Chemical Grout Stops Leaks

Since its development in the early 1950s, chemical grout has been used to stop water movement through soils in mines, earthen dams, tunnels, and excavation sites. It is also extremely effective in stopping leaks into buried structures. And, chemical grout is usually the most cost-effective way to stop leaks into, or out of concrete structures, above or below grade.

Although chemical grout has been widely used for more than 40 years, many engineers and building owners are not aware of how it is typically used, nor the time, costs, and benefits involved in typical applications. The following examples were chosen to illustrate these points.

BURIED RESERVOIRS

One Saturday when the Chief Operating Officer of Erie City Water Authority was playing golf at a municipal course, he drove a ball into a small stream which ran across the fairway. When he bent down to retrieve the ball, he smelled chlorine and wondered why treated water would be in the stream.

Since two, 5-million-gallon potable water reservoirs were buried immediately upstream, he asked that tests be made to determine whether or not they were leaking. One of the tanks had been constructed in 1905 and the other in 1937. Those tests revealed that one tank was leaking about 500,000 gallons of treated water every 24 hours. The second tank was leaking much less.

Divers who visually inspected the interior of the tanks found a two-inch layer of silt on the bottom of the tanks, but could not find any apparent leaks. This caused Ted Fithian, P.E., President, KLH Engineers, Inc., consultants to the Authority, to suspect that minor leakage was occurring through cracks and all of the construction joints. Each of the tanks had 3,897 linear feet of exposed, interior construction joints which had originally been filled with asphalt tar. Seepage through all the joints would allow 500,000 gallons to leak out daily without creating enough velocity to disturb the silt.

KLH Engineers considered various repair methods, including liners and a new concrete slab, but decided that chemical grout would be the best solution. Since the tanks were structurally sound, it was only necessary to stop water from seeping through joints and cracks in the concrete. Chemical grout could do this best because it could seal hairline cracks or large voids equally well.

The engineers specified a hydrophilic (water-activated) polyurethane system, 3M’s Scotch-Seal 5600 Chemical Grout was selected for several reasons. One reason was that it has very low viscosity (300-600 cps) until it comes into contact with water. This allows it to be pumped into hairline cracks with relatively low pressures (700-800 psi). Another reason is that grout, when activated by water, foams to between 8 and 10 times its original volume and forms a mechanical lock, as well as a compressive and adhesive bond with the crack surfaces. In its cured state, the grout is a rubber-like material which is impermeable to water, and NSF approved for use in potable water.

After a tank had been drained and cleaned, the asphalt tar which had been used to seal the original construction joints was removed with high-impact pressure washers. Foam rods which were twice the width of the joints were then dampened with water, saturated with grout, and compressed into the construction joints. After the grout swelled and cured, a grout needle was used to inject additional grout through the foam to seal any space underneath, and to improve the adhesive, compressive, and mechanical bond. Cracks in the floor and walls were sealed through a series of holes which were fitted with injector packers.

DURING

AFTER

At left: A stairwell in a dam gallery fitted with injection packers in preparation for injecting chemical grout. At right: The same stairwell after chemical grout injection.
Each tank was taken out of service about 90 days for the rehabilitation work. Frank Burns, President, State Pipe Services, Inc., Cranberry Township, PA, the contractor who performed the work, said the job was bid sight-unseen because the tanks were in service. "The first time I went into one of the tanks, I wondered what I had gotten us into. Each tank is about the size of a football field and 25 feet deep," he said.

After the repairs were complete, tests showed that 96% of the leakage had been stopped in one tank and 98% in the other. "Stopping the loss of that much treated water will pay for the entire repair in a year," Burns said. "I knew we could stop the leaks. We've used chemical grout to stop thousands of leaks, and I have never had a call-back."

**CONCRETE DAM**

When leaks were discovered during a routine inspection of Soda Dam near Soda Springs, Idaho, the owners ordered tests to determine the condition of the dam. It was determined that the dam was structurally sound, but that continued seepage of water through the cracks and joints could weaken it and lead to more leakage and perhaps, eventually, to a sliding failure. The decision was made to stop the leaks.

Remedial techniques considered and their respective costs included:

- Removing and replacing the concrete over the upstream face of the dam: $472,000
- Covering the upstream face with a two-component membrane (PVC and geotextile lining): $605,000
- Sealing all construction joints and cracks with chemical grout: $156,000 - $277,000

Chemical grout was chosen as the most cost-effective and the best technical alternative.

While the water in the reservoir was lowered 45 feet to permit the replacement of spillway piers, the joints and cracks on the upstream face were identified and mapped. 800 linear feet of cracks and joints were identified as requiring treatment.

AV-220 Hydracure, a one-component chemical grout from Avanti International, Houston, TX, was chosen for the repair. This polyurethane resin system reacts when it comes into contact with water and forms a flexible, dense foam which adheres to the surfaces of cracks and joints. The result is a tough, tight-fitting, highly resilient, rubbery seal which is immediately impermeable to water.

A staggered pattern of holes was drilled to intersect the cracks and joints at least 10 inches from the upstream face of the dam. After a 6-inch long mechanical packer was placed in each hole, water was injected for 5 minutes to test the tightness of the crack, ensure grout activation, and achieve maximum penetration of the grout.

A total of 290 gallons of grout was injected into 450 holes at an average pressure of 1700 psi. Grout acceptance varied from 0 to 5 gallons per hole, with only 1 percent of the holes accepting none. The final cost of the entire chemical grout program was $196,000.

Since the completion of the project, no measurable leakage through the dam has been found.

**SUBWAY TUNNEL**

The New York Subway System has a lot of problems with water leaks. Leaks into their subway system create significant safety liabilities such as the danger of electrical shock or slipping in water puddles, but leaks can also degrade the structural integrity of their tunnels.

Until about 15 years ago, the subway engineers had no long-term solution to the problem. That's when Tom Planert, P.E., President, SSESCO, Inc., Fairfield, NJ, introduced them to the idea of using urethane-based chemical grout to stop leaks. They were interested and asked him to make a repair for their evaluation.

Until Planert introduced the possibility of using chemical grout, the only options had been removal of the soil and street over the station and application of a waterproof coating to the outside of the concrete structure, or the installation of well points - both extremely expensive and disruptive options.

That first job was at Bergen Street Station, the lowest point in the subway system.

It took almost 6 months to get both sides of the station platform area dry, but the agency was very impressed with the low cost and the result. Then, they waited a year to see if the grout would hold. After all, they had used a lot of materials in the past which had held for awhile, but had blown out after the first ground movement.

"That station is still dry," Planert said. "And since then, we've successfully sealed miles of cracks for the subway. I don't know of any other materials that can stop leaks in existing cracked concrete as permanently as chemical grouts," he added.

Chemical grout can be applied in almost any place where water is leaking through concrete structures: where water drips on cars in parking garages, where pipes come through walls, where there are cracks in construction joints in vaults, manholes, sewer pipes, tunnels, or dams. But, grout can also stop leaks in almost any type of structure that is below grade, such as steel sheeting or tiebacks in excavation. In fact, certain types of chemical grout are designed to gel with soil to form a mass which cannot be penetrated by water.

In the final analysis, of course, success with chemical grout is very dependent upon the applicator, so guarantees are only as good as the company that makes them. A wide range of chemical grout products is available, but only experience can produce the in-depth knowledge of when, where, and how to use them.