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TECHNICAL ARTICLE

GEOKRETE GEOPOLYMER OUTPERFORMS ALTERNATIVE SOLUTIONS FOR MANHOLE REHABILITATION

Pilot Test Conducted in Cheektowaga, New York Finds GeoKrete Geopolymer A Superior Manhole Rehabilitation Solution

With the nation's manholes increasingly in need of repair, rehabilitation is considered a less expensive option to excavation and replacement. In a tough economy, when extra costs can create a big dent in a city's budget, manhole rehabilitation is increasingly seen as an excellent "bang for the buck."

Historically, one of the most cost-effective and efficient methods for rehabilitating manholes is the use of spray or centrifugally applied cementitious mortar systems. While cementitious mortars have been the standard specified material for over four decades, it has become increasingly apparent that the consistency and speed of application need improvement, cure times need to be accelerated and structural integrity enhanced.

10-Year Performance Test Results of GeoKrete Application Support Cheektowaga Pilot Test

In 2006, an inspection of 14 manholes in Neenah, WI revealed a lining failure of more than a dozen new manholes that had been lined with a polyurea coating just one-year prior. Extensive flaking and peeling were already present indicating that a complete failure was imminent.

The town chose to reline them with a geopolymer lining system called GeoKrete using a spin-casting apparatus to ensure a consistent and even coating from top to bottom. In 2016, Rodney Manthey, from the Grand Chute-Menasha West Sewer Commission inspected the same manholes and reported that after 10 years the manholes showed no signs of degradation and were still in like-new condition.

Superior Mechanical and Physical Properties

Recent advancements in geopolymer technology have offered the infrastructure industry a field friendly mortar, which offers outstanding bonding, structural, and corrosion resistance properties, when compared to Portland or Calcium Aluminate based cementitious mortars.

According to the Geopolymer Laboratory at the Trenchless Technology Center (TTC), the durability of geopolymers in corrosive environments surpasses that of Ordinary Portland Cement (OPC) and Calcium Aluminate (CAC) by two to ten times. And, since geopolymers are not hydration products like traditional concrete, they contain minimal water in their structure and owe their exceptional performance at more extreme temperatures and environments to this material characteristic. In addition, geopolymers will stick and adhere to virtually any surface, and unlike traditional cement-based mortars, they are also capable of bonding and building to great thicknesses.

Environmentally Friendly

Since Geopolymers are comprised of over 50% recycled materials, a product such as GeoKrete is a sustainable material with a low carbon footprint. These environmentally friendly substitutes for Portland cement and Calcium Aluminates also possess the physical properties to address highly corrosive sanitary sewer environments. This exceptional corrosion resistance replaces the need for the traditionally more expensive and cumbersome epoxies, polyureas, and intricate composite cement/epoxy systems.

Test Manhole

Selecting Material and Application Technique

Rehabilitating manholes can be a complicated process. Choosing the appropriate material and technique is vital to extending the life of the structure as well as ensuring cost efficiency. An important part of the selection process is investigating case histories, and working with a contractor who has experience with the chosen material.

Long-Term Viability

When the town of Cheektowaga discovered a case study of a 10-year-old geopolymer application in the unique climate of the Great Lakes US region, they decided they must include geopolymers in their town's pilot study. "We wanted a long-term quality solution," said Mark Christel, Cheektowaga's Principal Engineer. "The goal of the study was to determine the best product moving forward for our community in helping us stop the continuing deterioration of manholes and the inflow/infiltration issues in our system." The pilot study included the rehabilitation of 500 brick manholes totaling approximately 3,000 VF.

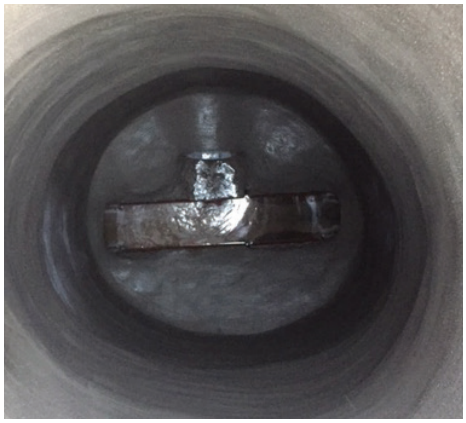
Pilot Study Project

Christel contracted with a local general contractor to perform the pilot study utilizing three commonly specified cementitious spray-applied manhole rehab products as well a geopolymer spray-applied product. Having had success with Quadex GeoKrete geopolymer on other projects, the general contractor proposed that it should be considered in the study.

