schist rock, and a new permanent structure on two adjacent landmark theatres, the subway structures, and the streets and utilities of Times Square. Additionally, there could be no interruption of theatre performances or subway service.

Engineering solutions included:

1. Supporting the subway structures during construction with a combination of a sand bag, wale and raker system.
2. Maximizing the underground tower space by creating a sidewalk vault.
3. Supporting and protecting two landmark theatres by sequencing the support with several tiers of rock anchors.
4. Supporting both theatre foundation walls and the “re-entry” corner of the New Victory Theatre by chipping the bedrock and carefully supporting what remained on the perimeter. Monitoring equipment was installed in the theatres for immediate notification of any movement and/or high vibrations.

INTRODUCTION

A Times Square location was chosen for the new Reuters Headquarters Building, referred to as Three Times Square. The site is located on Seventh Avenue between West 42nd and West 43rd Streets in New York City (City). The site is bordered by many structures making excavation a challenging task. The historic, 100 year old, New Victory Theatre (NVT) and the Ford Center for the Performing Arts (Ford Center) border the site to the west. An active New York City Transit Authority subway tunnel lies directly to the east below Seventh Avenue, set back two feet from the property line. Below West 43rd Street is an electric substation. The corner of West 42nd Street and Seventh Avenue is one of the City’s busiest subway stations. Refer to Fig. 1 for the site location with respect to adjacent structures, and Fig. 2 for a photograph of a model of the new Reuters building.

The Reuters Headquarters building consists of a 30-story office complex with a foundation footprint of approximately 30,000 square feet including two subsurface levels for retail shops, extending about 40 ft below sidewalk level. The basement levels extend under portions of the West 42nd Street and Seventh Avenue sidewalk areas. In order to achieve the basement footprint area desired by the owner, the foundation walls had to be placed on or beyond the property lines.

The main geotechnical challenge faced was having to anticipate what effects the construction excavation would have on the landmark theatres, and the subway tunnels and station. Additionally, there could be no interruption of theatre performances or subway service. The challenges included the methods to temporarily support the excavation walls, the stability of the exposed rock faces, and the monitoring of the theatre and subway structures during construction.

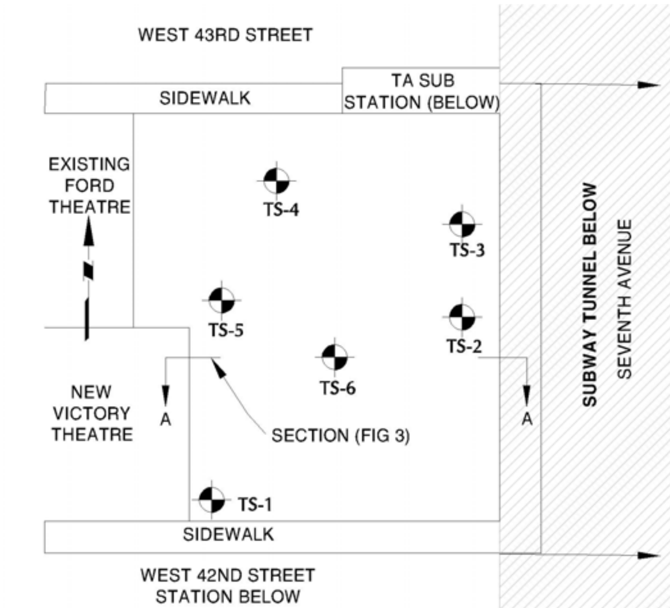

Fig. 1. Site and Boring Location

Fig. 2. Reuters Three Times Square

SUBSURFACE INVESTIGATION

Prior to construction, there were existing structures on the site that were built at or near the turn of the century and were renovated numerous times to accommodate changing uses. Each of the existing buildings ranged in height from one to eleven stories and contained a single basement level. Portable drill rigs were placed inside the existing buildings to conduct the subsurface investigation that consisted of six (6) test borings (TS-1 to TS-6) advanced 20 to 30 ft into rock, and the installation of a ground water monitoring well. A proprietary oriented rock core barrel system was used in three of the borings to measure the attitude (strike and dip) of the foliation and discontinuities in the rock cores. Refer to Fig. 1 for the boring locations.

