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Looking back
at Akron

Waterproofing solutions

NATJ queried several companies that offer varied waterproofing solutions to learn what is new – and, in some cases, to see what has proven successful in tunneling applications around the world.

Xypex Chemical Corporation

Xypex Chemical Corporation manufactures a range of concrete waterproofing and protection products used in the construction or restoration of building foundations, water and sewage treatment infrastructure, tunnels, manholes, and marine structures. Its unique crystallizing technology has been tested and proven worldwide in all climates and in widely varying construction situations. Sold through an international network of distributors and licensees in over 70 countries, Xypex is specified and used on countless projects around the world.

Available as a coating or admixture, Xypex Crystalline Waterproofing reacts with the by-products of cement hydration and other mineral constituents of the concrete, precipitating a chemical reaction that produces a non-soluble crystalline formation that fills and permanently plugs the pores, capillaries and hairline cracks that naturally occur in the structure. In this way, Xypex becomes a permanent, integral part of the structure.

Unlike surface barriers or membranes, Xypex cannot puncture, tear or come apart at the seams; it does not require protection during backfilling or during placement of steel or wire mesh; and it is not affected by exposure to the elements and will not degrade over time.

Xypex Admix has been used in multiple jobsites

Xypex Admix C-1000 NF played critical role in shotcrete waterproofing of Vuosaari Harbor tunnels.



around the world. One such tunneling project, in Finland's Port of Helsinki, proves the staying power of the Xypex Admix. The product was installed a decade ago, and a recent examination shows it is still going strong – and tunnels associated with the project remain dry.

When city planners and engineers began drawing up designs for a new harbor that could relieve the pressure on the Port of Helsinki, the need for easy access via roads and rails was a critical requirement at that time.

A four-lane highway and rail lines were built to help move people and cargo in and out of the new port. The highway passes through two new road tunnels that were built near the outskirts of the harbor to enable vehicles to travel unimpeded under 1 mile (1.6 km) of solid rock.

The exposed rock interiors of the road and rail tunnels were reinforced with deep anchor bolts and coated with a base layer of standard shotcrete to a thickness of 2.4-3.2 in. (60-80 mm). On top of this base layer, a 1.6-2.4 in. (40-60 mm) layer of shotcrete mixed with Xypex Admix C-1000 NF crystalline waterproofing was applied to provide a permanent seal against moisture intrusion.

Finally, a 1 in. (25 mm) layer of standard shotcrete was applied to the innermost surface. More than 61,700 lbs. (28,000 kg) of Xypex Admix was needed to treat the waterproofing shotcrete layer. The Xypex Admix was added to the concrete at the ready-mix plant using water-soluble bags for accuracy, convenience and the improved safety of the workers.

The tunnel designers considered other, more conventional waterproofing approaches – such as heavy membranes – but the time and cost of these options led other alternatives to be explored. The thought was that membranes installed over exposed rock would always be at risk for future damage and leakage.

"The application of shotcrete treated with Xypex Admix in the Vuosaari highway tunnels (in 2009) is believed to be the first time crystalline waterproofing has been used for this purpose in Finland," said Ronald Sulin, Xypex sales manager for Finland. "The two tubes of the road tunnel actually dip below sea level, so the need for protection from the ingress of saltwater is a real concern. Within a few months, any seepage that was seen initially dried up as the Xypex Admix did its job, filling in micro cracks and voids with non-soluble crystals. It'll continue working for the life of the tunnels."

Now, more than 10 years after the opening of the harbor and the road and rail tunnels that help keep it moving, the Xypex Admix treated shotcrete continues to prove its effectiveness.

"The use of Xypex crystalline waterproofing Admix in this shotcrete application has truly been a revelation in this market," Sulin said. "Experts have had a long time to study the product in action and I think it is safe to say we have impressed the skeptics. Not only in Europe, but around the world, designers, engineers and contractors are increasingly specifying Xypex Admix for spray-applied concrete. It saves time, saves money, ensures two-way moisture protection and lasts the life of the structure. It makes sense."

Alchemy-Spetec

Alchemy-Spetec has been in the concrete repair industry for nearly 30 years, since the company's president, Stephen C. Barton, first developed a polyurethane technology while working on a leak-seal crew in his teens.

