Tactile Pressure Sensor Technology Applications to Geotechnical Engineering

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ABSTRACT

Granular materials are comprised of multiple discrete units. These materials touch every aspect of our lives including food (e.g. sugar, grains, cereals, and flour), industrial powders (e.g. coal, metal, glass, and fertilizers), chemicals, and pharmaceutical products. Soils under and adjacent to structures (e.g. building foundations, tunnels, and retaining walls) as well as soils used as a construction material (e.g. earth dams)are also made of discrete units. The measurement of stresses developed within or at the boundaries of these materials is of great importance in design, construction, and many industrial processes. Extreme sensitivity of granular materials to variations in stiffness and displacement affects the states of stress and hence the ability to obtain accurate measurements using traditional intrusive devices (e.g. standard pressure cells).

Recent advances in tactile sensor technology have produced very thin sensors allowing the measurement of pressure using a series of individual sensing points over a relatively large area. In the past, measurements of stresses acting within or at the boundary of a granular mass were evaluated mainly through the use of relatively large load cells, and provided only a limited number of average measurements. In addition, the use of load cells is complicated due to the interference of the measuring device with the load distribution within the material and hence the resulting measurement. The thin, uniform structure of the tactile pressure sensors greatly reduces the interference caused by the measuring element and allows for a more accurate recording of the stresses in granular materials.

The current research focuses on the utilization of tactile pressure technologies in the measurement of stresses associated with granular materials. Previous research conducted at the Geotechnical Engineering Research Laboratory has focused on the calibration of the sensors and the exploration of the difficulties associated with their use in granular materials. The presented research addresses three subjects: (i) the effect of grain size on stress distribution measurement, (ii) the measurement of the contact stresses under a rigid strip footing, and (iii) the measurement of the stress distribution behind a model retaining wall. The performance of tactile pressure sensor technology for these applications is presented and evaluated.