The following summarizes the generalized subsurface information obtained from the site study. The generalized stratigraphy underlying the site was comprised of miscellaneous fill overlying a thin sand stratum, decomposed rock and finally bedrock. These strata are discussed in the following sections. A generalized east-west subsurface profile is presented in Fig. 3.

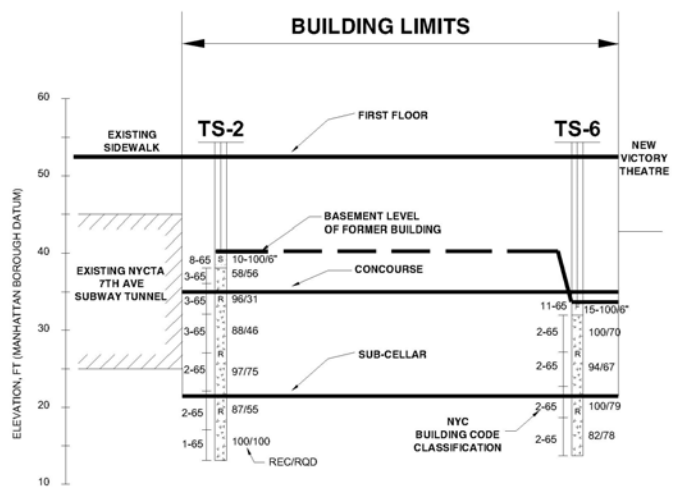

Fig. 3. East – West Sub floor Profile (section A-A)

1. <u>Miscellaneous Fill (11-65)</u> [(1)]
   An approximately 1 ft to 7 ft thick layer of miscellaneous fill, composed essentially of debris, was encountered in most of the borings, just below the existing concrete basement floor slabs. SPT N-values ranged from 11 blows/foot to 100 blows/5 inches (100 blows to drive a split spoon sampler 5 inches). This was indicative of a deposit of highly variable compactness and/or the presence of gravel-size and larger fragments.

[(1)] Numbers in parenthesis that follow material designation indicate classification of soil and rock materials in accordance with the City building code.

2. Medium to Fine Sand (8-65)
   An approximately 1 to 2 ft thick layer of medium to fine sand was encountered in some borings below the fill. This material consisted of grey, medium to fine sand with a trace of silt.

3. Grey/Brown Decomposed Schist (4-65)
   A thin layer of grey/brown decomposed schist (micaceous sand and silt mixed with mica schist fragments) was encountered below the fill and sand (where present). The N-values in this layer ranged from 21 blows/6 inches to over 100 blows/6 inches, indicative of a medium to very dense state and/or the presence of gravel size or larger materials.

4. Manhattan Schist (3-65, 2-65 and 1-65)
   Underlying the fill, sand (where present), and decomposed rock (where present) is the Manhattan Schist Bedrock. The bedrock was generally found to be fresh to moderately weathered and had moderate to little fracturing.

Core recoveries for the borings ranged from approximately 50% to 100%, with most core recoveries over 90%. Rock Quality Designation (RQD) values ranged from 0% to 100%, with an average RQD value of about 70%, indicative of good quality rock.

In general, the rock quality improved with depth. The top 5 to 10 feet of rock was found to be moderately fractured and was classified as Class 3-65 to 2-65 rock (20 to 40 tsf bearing). Below a depth of about 10 feet into the rock, the quality improved and classified as Class 2-65 to Class 1-65 rock (40 to 60 tsf bearing). At the proposed foundation depth, nearly 40 ft below grade, the rock was classified as Class 2-65 to Class 1-65.

Oriented rock cores were taken in three borings to determine the attitude (strike and dip) of the foliation and discontinuities in the rock mass. Based on the oriented core results, the rock foliation was found to strike in an essentially north-northwest direction and slope to the west-southwest direction with a easured dip angle of about 50º to 65º. Refer to Table 1 for a summary of the oriented core data. The attitude of the rock foliation is such that rock cuts along the east and portions of the south and north side perimeter walls would be sloping into the excavation.

