CHEMICAL GROUTS: APPLICATIONS AND CASE STUDIES

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Chemical grouting has been successfully used for over forty years to control the movement of groundwater in a wide variety of situations. This presentation will review three projects where chemical grout was utilized to address some very difficult water control challenges.

The City of Dearborn, MI was cited by the EPA for combined sewer overflow violations. The City elected to address these violations by constructing two 120' diameter by 150' deep shafts to collect and treat the sewer overflows that occurred during storm events. These shafts are positioned adjacent to outfalls along the Rouge River. The initial site investigations revealed that several types of very porous geology were located in the 150' shaft depth and that artesian conditions were also present. In addition, methane and hydrogen sulfide were detected in the groundwater.

Engineers and consultants elected to perform a pre-excavation grouting program around the perimeter of the two shafts prior to construction to prevent problems with water and gas entering the shafts during excavation and construction. The grout selected was required to meet the following performance criteria: 1) Very low viscosity capable of penetrating all of the site geology, 2) Adjustable set times, 3) Chemically resistant to gases present, 4) Strong enough to withstand the artesian pressures, 5) Compatible with the construction techniques being utilized and 6) Cost effective when compared with other options. Acrylamide and cementitous grout were selected for use on the project.

The performance criterion was designed to achieve a permeability rating of two lugeons in the soil around the two shafts. Two grout curtains were established around the shaft perimeters, the outer curtain was formed using cementitious grout and the inner and less permeable curtain was formed using acrylamide grout. Testing revealed that the pre-excavation grouting program achieved a final permeability of 0.2 lugeons.

This is one of the largest acrylamide grouting projects ever performed in North America and the final results far exceeded the original project requirements. The project was completed during some very challenging weather conditions and was completed without any safety or environmental issues.

Acrylamide grout was utilized to complete a hazardous waste containment project at the Oak Ridge National Laboratory (ORNL) facility. Acrylamide grout was selected because there is a long history of test work at ORNL which demonstrates that of the available materials, acrylamide is the only material with a history of withstanding nuclear bombardment satisfactorily over time.

The project entailed encapsulating approximately 9.5 million gallons of mixed (hazardous and nuclear) liquid waste that was stored in several trenches at the facility. Fractures developed in the soil structures surrounding the trenches allowing the contaminated liquid to seep into the soil and also into the groundwater which was located about 25 feet below the bottom of the trenches. A combination of cementitious and acrylamide grout was utilized to encapsulate the waste material. After completion of the project no further contamination has been noted in any of the monitoring wells around the project site.

The Toronto Transit Commission (TTC) subway system is one of the largest in the world with over 27 miles of underground tunnels and numerous below grade structures in varying geological zones and hydrological conditions. The tunnels were constructed in 1954 and for many years did not receive and sort of major restoration. As a result, numerous water leaks had developed throughout the system. Water infiltration had been a problem with the TTC since the time of construction. Only emergency repairs were done on an as-needed basis to control the water infiltration problems. These problems included electrical and mechanical system problems and structural problems. It was determined that tunnel leak remediation was necessary as a result of these and other problems with water intrusion.

A regular program of maintenance was established in 1997 with the formulation of a tunnel leak remediation crew. The crew is comprised of 13 TTC employees who perform all of their work during times that the subway is not in operation. TTC consulted with a number of experienced grouting professionals during the development of their program and elected to utilize an “in-house” design-build approach to address the large and complex scope of work.

The mechanism for water infiltration into the tunnels is predominantly via the expansion and construction joint systems. The groundwater table is typically above the tunnel roof and is the source for all of the water infiltration problems. The grouting repair technique that has been successfully used to stop the water infiltration into the tunnels is curtain grouting. Grout is injected into the soil surrounding the tunnel structure where the grout combines with the soil to form an impermeable water barrier or curtain around the tunnel exterior. Extensive testing revealed that acrylamide grout was the best product to be used under the challenging geological and hydrological conditions. The acrylamide grout was selected based on the low viscosity of the product, the adjustable gel set times that are available, the longevity of the product in the soil, and the very low permeability of the treated soil. The success of this program has been exceptional.