Geomaterials Testing System for Teaching and Research

Team Leader: Kam Ng (Professor in Geotechnical Engineering, CAECM)
Team Member: Shawn Griffiths (Assistant Instructional Professor, CAECM)

Total Amount Requested: $44,308

Budget: The cost to purchase, ship and install a triaxial equipment and a constant head permeameter for geomaterials. The equipment will be supplied by GeoTac based in Houston, USA. Table 1 shows the cost breakdown of the soil testing equipment and a computer system for data collection and operation. The total cost is estimated at $44,308, which includes equipment and all necessary accessories, installation, 3-day on-site training, and shipping. Tax will be exempted from this purchase. The power requirement is compatible with the readily available single phase, 120V 20A circuits in the UW Engineering Building room 3046, which is selected for housing this new geomaterials testing system.

Table 1. Cost breakdown for the proposed DSC system

Item	Description	Amount (USD)
1	Sigma-1 10K Load Frame and Large Triaxial Cell	$29,448
2	Constant Head Permeameter	$1,860
3	Computer System	$2,000
4	Installation and 3-day On-site Training	$9,000
5	Shipping Fee	$2,000
	TOTAL	**$44,308**

DESCRIPTION OF GEOMATERIALS TESTING SYSTEM

We are requesting a one-time fund from the CEPS Engineering Tier 1 Initiative to acquire and install a new geomaterials testing system to be installed at the UW Engineering Building Room 3046. This room shown in Figure 1 is an existing teaching laboratory for geomaterials of the Department of Civil and Architectural Engineering and Construction Management (CAECM). The laboratory is mainly used for teaching undergraduate and graduate level civil engineering courses and the lab sessions of construction management. The laboratory is equipped with water supply, power sockets and vacuum lines along the right workbench where the geomaterials testing system will be installed. Furthermore, two black water panels on the workbench are ready to be connected to the new system for immediate testing and demonstration during classes.

Figure 1. A panoramic view of existing geomaterials teaching laboratory in EN3046.

This geomaterials testing system consists of a triaxial testing equipment and a constant head permeameter. The triaxial testing equipment consists of a 10-kip sigma-1 automated loading frame, 500-lb, 2000-lb and 10000-lb load cells, 3-inch deformation sensor, two pressure sensors, software for automated triaxial testing, a large triaxial cell to accommodate 4-inch and 6-inch diameter geomaterial specimens, a medium triaxial cell to accommodate 2-inch diameter specimen, and other accessories such as latex membranes, porous stones, and pistons. This equipment is capable of closed-loop control of deformation, load or pressure. Geomaterial specimens can be loaded at a constant rate of deformation, constant rate of loading or a series of step loads. Unlike the standard triaxial equipment in most academic institutions, this triaxial equipment can be used for testing geomaterial specimens consisting of larger particle sizes, such as aggregates.

The new automated constant head permeameter, Trautwein P400000 series, is designed for measuring hydraulic conductivity of geomaterials, such as gravel, sand and silt. It is requested to replace our existing manually controlled permeameter (Figure 2) that was built by the CAECM department more than 30 years ago. The deterioration of the rubber tubing, values, specimen holder and standpipe of the existing permeameter can no longer be suitable for teaching, complying with the ASTM standard, and yielding accurate hydraulic conductivity measurement. The new permeameter offers the following advantages: 1) eliminate head loss by use of an inlet reservoir directly above a specimen mold, 2) convenient, precise positioning for accurate head settings using a bubble tube, and 3) convenient clamping of a specimen mold, screens and supporting plates. The new permeameter can be used for performing constant head tests, falling head tests and falling head-rising tail tests on 4-inch and 6-inch diameter specimens.

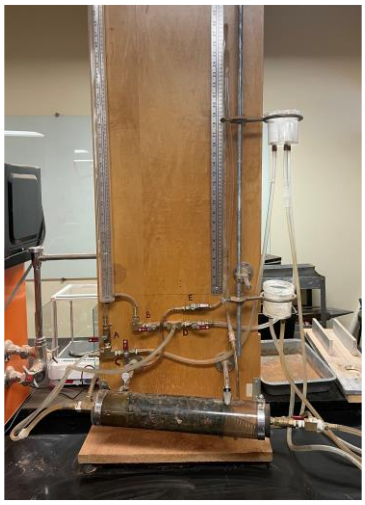

Figure 2. Existing permeameter

BENEFITS TO COLLEGE AND TIER 1 ENGINEERING INITIATIVE

Excellence in Undergraduate Education:

The geomaterials testing system along with other existing equipment in our teaching laboratory, such as consolidometer, direct shear test device and geotechnical devices, will be incorporated into the lab module of existing undergraduate course CE3600: Soil Mechanics. Particularly, module No. 6 on hydraulic conductivity will be revised by incorporating the operation and measurement procedures of the new permeameter. A new module No. 11 on triaxial testing can be added to CE3600 to allow students to learn the most common test method in current practice. In addition, the triaxial equipment will be demonstrated to students taking these civil engineering courses (CE4610: Foundation Engineering, CE4610: Soil and Rock Slope, and CE4630: Geotechnical Engineering). The geomaterials testing system can be incorporated into the lab sessions of construction management course CM3220. In addition, our undergraduate students will be trained on the operation and maintenance of this system and gain the necessary hands-on experience on using the system for measuring compressive strength parameters and hydraulic conductivity.

World-Class Research and Graduate Education:

The proposed geomaterials testing system will increase the competitiveness of our researchers to attract external research funding and promote research collaborations associated with testing larger granular particles. The system will immediately increase the experimental capability of our research team working on geomaterial-related research projects including 1) utilization of recycled rubber filles in infrastructure recently funded by Department of State (ID: 24-0993), 2) CO_2 capture and utilization for bio-inspired soil stabilization recently funded by the School of Energy Resources (SER), and 3) development of char-based aggregates for transportation applications funded by WYDOT (RS05223). The geomaterials testing system will also be beneficial to the interdisciplinary Center for Energy Materials in which Kam Ng is the main researcher. This system will facilitate collaborations with the SER to advance our current development of coal-derived building materials. This unique system will enhance our competitiveness to recruit new and talented graduate students and researchers to join our research programs. This equipment will enhance our ability to perform cutting-edge research on materials that will promise broader impacts. The equipment will be incorporated into the graduate level civil engineering courses (CE5610: Advanced Foundation Engineering and CE5620: Advanced Soil and Rock Slope) to improve graduate learning. Graduate students will have the opportunity to understand the fundamental behavior of geomaterials under the different conditions: unconsolidated-undrained, consolidated-undrained and consolidated-drained.

K-14 STEM Education:

This new equipment will help CEPS to recruit and increase undergraduate students pursuing their studies in engineering. Dr. Ng has been actively participated in the seminars organized by the UW Society of Women Engineers to expose 5^{th} to 9^{th} grade girls to engineering and encourage them to pursue those newfound interests through the demonstration of our modern research equipment. Dr. Ng has and will participate in the Engineering Summer Program to promote STEM education to high school juniors, enrich their learning experience at UW, and inspire future engineers. This new system will be incorporated into the teaching modules with the emphasis on geomaterials, such as soil and recycled aggregates to train students on sample preparation, equipment operation, data collection, result analysis, and practical applications.