Among the items that Alchemy-Spetec offers is a flexible hydrophobic urethane grout, Spetec PUR HighFoamer, for gushing leaks. Another popular product is Spetec PUR F400, which is ideal for sealing cracks – and in areas that endure wet/dry cycles. In other situations, a hydrophilic flexible grout like Spetec PUR GT350 is often the choice when drying is not a concern.

All three are cured polyurethane products, which exhibit high strength and good chemical resistance. In addition, cured polyurethane is harmless to the environment and resistant to biological attacks.

Spetec PUR GT350 was recently used to patch tunnel walls as links to new stations were being developed in the Seattle underground transit system. It was also employed during patching of cross-hatches.

Spetec PUR GT350 is an MDI-based hydrophilic, one-component flexible polyurethane injection resin, ideal for waterproofing and shutting off water leaks permanently. It is often used when drying is not a concern. Its flexibility is key as it allows the joints or cracks to move while maintaining a watertight seal.

Spetec PUR GT350 offers a fast reaction time and an immediate increase in viscosity. While it's often injected as one component, it can be injected in combination with water when circumstances require.

Spetec PUR HighFoamer, a flexible hydrophobic urethane grout, is the choice for gushing leaks. It quickly fills the voids behind concrete structures and is most commonly selected to stabilize and cut off larger water leaks. Its success results from combining a high rate of expansion with maximum flexibility.

Applications include eliminating large flow and high-pressure water leaks, including those in foundations such as diaphragm walls, piling sheets and secant piles. It also is used in pre- and post-injections in mines, tunnels, pipe jacking, drill and blast and TBM applications.

Spetec PUR HighFoamer is a one-component product. Varied reaction times are made possible by adjusting the percentage of GEN ACC Accelerator. The closed-cell structure of cured polyurethane ensures permanent sealing of cracks and joints.

Spetec PUR F400 is utilized to seal cracks when the area is likely to undergo wet/dry cycles. It is a one-component polyurethane injection resin; is solvent- and phthalate-free; and is water reactive.

It, too, is adept at shutting off water leaks in concrete, brickwork and sewers where movement and settlement may occur. It also seals water-carrying cracks and joints in tunnel segments and curtains grouting behind tunnel, concrete, brickwork and sewer walls.

Sika Corp

A new macro fiber product from Sika Corp. has achieved a significant approval and successfully

completed a series of independent tests.

SikaFiber® Enduro® Prime was developed to reinforce concrete slabs, on grade, with extremely high performance characteristics. The product, manufactured in Chattanooga, Tenn., went through a battery of stringent, third-party testing to achieve the designations.

SikaFiber Enduro Prime is one of the first macro fibers to obtain an International Code Council (ICC) Evaluation Services (ES) Report for AC308.3. The ICC technical staff develops acceptance criteria for new products, which are approved by the Evaluation Committee during open public hearings.

The evaluation report included testing SikaFiber Enduro Prime for freeze-thaw, plastic shrinkage cracking resistance, ring shrinkage and flexural performance of fiber-reinforced concrete.

SikaFiber Enduro Prime also successfully completed testing for an ICC evaluation report, which verifies that new and innovative building products comply with code requirements and recommendations for use.

Sika says its macro fiber products offer the performance of steel fibers at a lower dosage rate.

"The unique anchorage system of each macro synthetic fiber and the higher aspect ratio (length/diameter) allows for higher performance in the concrete matrix," the company stated. "The macro synthetic fibers infuse the concrete with added levels of toughness, energy absorption and durability. In addition, macro synthetic fibers provide an added measure of crack control without the risk of corrosion associated with steel."

Sika products reflect that concrete is the most commonly chosen material when durability is the key factor. The reinforcement of concrete is equally as important.

"About 40 years ago, an old technology of using discontinuous reinforcement started to reemerge," the company said. "We know this material today as concrete fibers, representing one of the fastest growing segments in the construction industry in recent years."

Sika is a specialty chemicals company that develops and produces systems and products for bonding, sealing, damping, reinforcing and protecting in the building sector and motor vehicle industry.

AGRU America

A key waterproofing product from AGRU America is playing an essential role in the expansion of a new, state-of-the-art wastewater treatment system in Canada.

