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An addition was proposed for the single story, steel framed structure.

Grouting Rock Fill Stabilizes Sub Surface For Redevelopment

Urban redevelopment often requires that improvements to existing soil conditions be made prior to new construction. Rock grouting of non-cohesive coarse aggregate materials including construction debris such as brick bat is a method of improving site soils, in situ. Rock grouting of the unstable rock fill is a viable alternative to the typical "remove and replace" solution.

Rock grouting offers the following advantages over dynamic compaction or conventional over excavation.

- Disruption of neighboring properties with vibration or heavy equipment operation is negligible.
- Rock grouting increases the soils stability and load bearing capacity without disruption to adjacent neighboring buildings. Grouted soils also inhibit the lateral migration of water by reducing the permeability. This approach is also effective when treating old trench backfill.
- Using low viscosity Redi-Mix grout for rock grouting does not generate any spoils which require special handling or disposal.
- Rock grouting typically has lower total costs.
- Rock grouting can be performed in close proximity to buried utilities.

Remediation Options

The existing structure was constructed on a site which had previously been occupied by a gas station. Demolition of the gas station, which included removal of the underground storage tanks was completed a number of years ago. Following the tank removal, the excavations were backfilled with open graded 3-inch crushed rock. Because there were no records of the backfilling it was assumed that the backfill was placed in an uncontrolled manner. The geotechnical investigation performed prior to designing the foundation indicated the presence of the stone backfill within the footprint of the proposed addition extending to a depth of approximately 9 feet below subgrade, or approximately 5 feet below the proposed footing grade. The geotechnical report indicated that without remediation, unacceptable differential settlement of the proposed footings was possible.

The remediation options that were considered included both removal and replacement of the previously placed crushed stone; or, stabilization of the stone by pressure grouting. Pressure grouting of the backfill was chosen for the remediation. A major advantage of the pressure grouting alternative was eliminating the need to remove the existing backfill material. The ability to leave the material in place is extremely attractive when there is the possibility of producing excavation spoils requiring special handling or disposal permitting. This commonly occurs when excavating on a previously contaminated site.

The addition was ultimately designed using piers to provide support for the steel columns with intermediate support provided by grade beams constructed between the columns. Initially the plans called for multiple grout injection points at each pier; however, prior to commencing the pressure grouting, the design team approved a single injection point program provided the required horizontal grout penetration could be verified. The monitoring plan consisted of installing 1-inch pipes a specified

distance from the center of the pier to verify that the required grout envelope could be constructed using the single injection point.

The 2-inch diameter grout injection pipes were driven to the base of the stone backfill, approximately 5 feet below the design footing grade. A sacrificial driving point was inserted in the leading end of each pipe prior to driving to keep the soil from entering the pipe. The pipes were driven using a 140 pound pneumatic hammer. After driving, the pipes were raised approximately 6-inches and the sacrificial point was driven out to open the end of the pipe. The 1-inch monitoring pipes were then installed at representative locations, offset the specified distance from the center of the piers. The monitoring pipes were also raised 6-inches following driving to release the sacrificial points and allow the grout to enter the monitoring pipes. An injection pipe is pictured below. Also noted is the monitoring pipe.

Arrow denotes horizontal dispersion monitoring pipe

Grout Injection Pipe

The following grout mix was approved for the project.

Material	Quantity per cubic yard
Cement	252 pounds
Fly Ash	500 pounds
Fine Aggregate	2500 pounds
Air Entraining Agent	8 oz.
Water	400 pounds

The project criteria required one of the following conditions is achieved prior to lifting the pipe to the next stage.

- A pre-determined quantity of grout was injected. For this project, the quantity varied linearly with a maximum 16.6 cubic feet at the lowest stage to approximately 4.1 cubic feet at footing grade. The quantity was reduced at each stage to provide an envelope with walls that sloped 2V:1H. Additionally the horizontal penetration of the grout was required to extend a minimum of 5'6" from the pier midpoint for the first stage at representative locations.
- A maximum pressure of 100 psi was developed in the injection pipe.
- Structure or ground surface heaving in excess of 1/16-inch was observed.

A laser level was set-up outside of the grout influence area. Various baseline elevations were noted on the existing structure and on portable targets, which were reset for each injection location, to monitor the ground surface elevation.

Grout was pumped at each stage until the project criteria was met. The target stage interval was specified to be 6-inches; however, due to various field conditions the stage intervals varied from 4-inches to 12-inches.

Arrows indicate approximate injection point locations and survey flags indicate utility locations

Grouting performed in close proximity to utilities

The photo above was taken hours after the project was completed, prior to final clean-up. The project was completed ahead of schedule without the removal of any spoils from the site and without damage to any of the utilities. For this project the grouting was performed prior to excavation for the pier foundations. When the grouting is performed in advance, the penetration and dispersion of the grout can be verified visually during the foundation excavation.

For more information, please contact:

Steve Trout
strout@lincolnllc.com
T (630) 980-0339
F (630) 295-9197

75 Monaco Drive
Roselle, IL 60172-1956

www.lincolnllc.com

LINCOLN COMPANY, LLC