Table 1. Summary of Selected Oriented Core Data

Boring Number	Depth (ft)	Direction [1]	Dip Angle (Degrees)
TS-1	17.5-22.5	S80W	65° (J)
	22.5-27.5	S70W	60° (F)
	27.5-32.5	S60W	60° (J)
	32.5-40.5	S35W to S40W	55°-65°(J)
TS-2	17 – 26	N20W	55°-60°(F)
	26 – 31	N25W	60° (J)
	31 – 40	N25W-N30W	65° (F)
TS-3	19.5-24.5	N60W	64° (F)
	24.5-27	N60W	62° (J)
	32-37	N55W	62° (J)
	37-39	N30W	65° (F)

(1) Project North-South is Seventh Avenue
(J) Joint
(F) Foliation

ROCK EXCAVATION

The rock excavation program was complex and very risky due to the site location in the City. A large amount of rock had to be excavated in a relatively small footprint that did not offer any non-issue areas. Normal construction methods would have called for the blasting of the large amount of bedrock to be excavated; however, the existing conditions did not allow for blasting. The site was in the middle of what is notably one of the biggest tourist attractions in the City. The site had to be secure not only to allow for the pedestrian movement but also for their safety during a lengthy construction process.

Due to the fragile conditions of the surrounding structures, the upper perimeter of the excavation had to be secured before the site could be excavated to lower depths. A method of carefully chipping the bedrock and securing what remained on the perimeter became critical to the success of the project. The excavation began in the center of the site and expanded outward to keep a berm of existing soils and rock on the perimeter walls for as long a period of time as possible. The sensitive foundation excavation began on the western edge of the site next to the two landmark theatres. The excavation ultimately extended 30 feet below the theatre structures. The NVT had two faces of rock beneath its foundation (northeast corner) exposed to the excavation; this re-entry corner was critical. The Ford Center had one face of rock exposed below its foundation. Both theatres were originally constructed without support redundancies. Refer to Fig. 1.

Excavating rock adjacent to and below the basement level would make the NVT susceptible to cracking or failure when the lateral confinement was removed on two sides of the corner. The manner of removal of this rock could trigger a load transfer. The bedrock was carefully chipped rather that blasted to minimize the rock instability. Monitoring equipment, consisting of crack monitoring gages and survey points, were installed in the theatre to immediately notify the design and construction team of any movement. Also, seismographs were installed to monitor vibration levels.

The allowable vibration levels (peak particle velocity) for the theatres and subway structures were established at 0.5 and 2.0 in/sec., respectively. The maximum allowable vertical and horizontal movements were established at ¼-in for the two theatres.

Knowing that a load transfer due to rock removal would create building movement, a project mitigation plan called for the stabilization of the exposed rock beneath the theatres as the excavation progressed using rock anchors and supplemental bracing. As specified in the contract documents, the contractor was required to install rock bolts in a maximum 4 ft grid spacing as the rock was "peeled" away from the re-entry corner under the NVT.

Fig. 4 presents a schematic of the stabilization plan for the NVT re-entry corner that was included as part of the contract documents. Also, the foundation contractor had to pour the permanent foundation wall adjacent to the NVT structure prior to moving forward with the general site excavation, a very critical step in the mitigation plan for the site.