The Annacis Island wastewater treatment plant in Vancouver processes about 46 billion gallons (175 billion liters) of wastewater each year. It



Alchemy Spetec
PUR F400



AGRU
waterproofing
in action

services more than 1 million residents, about half the population of the Vancouver, British Columbia, metropolitan area.

Metro Vancouver is expected to grow to a total population of 3.4 million by 2041 – an increase of about 1 million residents. The rising population will weigh heavily on the existing infrastructure, requiring upgrades or new developments to fill the gap.

A key initiative to help meet the region's wastewater treatment needs is the expansion of the Annacis Island facility.

The expansion will take place over several years and comprise over 20 projects that will ultimately improve the facility's capacity. These expansion projects, which are being conducted in phases, will increase the volume of treated wastewater, improve the generation of on-site green energy and manage odor. Eventually, the facility will be able to quickly recover after a major earthquake.

Concrete protection is an essential element in extending the lifespan of many critical concrete structures that make up wastewater treatment facilities. Concrete protection liners (CPL) help prevent corrosive compounds and gases from damaging the structures.

Since the early 1990s, Metro Vancouver has utilized AGRU's Sure-Grip®, a high-density polyethylene (HDPE) CPL, on at-risk concrete structures exposed to and in contact with wastewater. As part of the effort at Annacis, the primary influent channel, pre-aeration tanks and primary effluent channels are being expanded, and another AGRU product – Ultra-Grip® – will be used to line the walls and ceilings.

Ultra-Grip is a concrete protection liner made of chemically resistant plastics that prevents concrete corrosion and therefore significantly extends the life of structures. It is a new version of Sure-Grip that utilizes an enhanced anchoring system design. Ultra-Grip is ideal for construction with high groundwater pressure, harsh environments or strict environmental requirements.

Ultra-Grip is available in a variety of colors and configurations for both rolls and sheets and, at 10

ft. (3 m), is among the widest CPLs produced in the United States.

"Backpressure resistance is what sets it apart from its competitors," the company stated. "If a corrosion protection system cannot sustain the required backpressure long-term, then its failure is imminent. Failure leads to concrete corrosion with high costs associated with replacement, traffic control measures and bypass pumping systems."

Groundwater backpressure also presents a significant concern for wastewater professionals. Allowing other fluids like groundwater to enter a wastewater treatment system is an unnecessary and costly expense. Therefore, wastewater professionals are compelled to design systems that are limited to only treating wastewater. Ultra-Grip's tensile strength and high elongation allow it to bridge cracks in concrete structures and prevent groundwater from entering the wastewater system.

In one of the many ongoing Annacis projects, Metro Vancouver worked with the design consultant to develop plans for the new grit removal facilities. AGRU's customer and fabricator, PREDL Systems North America, Inc., then coordinated with the designers and engineers to provide support for the structures to be lined with Ultra-Grip, fabricating the product into panels sized to match the exact dimensions of each concrete pouring sequence.

Completion of the first expansion phase is expected by August 2021. The entire project should be finished by the end of 2026.

Avanti International

For decades, Avanti International products have been used to stabilize soil and control groundwater in geotechnical applications. The company produces injection grouts, which are essential to tunnel waterproofing. The products can be used:

Before tunnel break-ins and break-outs to stabilize surrounding soil and rock, control groundwater inflow, and improve project productivity

During tunnel construction to stabilize weak soil and rock, control groundwater ahead of and behind TBMs to ensure efficient mining, and create a safer work environment

After project completion to create an impermeable water barrier that permanently stops inflow and infiltration, and extend the structure's life cycle.

With these products, a multicomponent injection grout or an expansive hydrophobic foam grout is injected into various rock strata, soil and voids. This process creates a grout curtain to stabilize the soil, stop the infiltration and provide structural support.

The injection grout is pumped under pressure from a delivery system that is either above ground or located near the grouting area. This liquid mixture is pressurized through the rock, soil or structural wall – filling voids and creating a watertight grout/soil matrix that prevents groundwater infiltration/exfiltration and potential soil erosion.

The grout seals off infiltration within 30-60 seconds and is controllable from the delivery system. Grouting pressures measured at the injection point are monitored. This ensures that the materials are pumped at higher pressures than the groundwater pressures.