Trenchless Technology Center Newsletter

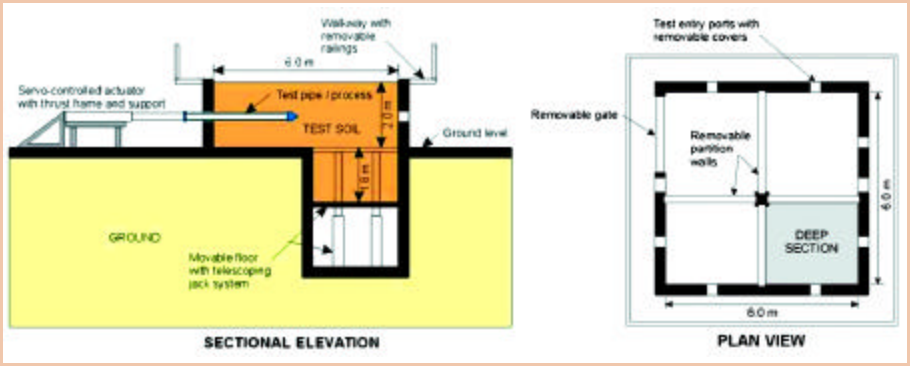
SEPTEMBER 2004

L-STaR Major Research Equipment Proposal Funded

The TTC is pleased to announce that its proposal for major research equipment was funded by the National Science Foundation.

The facility was given the acronym L-STaR (Large-Scale Trenchless Technologies Research and Testing Facility). The proposal, submitted in January, was made to support the ongoing development of the TTC's national trenchless technology research and education facility. The award amount was $272,495 from the National Science Foundation, with $116,783 pledged in matching support from Louisiana Tech University and the private gift of Mike Garver.

The centerpiece of the equipment requested is construction of a soil test chamber (see accompanying figure for a conceptual sketch of the facility) that will facilitate academic and proof-type studies related to the design procedures, installation methods, short- and long-term performance, non-destructive testing and evaluation technologies and repair, rehabilitation and replacement methods of buried structures including pipes, conduits and utility tunnels. The key aspect of such a test chamber is the ability to more closely control the soil conditions in the chamber than would be possible in a field test environment. This allows researchers to build an understanding of technology performance keyed to differences in soil type, density, moisture content, etc., as well as variations in installation parameters. Such a chamber is a companion to studies in real field installation conditions rather than a replacement for field monitoring.



The facility is planned to have overall dimensions of 18 m by 10 m in plan, with a 6-m by 6-m by 2-m tall soil bin located at one end. On three sides, the bin area will be surrounded by 2-m tall reinforced concrete wall. The fourth side will be constructed to include an approx. 2.5-m long and 2-m tall removable concrete barrier. Round steel plates, 0.40 m in diameter, will be installed with 1 m spacing center-to-center on the inner and outer faces of the three solid concrete wall, just above grade level.

When removed, these openings will enable the insertion of drill rods, chains and pipe segments, thus enabling the use of commercially available small diameter equipment, such as pit launch horizontal directional drilling rigs and pipe bursting heads, piercing tools and microtunneling heads. It will also enable the simulation of the installation of pipes up to 300 mm in diameter using the above-mentioned methods, as well as pipe reaming and pipe jacking. Another function of the opening is to enable access for autonomous and semi-autonomous robotic devices into the soil formation or pipe specimen.

Approximately one quarter of the bin area (3 m by 3 m) will be excavated to a depth of 3.5 m below grade and provided with an adjustable floor that will enable the depth of soil to be readily extended in this zone between 2 m and 3.8 m and (with the adjustable floor removed) to 5.5 m. The bin will be constructed such that it will be possible to divide the soil bin into approximately four 3-m by 3-m chambers. Thus, the bin will be able to accommodate between one and four different tests at the same time. One of the removable barriers will include a 0.6-m by 1.2-m window made of reinforced Plexiglas, thus enabling the viewing and photographing of soil movements along the cross-section of the bin during tests, such as pipe bursting.

