GEOPOLYMER TECHNOLOGY

Geopolymer is a novel silicoaluminate polymer cementitious binder with outstanding properties compared to Ordinary Portland Cement (OPC). Geopolymers can be produced out of industrial by-products such as fly ash (from coal combustion) or slag (from blast-furnace), which are alkali activated and cured to produce a polymeric binder gel. The durability of geopolymer in corrosive environments surpasses that of OPC by 2 to 10 times, depending on the geopolymer formulation. This is a specially interesting feature that makes geopolymers an important candidate for the replacement of Portland in applications where it usually fails, such as corrosion protection at marine environments, paper mills, water treatment facilities, buried infrastructure, storage tanks, etc. Another key aspect of geopolymer quality is fire and heat resistance, being able to withstand temperatures of up to 2500°F, while Portland cement is known to fail drastically at temperatures of 800°F. Since geopolymers are not hydration products like traditional concrete, they do not contain water in their structure and they owe their exceptional performance at high temperatures to that aspect. Among the ecological benefits of this technology are the carbon footprint reduction (about 85% compared to OPC) and the utilization of waste material to produce concrete instead of landfilling. A special aspect of interest in this matter is that precisely the fly ash type that is not suitable to use for Portland cement replacement is the one that suits better for geopolymerization, and produces the highest quality geopolymer, i.e., much of the fly ash that is currently landfilled could potentially be used in this technology with high performance results.

The Geopolymer Laboratory at the Trenchless Technology Center (TTC) has been active since 2006 and is focused on large scale applications as well as microstructural characterization of geopolymer materials. The research personnel at the laboratory have 8 to 10 years' experience in the technology. The TTC has produced several patents in this field and has achieved significant milestones. Some notable milestones include: producing the first geopolymer formulation for the manufacture of sewer pipes in North America, in conjunction with Lehigh Hanson. Field tests results are expected within the next 6-12 months for the first installation of geopolymer manholes in North America. Another milestone achieved by the TTC was creating a super high temperature resistant geopolymer to be used by NASA as a floor for the rocket engine testing facilities at the Stennis Space Center, with results surpassing the performance of commercial refractory cements used currently by NASA. A third milestone was the creation of a mix design for geopolymers to be used in massive scale applications (about 100 yd^3) with controlled setting time and optimum workability, which is something unique in the United States. Other milestones include designing a sprayable geopolymer formulation for the rehabilitation of sewer pipes and manholes, and developing a dry cast formulation. The collective experience and accomplishments in this area make the TTC the most important research center for industrial applications of geopolymer in the United States.

Geopolymer pipe about to be tested for D-load.

Geopolymer 1 yd^3 sidewalk at the TTC.

10' geopolymer bridge barrier for LTRC.

High Temperature Geopolymer panel tested at 4000°F at NASA Stennis.

Sprayable geopolymer formulation for the rehabilitation of manholes and sewers.