SEVEN QUESTIONS TO ASK YOUR GEOPOLYMER SUPPLIER

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Milliken Infrastructure is a leading supplier of geopolymers for the rehabilitation of underground pipeline assets. Here, the company's development manager outlines a number of vital questions that should be addressed when deciding on the right product.

The first commercially available geopolymer mortar for sewer and stormwater rehabilitation was introduced in 2011. Since then, 'geopolymer' has become a buzzword in the trenchless industry, and several companies have introduced so-called 'geopolymer' products.

Some of these companies have just rebranded the products they were selling as portland cement mortars once the key aspects of geopolymer chemistry (i.e. chemical resistance, no cold-joints and enhanced structural properties) became widely recognised as advantages in the trenchless industry. However, it is vital that potential consumers have knowledge that the product they are considering has a history in the marketplace.

THE QUESTIONS

When you are deciding on what geopolymer to use for your next project, before you make any final decisions or specifications, ask your supplier the following seven questions to ensure you are getting the qualified, quality product you are expecting.

How do you know you are really getting a geopolymer and not just a formulated portland cement?

This is a key question because there is misinformation within the industry about what qualifies as a geopolymer. In strict terms, a geopolymer is a network of mineral-based elements linked with covalent bonds, but that explanation is a hard definition to quantify.

Typically, in the trenchless market, geopolymers are aluminosilicates, which have a high percentage of Si-O-Al-O bonds. While there are several detailed techniques that can be used to quantify the chemical composition of a mortar, none are perfect at assuring that the mortar is a geopolymer.

The best option currently available is X-ray fluorescence (XRF). XRF can be measured using ASTM C114 and helps determine the actual composition of the material.

A geopolymer material formulation should contain at least 70 per cent of raw materials that can react in the correct way (also called pozzolanic material); these raw materials include SiO_2, Al_2O_3, Fe_2O_3 and MgO.

If someone asks for a specification of an exact ratio or percentage of chemistry or more exotic testing, they are trying to get you to sole source the product without knowing it. This XRF test ensures that one of the main components of portland cements – CaO, which can come from other sources as well – is below 30 per cent.

This value minimises the chance the product is a portland cement mortar with some pozzolanic filler material thrown in, claiming to be a geopolymer.

How many projects have been completed with your geopolymer material?

It is always important that any product has a reliable history in the marketplace. You should ask how many projects your contractor has been involved with using the geopolymer.

A reliable provider should have more than 100 projects completed within the past 5–10 years.

How much pipe has been repaired with your geopolymer material?

Since 2011, it is estimated that more than 30,000 linear metres of large diameter pipe has been structurally repaired with geopolymer mortars, including pipes as small as 24 inch (610 mm) to greater than 204 inch (5,182 mm) in diameter. Material suppliers

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with genuine geopolymer experience should be able to provide project lists for significant amounts of this work.

Has your geopolymer been tested in pipe form?

Testing and data is critical to ensuring the product bought is truly suited for your trenchless application. Currently, only one geopolymer mortar has been fully tested and validated for structural performance in pipe configurates by third party labs.

Two of the most respected civil engineering labs in North America have done extensive tests on pipes repaired with a geopolymer mortar. Both the Trenchless Technology Center at Louisiana Tech University, as well as Dr Ian Moore's laboratory at Queen's University in London, Ontario, have characterised the structural performance of actual pipes rehabilitated with a geopolymer mortar.

Full reports of the testing are publicly

A Milliken employee oversees a geopolymer application.

available as the research was published via peer reviewed journals and at conferences to asset owners and engineers interested in understanding the structural performance.

Has your geopolymer design model been verified by pipe testing?

Because only one geopolymer mortar has been third party tested in both standard physical properties as well as full pipe testing, it is critical to investigate that the design method used in determining the liner thickness is appropriate. Using design methods for flexible pipes, like cured-in-place pipe, does not accurately predict the behaviour of geopolymer mortars.

The material supplier should be able to provide you data on how its materials perform in a full pipe and align it with the design method. This data can help assure the engineers and asset owners that the design thickness calculated using this validated methodology will stand up to rigorous engineering standards.

What is the flex strength of your geopolymer product and why is it important?

The rigorous third party testing conducted in pipe form confirms that the failure mode of cementitious and geopolymer mortars will be longitudinal cracking in the crown of the pipe under excess load. This failure is different from flexible pipes, which can fail by buckling.

This longitudinal crack will form when the tensile forces on the interior surface of the pipe exceed the tensile strength of the material, but because this load is applied perpendicular to the tensile face, the critical physical property of the material failure mode is flexural strength or flexural modulus.

This result means that for any given load configuration, geopolymers with a higher flexural strength will have the minimum required structural thickness.

What test method is used to determine the flexural modulus of your geopolymer?

Not all test methods are created equal. In fact, just because a company says it measures a certain physical property, it does not ensure the company provides the proper conservative engineering value.

For flexural strength, there are several methods that suppliers are using to report their values: ASTM C293, ASTM C348 and ASTM C78. Which one is right? Which one is conservative?

ASTM C293 and ASTM C348 both use centre point loading, which loads the beam from a single central point across a known span, while ASTM C78 loads a beam at two equidistant points across the span, or in what is called 'third-point loading.'

Third-point loading is more conservative and produces a lower value when the same material is tested, thus ASTM C78 will give you a more conservative value versus ASTM C293 and C348 respectively. Therefore, all values of flexural strength do not conservatively predict the material behaviour in actual loading conditions.

The full scale pipe testing confirms that the third-point loading method as outlined in ASTM C78 is an appropriate measurement for predicting pipe performance. Using less conservative test methods in the same model will under-predict the required design thickness and should not be considered conservative engineering.

The necessity of chemical resistance, no cold-joints and enhanced structural properties as key aspects in the trenchless industry, combined with the rise in popularity from multiple introductions of geopolymer products in the trenchless industry, increases the requirement of adequate data.

Any legitimate geopolymer mortar supplier should be able to confidently answer every question with data, research and testing to back up its claims. Only then should you consider the supplier for future projects that call for geopolymer mortars.