

# Public Works

## DIGEST

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*A technician controls application of geopolymer mortar liner to rehabilitate a steel storm drainage culvert at Simmons Army Airfield, North Carolina. (U.S. Army Photo)*





# Geopolymer mortar system rehabilitates pipes, culverts

by Clint Wilson and Jaclyn Mathis

The U.S. Army Engineer Research and Development Center and Fort Bragg's Directorate of Public Works demonstrated and validated the performance characteristics of a new geopolymer mortar liner system for culvert rehabilitation at Simmons Army Airfield, North Carolina.

This rehabilitation technique uses geopolymer mortars that are often from the aluminosilicate family and are blended with Portland cement. This geopolymer mortar formulation can be centrifugally cast to reline pipelines while minimizing disruption to the installation by eliminating the need to dig up and replace existing pipelines and culverts. The material offers rapid cure times, higher strength, and reduced porosity as compared to traditional mortar and concrete.

The geopolymer liner system can be used to restore structural integrity and extend the life of storm water structures with little impact on the pipe's performance. A new pipe is essentially formed within the old one. The original pipe can completely fail and the remaining geopolymer liner is structurally effective on its own. It cures quickly and can reach up to 10,000 pounds per square inch compressive strength at 28 days. While the internal diameter is reduced by the added lining, the improved surface condition may provide better hydraulics to compensate. When fully cured, the

geopolymer mortar becomes a synthetic stone, or ceramic.

Trenchless technology for repairing and rehabilitating culverts and storm drainage infrastructure has been rapidly improving during the last two decades. There are a number of technologies available today for rehabilitating deteriorated culverts and storm water drainage rather than conventional trench and replace. Geopolymer mortar is one of the more recent emerging technologies.

At Simmons Army Airfield, geopolymer mortar was centrifugally spray-applied to a corrugated metal culvert. The culvert, approximately 100 feet in length with a 48-inch diameter, drains water from the airfield beneath a perimeter road. The geopolymer mortar is brought to the site in bags similar to ready mix concrete, and is pumped from a continuous mixer. The centrifugal spray unit is pulled through the culvert using an electric winch to control the speed and provide an even and continuous application.

The culvert drainage flow must be bypass pumped until shortly after the relining is complete. The process requires that the culvert be prepared by pressure washing. Once cleaned and any debris removed, damaged areas and holes must be filled and troweled with the geopolymer or high strength grout before the centrifugal application of the geopolymer.

The required thickness of the geopolymer was 2 inches for the relining of this culvert. The application required three layers to reach the full thickness, with one application being done each day. The application was performed at about 40 degrees Fahrenheit, which is slightly above the lower temperature limit of 37° F. Even in these conditions the geopolymer cured rapidly and achieved expected strength.

This evaluation included field testing methods, which are similar, but not the same as those for regular concrete.

Additional details are available from the U.S. Army Engineer Research and Development Construction Engineering Research Laboratory, and will be published in detail in a technical report.

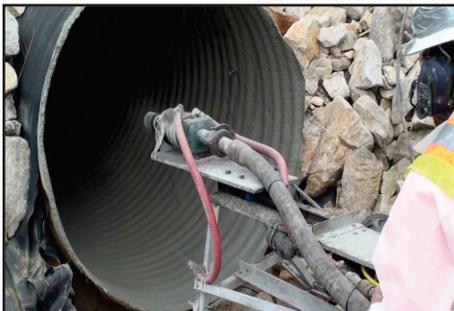
The demonstration at Simmons, funded by the Office of the Secretary of Defense Corrosion Prevention and Control Program, showed that this process of culvert relining with geopolymer mortar can be an effective alternate to other trenchless lining technologies (Slip lining, Cured-In-Place Pipe, Fold-and-Form, Spiral Wound, Invert Lining). This should be especially true when the pipe diameter is 54 inches or larger.

The spin cast application is typically not compatible with pipelines less than 36 inches in diameter unless the geopolymer is applied with robotic controlled centrifugal spray equipment. It is versatile and the geopolymer can also be hand sprayed on pipes with irregular shapes and large sizes. As part of a market survey it was determined that there are multiple vendors for installing geopolymer mortar. The culvert was reevaluated after 12 months and was in good condition with only minor cracking.

This is a process that should be seriously considered by all Army organizations when planning to repair or rehabilitate deteriorated storm culverts, and storm or sanitary pipes. In particular, this is a very useful process to use when structures are located beneath roadways, since digging up the road is avoided.

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The spin-cast head is shown at the end of the first out of three passes. The unit has been pulled through the pipe while spraying the gray-colored geopolymer liner on the inside of the pipe.  
(U.S. Army Photo)