Manhole condition prior to GeoKrete geopolymer application.

Installation and Testing Parameters

As directed by the town, the manhole rehab work was performed during regular working hours. Each product was installed (spray-applied) on 56 manholes for a total pilot size of 224 of the 500 total manholes. Inspections were performed on each of the manholes several hours following each rehab. These end-of-day inspections revealed cracking in the lining of several of the manholes utilizing cementitious products, while those rehabilitated with geopolymer were crack-free.



GeoKrete Geopolymer showed no signs of cracking and peeling.

Study Results

Once the linings in the 224 manholes were complete, Christel conducted further study during which it was revealed that the three different cementitious lining materials — each with a sample size of 56 manholes – were showing cracking in 20-25 percent of the manholes. It was noted that many of the cracks were large enough to fit a credit card into, suggesting that the long-term structural integrity and bonding of the liner material may be jeopardized. The 56 manholes that had been sprayed with GeoKrete were found to have a 0% crack/failure rate.

Explaining the cracking of the cementitious materials, Steve Henning, Technical Director for Quadex said, "The curing of cementitious products all comes down to heat and humidity. Due to the cure reaction and the heat produced, cementitious materials have a high likelihood of drying out. When this happens slowly over time, it's not a big issue, but when it happens

quickly, cracking occurs. In our world where you want to close up manholes and return them into service quickly it's a bit difficult to babysit each manhole for 24-48 hours after initial application." Since geopolymers undergo poly-condensation, as opposed to hydration, they do not retain water long enough for this to be an issue.

Test Manhole

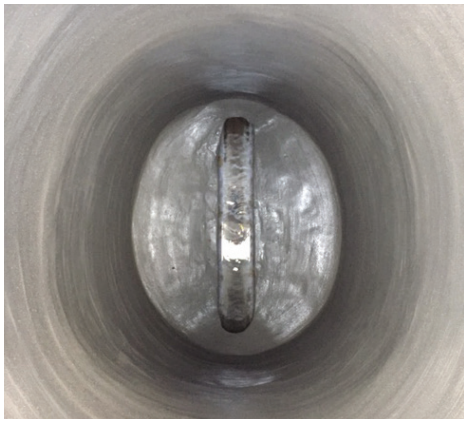
Pilot Project Results Convince Town

Based on the product's 100% success rate, Quadex GeoKrete proved to be the best solution for the town of Cheektowaga. As a testament to just how well the GeoKrete product performed in the pilot project, town officials are excited about using the product in the future.

Manhole condition prior to application of GeoKrete Geopolymer.

Conclusion

There are a number of technologies available for rehabilitating existing manhole structures without the need for excavation and replacement. The selection and application of material however, is vital to providing the end results desired by the customer. Any product can fail if the application is not performed by an experienced, trained and certified applicator. While Portland cement-based spin cast systems have worked well, the industry recognizes the obvious performance and application advantages of using geopolymer lining systems. They have proven to be an extremely cost-effective and environmentally friendly solution for the long-term structural rehabilitation of manholes, wet wells, junction boxes, pipes and tunnels.



GeoKrete Geopolymer showed no signs of cracking and peeling.

Quadex GeoKrete Structural Rehabilitation Mortar

GeoKrete is a proprietary factory blended, fiber-reinforced material enhanced with a monocrystalline quartz aggregate. It provides corrosion resistant protection in high hydrogen sulfide environments, increases structural integrity and stops the infiltration of ground water in deteriorated structures.

Unlike cementitious liners, which hydrate to harden, the reaction mechanism in GeoKrete is polymerization that does not create heat (which contributes to cracking) and yields superior strength and chemical resistance. Once it is applied onto the damaged surface, GeoKrete quickly forms into a crystalline structure for higher resistance to acids, lower porosity and greater surface durability. The quick cure rate shortens by-pass time and allows flows to be re-established much quicker than Portland cement-based mortars.

GeoKrete is used for vertical and overhead repairs to metal, concrete or masonry sewer structures such as manholes, wet wells, pipe and treatment plant structures where microbiologically induced corrosion is a problem. It is applied by low-pressure spraying or spin-cast application process.