



# Trenchless Technology Center *Newsletter*

J U N E 2 0 1 0

## Geopolymers – Innovative ‘Green’ Materials for Rehabilitation of Wastewater Infrastructure

Inorganic polymer (geopolymer) is an emerging class of aluminosilicate cementitious materials synthesized from byproducts such as fly-ash, which do not need the presence of Portland cement as a binder. Key reasons for the growing interest in geopolymer concrete technology are its life cycle greenhouse gas reduction potential (Portland cement contributes about 7 percent of the total global man-made CO<sub>2</sub> emission to the atmosphere), its rapid strength gain rate, dimensional stability, excellent chemical resistance to acid and sulfate attacks, as well as high thermal resistance. Geopolymer grouts offer a cost-effective and ecologically-friendly alternative for the rehabilitation of aging wastewater conveyance systems, and are expected to assist municipalities in responding to the growing pressure to deploy sustainable, eco-friendly construction technologies and materials (80 percent CO<sub>2</sub> footprint reduction).

The Trenchless Technology Center undertook a two-year research project aimed at the development of a geopolymer grout, tailored specifically for the rehabilitation of manhole structures and gravity driven sewer pipes. Test data include standard ASTM procedures for quantifying mechanical strength (compression, tensile and flexure), corrosion resistance, adhesion, viscosity, abrasion and flowability. During the course of the work several admixtures were developed to improve the workability, flowability and spraying characteristics of the geopolymer grout, as well as its adhesion to vertical concrete surfaces. Furthermore, a specialized formulation was developed to provide the geopolymer grout with bactericide characteristics for the mitigation of biogenic corrosion in wastewater pipes.

Geopolymers grouts show excellent compressive resistance (up to 16,000 psi) and rapid strength gain, with 95 percent of the ultimate strength achieved in as little as three days under proper curing conditions. Another beneficial property of geopolymers is their low vulnerability to chemical attacks. Since their chemistry is not based on calcium silicate hydrates, geopolymers are practically inert to sulfate salts attack. Furthermore, composed of an alkaline silicate net, these cementitious materials are also inert to alkali-aggregate reaction, a common concern with Portland cements. The testing program included selection of base materials, optimization of the activator solution and the steps necessary to achieve a sprayable geopolymeric mix.

Further studies include evaluation of the rheological characteristics of the mix, the performance of an array of standard ASTM tests recommended by NASSCO and/or specified by municipalities for spray-applied cementitious grouts used in the rehabilitation of manhole structures. Extensive electronic scanning microscopy (ESM) and elemental analysis using energy dispersive spectroscopy (EDS) were undertaken during development of the biocide agent. This new innovative product was subjected to a series of full-scale field tests, where it was prepared and applied using standard construction equipment. Pilot projects of this exciting new technology are planned for the summer of 2010. For more information please contact Dr. Carlos Montes or Prof. Erez Allouche at (318) 257-2852 or via e-mail at [allouche@latech.edu](mailto:allouche@latech.edu).

### Test Results for Sprayable Geopolymer Grout

Compressive strength (ASTM C-109), 24 hrs.....	6,000 psi
Flexural strength (ASTM C-78), 24 hrs .....	900 psi
Elastic Modulus (ASTM C-469).....	1,800 ksi
Poisson’s ratio (ASTM C-469) .....	0.16
Dynamic viscosity .....	24,000 cPoise
Pot life (ASTM C-403) .....	~ 3 hrs
Corrosion resistance (ASTM C-267) .....	Approx. 5 times better than OPC-silicate fume blend
Bond strength (ASTM D-4541).....	1,400 psi
Abrasion resistance (wear index) ASTM C-744.....	550 (typical value for OPC = 400)
Sulfate expansion (ASTM C-1012).....	0.12 percent after an 8-week exposure
Absorption after immersion (ASTM C-642) .....	4.75 percent



Geopolymer concrete is mixed and sprayed using standard construction equipment.

## TTC Holds 2010 IAB Meeting at No-Dig

This year the TTC held its semi-annual Industry Advisory Board meeting during the 2010 No-Dig Conference in Schaumburg, Ill. On May 5, the TTC hosted a lunch meeting with 35 board members in the conference hotel. The meeting was run by TTC industry advisory board chairman Joe Barsoom and featured updates on the research program, municipal forums, staffing and the proposed 3,000-SF expansion of the National Trenchless Technology Laboratory, TTC's premier research facility. Dr. Erez Allouche provided the board members with an overview of the ongoing 21 research projects that the TTC is presently undertaking, valued in excess of \$3.8 million. Of special interest is the capital investment program under way at the TTC that is seeing more than \$600,000 in new equipment including a new 1,000 SF electromagnetic laboratory.

Jadranka Simicevic provided an overview of the very successful Municipal Forum series that is held in over a dozen locations per year. This year the average attendance exceeds 50 people per event, with the spring agenda including New York City, Seattle, Houston, Minneapolis, Columbus, Ohio, Denver and Shreveport, La. TTC Staffing was covered by Drs. Rob McKim and Allouche and included the addition of Cathy Sly and Linda Echles to cover for the ailing Sandi Perry. Dr. John Matthews and Dr. Saiprasad Vaidya have joined the TTC as Post-Doctoral Fellows, and are assisting with the center's multidisciplinary research program.

## NASTT Student Chapter Goes to the No-Dig Show

The NASTT student chapter at Louisiana Tech University recently sent a contingent of 11 students (seven undergraduate and four graduate) to the 2010 No-Dig Show. The group drove about 15 hours from Ruston, La. to Schaumburg, Ill., under the supervision of TTC Lab Technician Nathan Pettit. While there, students were able to meet with their colleagues from other student chapters, as well as industry leaders to discuss and learn more about trenchless technology. The students were able to attend the conference in large due to the support of NASTT. In exchange the students assisted conference organizers with the technical paper sessions and other conference related tasks.

Two doctoral students, Carlos Montes and Shaurav Alam, presented technical papers discussing their research projects. Alam also competed in the Student Poster Competition. The Chapter was able to take home three awards from the conference. Rodney Harris and Anthony Macaluso won third place in Student CCTV Completion and Eric Slusser was awarded one of the Charles P. Lake Rain-for-Rent scholarships presented at Monday's Educational Auction. Ivan Diaz was awarded one of the five inaugural Michael Argent Memorial Scholarships in the amount of \$5,000 at the Kick-Off Breakfast.

### Industry Advisory Board

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