WaterWorld®

Guide to Use of Polyurethane Grouting to Reduce Infiltration

There are many options for repairing leaks in concrete structures. One of the oldest, yet least understood repair methods uses polyurethane chemical grouts that react with water to either bond with the concrete to form watertight, permanent seals or to become rigid, filling voids and stabilizing soil. According to the National Association of Sewer Service Companies (NASSCO), chemical grout was first developed in 1955. Since that time, it has been used in sewers, manholes, tanks, vaults, tunnels, and many other applications all over the world.

Studies show that 40% of groundwater infiltration in sewer systems enters through manholes. Some manholes require structural rehabilitation usually involving a spray, hand-applied or cured in place (CIP) lining system. It's important for the municipality or the contractor installing any of these systems to realize that groundwater infiltration must be eliminated prior to the lining system installation. Too often, existing leaks in manholes are treated by applying a quick-set hydraulic cement over the active infiltration, which stops the leak temporarily, thus giving the lining system time to be installed. This temporary patch allows water to remain within the primary structure and can lead to a weakened bond or the failure of the lining system.

Installation Basics

Polyurethane chemical grouts are usually injected under pressure as a liquid resin into or in the vicinity of the leak. Once the resin contacts water, a chemical reaction occurs. Depending on the material formulation, the grout/water combination forms either an expansive closed cell foam or a gel. The foam created can be flexible and resilient (hydrophilic) or ridged, meaning the cell structure of the foam crushes when compressed (hydrophobic).

In most manhole leak scenarios, the water flow or leak can be used to pull the grout into the structure. To accomplish this, a hole is drilled in the vicinity of the leak and the chemical grout is injected through the wall into the water source. As the resin reacts with the ground water, it is pulled back into the structure and seals the leak from the outside in, thus creating a seal through the entire wall.

Chemical grouts can also be injected directly into the defect in cases where the leak is not strong enough to pull the chemical grout into the structure. The expansion of the foam helps drive the grout through the structure to seal the defect. Hydrophilic polyurethane resins that produce gels are typically installed by injecting water along with the resin through a manifold that briefly mixes the two prior to being injected. These gels are non-expansive but can be produced at water-to-resin ratios as high as 15 parts water to one part resin.

Know Your Material

Both hydrophilic and hydrophobic chemical grouts will seal leaks in all types of concrete structures initially. The issue is how to create a permanent seal.

“As with any type of repair, choosing the right repair material has a great impact on the longevity of the repair,” said Scott Kelly, Technical Support Specialist for Prime Resins Inc. “There is not a single product on the market today that is a fix-all, do-all for repairing all leaks in concrete. Many products will temporarily fix a leak, but if applied correctly, most polyurethane grouting repairs are permanent.”

To break down the decision process, let’s look at the basic properties of both hydrophobic and hydrophilic chemical grouts. The properties of each type can be used to reduce the cost of installation and improve the quality of the repair long term.

Hydrophilic: Latin (hydro)=water and (philic)=affinity.

Hydrophilic chemical grouts can produce either closed cell foam or a non-cellular gel when mixed with water. The reaction time is typically 30-45 seconds for foams and 12-15 seconds for gels. When activated, foams expand in volume between 5 “8 times. The volume of gel produced is relative to the ratio of water mixed with resin during installation. Hydrophilic Gels can shrink after cure in the absence of water. Hydrophilic chemical grout likes water and is able to bond to wet surfaces tenaciously; water-scavenging agents that seek out water as they react and allow the resin to work its way into water filled pores that exist in wet concrete surfaces. Hydrophilic chemical grouts are flexible and resilient after full cure and will allow movement to occur in the structure without damaging the seal or bond.

Hydrophobic: Latin (hydro)=water and (phobic)=fear.

Hydrophobic chemical grouts require a catalyst that is blended into the resin prior to installation. The dosage of catalyst added to the resin controls the reaction time and the volume of foam produced. Using the maximum dosage of catalyst, (10% by volume) hydrophobic resins have an aggressive

expansion; the reaction time is 10-12 seconds and expansion can be as much as 29 times in volume. Hydrophobic chemical grouts repel water after activation. When injected into a wet crack or joint hydrophobic resins can trap water in the pores of the wet concrete. This trapped water becomes a bond inhibitor. Hydrophobic resins cure rigid and do not recover from compression. If the structure moves there is good chance the cell structure will be damaged and leaks will reappear. Hydrophobic chemical grout is low viscosity and permeates loose and non-consolidated soils readily.

Knowing the basic differences in hydrophobic and hydrophilic chemical grouts is a crucial step in making the correct choice of repair material.

What to Do

If a leak repair project involves a non-structural defect in a concrete or masonry structure, a hydrophilic chemical grout should be used to seal the leak unless job conditions dictate otherwise.

Gels should be used only in below grade structures where either moisture from the interior (like in a manhole) or from ground water is present to keep the cured gel hydrated. Gels will shrink if water becomes absent, but provide a low-cost alternative to foams.

Foams are appropriate for above grade or below grade installation. They are typically 85% air filled after cure and have excellent elongation, compression and rebound for use in expansion joints, cracks, or any other non-structural defect in concrete structures.

Use the aggressive expansion of hydrophobic chemical grouts if repairing a gushing leak that is impractical to repair with milder expanding hydrophilic resins. In below grade structures, this is a good way to fill voids that may be present outside the structure. Once the leak is reduced to a manageable level, hydrophilic resin should be injected into the defect to back up the hydrophobic material.

Inject hydrophilic gel into gushing leaks neat or with a 1:1 water-to-resin mix ratio to shut down gushing leaks. This is a case where you push in as much material as possible as fast as you can. If a high volume pump is available, less material will be used to stop the leak because it reduces the dilution of the resin in the mass of water source.

Use “Activated Oakum” (dry oakum soaked in hydrophilic resin) to reduce the flow in gushing leaks. If the leak can be slowed, a hydrophilic resin may be used to complete the repair.

What to Avoid

Avoid installing gels in expansion joints or cracks that are subject to movement. Gels form a solid material with little or no cellular structure to disperse tension under compression. This tension can split the gel and damage the seal.

Avoid installing hydrophobic chemical grouts for repairing minor leaks in cracks or joints. The repair will be temporary.

Don’t get in a hurry when repairing tight cracks and minor leaks. These can be the most difficult to repair long term.

Conclusion

As our infrastructure ages, chemical grouting will continue to maintain its value as one of the easiest, most cost-effective and longest-lasting repair solutions available.

“If the right polyurethane chemical grout is chosen for your repair project and the correct installation techniques are used, the repair will actually outlast the structure,” Kelly said.

Editor’s Note:

Prime Resins is a manufacturer of polyurethane grouts and epoxies used for infrastructure repair and restoration. For more information about leak repair, visit the company’s website at www.primeresins.com. The site includes case studies and a learning center offering online tutorials.