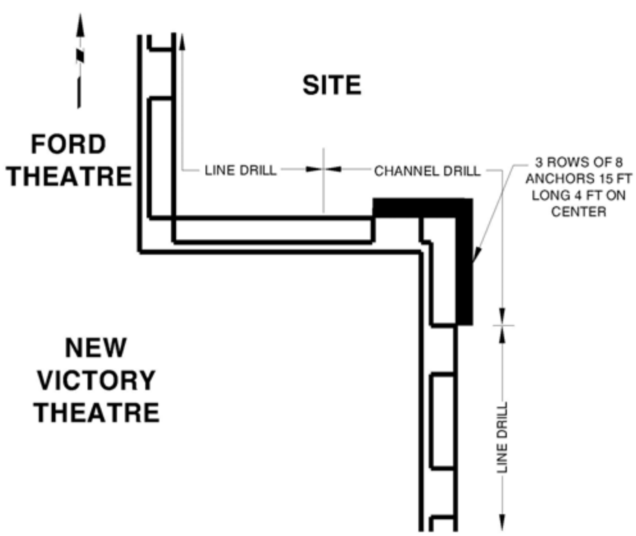

Fig. 4. Plan View at Re-Entry Corner

The re-entry rock corner of the NVT remained stable during the 25 ft of rock excavation that took place below the theatre. Maximum horizontal and vertical movements measured with instrumentation installed in the NVT were about 1/8 in and 1/16 in, respectively. Measured vibration readings were generally kept below 0.5 in/sec, with occasional "spike" levels reaching 1 in/sec.

SUBWAY RETENTION SYSTEM

The engineering design used to laterally support the subway tunnel combined existing techniques in a more creative way to meet the needs of the project. Conventional procedures would have called for the use of soldier beams driven or drilled into the rock; wood lagging would be installed between the beams to serve as an earth retention system. However, the proximity of the subway tunnel to the excavation limits and the high elevation of rock required an innovative approach. Above the subway structure a gravity retaining wall was installed using a series of pits that were then filled with sand bags to allow for only minimal disruption to the sidewalk area. Below the top of the subway, a temporary bracing system of stub beams was installed directly against the subway tunnel roofline on West 42nd Street. This allowed for minimal intrusion into the building's foundation wall and facilitated the disassembly of the retaining system. A series of wales and rakers were connected to the stub beams to provide lateral stability to the subway tunnel roofline. The subway structure analysis calculations showed that the inherent strength of the subway walls below the roofline itself would provide the necessary stability during the excavation, eliminating the need for additional bracing of the Transit Authority subway.

There was constant coordination with the New York City Transit Authority and the New York State Department of Transportation through the design process and through construction. A monitoring system was developed including seismographs and survey points to provide information to the agencies to confirm the impact of construction on the tunnel. The sand bag gravity wall and the wale/raker system are shown in Fig. 5. Vibration readings were measured well below 2 in/sec. Survey readings measured essentially no movement of the subway tunnel.

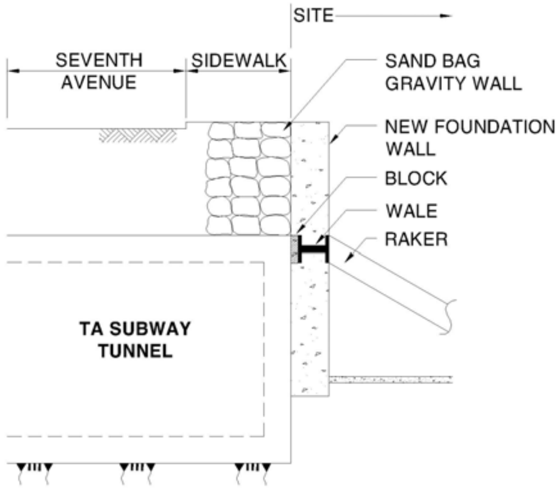

Fig. 5. Excavation Support at Subway

CONCLUSIONS

The Reuters Headquarters Building was successfully constructed within a constrained plot of land in the busy Times Square area of New York City. The keys to the success were:

1. Recognition during the early design stages of the project that the re-entry corner of the NVT was structurally fragile. Therefore, construction documents identified this area for careful excavation measures, monitoring, staged installation of rock anchors, and a rapid construction of the permanent foundation wall prior to excavating the remainder of the site. The contractor prioritized this work early in the project schedule.

2. The design of the lateral support system for the subway tunnel under Seventh Avenue was relatively simple, minimally intrusive, yet provide an effective method to quickly excavate rock and build the foundation wall along the east, north and southern perimeters of the site.

3. The sand bag wall, wale and raker system allowed additional space to be constructed under the Seventh Avenue sidewalk, next to the subway tunnel.

REFERENCES

Ciancia, A. [1998]. “Report on Geotechnical Investigation, Reuters Building – Three Times Square, New York, New York,” Langan Engineering and Environmental Services, P.C. Report, New York, New York.