An important aspect of the development of the facility is that it can serve many needs for controlled testing related to buried infrastructure. Reflecting this potential, faculty from a variety of disciplines participated in the proposal. Within Louisiana Tech University these faculty were:

- Civil Engineering — R. Sterling, E. Allouche, J. Wang, A. Saber, J. Pescatore
- Mechanical Engineering — D. Hall;
- Physics — N. Simicevic
- Chemical Engineering — H. Ji
- Electrical Engineering — R. Selmic.

Outside Louisiana Tech University, many faculty indicated their interest in using the facility and also formally supported the proposal. They will be able to collaborate in setting up the kinds of experiments that can best be accomplished using a soil test facility with highly controlled testing conditions. It is hoped that more faculty across the United States will join the group as the facility becomes available for research activities. The external faculty named in the proposal were:

- Dulcy Abraham, Purdue University
- Sam Ariaratnam, Arizona State University
- Alan Atalah, Bowling Green State University
- Sanjiv Gokhale, Vanderbilt University

- Mo Najafi, Michigan State University
- M. Tumay, Louisiana State University
- and C. Vipulanandan, University of Houston.

Although the facility will be adaptable to many different types of experiments, the following areas were identified in the proposal as the key directions for use of the facility:

Soil-Pipe and Soil-Fluid-Pipe Interactions

Controlled testing of trenchless installation technologies and various interactions of pipes, liners, fluids and soil in installation, replacement and rehabilitation configurations. More specifically this will include research to:

- Improve understanding of pipe/ground and machine/ground interactions so that the soil excavation/displacement processes and their effects on the surrounding ground can be better understood.
- Improve the understanding of soil/fluid/pipe interaction for various drilling media — covering phenomena such as borehole stability; hydraulic fracturing; and, post-installation settlements.
- To better understand the short- and long-term effect of creating a cavity in granular soils using various mechanical excavation methods in a full-scale testing environment.
- To improve design methods and construction specifications as related to installations of pipes using trenchless and open-cut technologies.

Robotic and Remote Sensing

Development, enhancement and testing of innovative concepts and technologies that have the potential for a breakthrough in a specific aspect of the trenchless industry. The facility will enable testing of these devices in a full-scale setting in which key parameters can be closely controlled and monitored. Specific areas already under way include:

- Smart Subsurface Horizontal Investigation Probes
- Laser-Based Device for Monitoring the Ovality and Progressive Deformation of Pipe Liners
- Obstacle Detection for Horizontal Directional Drilling
- Miniature Wireless Sensors for Monitoring of Buried Pipes.

Non-Intrusive Locating Technologies

Experimental studies in the area of non-intrusive locating technologies to support current and future numerical work in this area. Three principal areas of research are envisioned:

- Detection of Buried Utilities
- Propagation of Nanopulses in Geologic Materials
- Detection of Voids Adjacent to the Wall of Buried Pipes.

TTC Student Receives Award from JBJ Science Foundation

John Matthews, former president of the NASTT Student Chapter at Louisiana Tech University and currently a graduate student in the Urban Infrastructure Systems M.S. program, is the recipient of a $5,000 award from the J. Bennett Johnston Science Foundation.

Matthews

Under the grant, Matthews, and his supervisor, Dr. Allouche, will be developing a methodology for assisting Louisiana's municipalities in selecting the best construction methods for the buried infrastructure projects. Specifically, Matthews will be focusing on risk identification, quantification and mitigation in the context of the utilization of trenchless technologies by Louisiana's municipalities.

The data, to be collected via personal interviews with technical and administrative staff in Louisiana's seven largest municipalities, will provide insight into the impact of factors such as standard QA/QC procedures, availability of national standards, contract structure and perceived environmental impact and social costs on the willingness of a municipality to utilize various trenchless technologies as mainstream construction methods.

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