
Examination of Boundary Effects in Interfacial Testing

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ABSTRACT

The friction developed along an interface between a granular material and a solid surface is of great importance in many disciplines including soil-structure interaction. The fundamental analysis and accurate measurements of such friction are difficult, and routine testing procedures (e.g. modified direct shear box) have been found to be markedly influenced by the testing device used. A dual interface apparatus (DIA) was developed at the University of Massachusetts Lowell enabling the measurement of unrestricted interfacial friction and the distribution of frictional stresses along restricted interfaces. Past research at UML concentrated on the development of the DIA and its implementation under various testing conditions.

Modifications were implemented to improve the DIA. Consequently, the present research focused on refining the study of the controlling factors associated with interfacial friction and its measurement. An in depth study was carried out to examine the effect of quality control when using ideal granular materials (i.e. glass beads) and the evaluation of glass interparticle friction angle. Additional tests were carried out to extend the previous efforts and investigate the effects of the physical boundary conditions on the test results. A revolutionary testing device, allowing the measurement of pressure distribution over an area enabled a close examination of the stress variation at the boundaries.

Glass beads were found to be an ideal granular material, effectively eliminating the important role particle shape plays in the shear of granular material. The use of glass beads under the assumption of perfectly round uniform spheres was found, however, to be questionable, requiring a quality control procedure. The development, debugging, and implementation of quality control process resulted in the proof that particle size within the zone of cohesionless material diameter, has no influence on the shear resistance. When dealing with smaller sizes (i.e. silt and clay), particles acted as a solid body changing the shear mechanism to that of the contact between two solid surfaces (as long as shear takes place along the interface).

The interfacial shear distribution was found to be greatly influenced by the geometrical boundaries. The accuracy of the test results using the standard direct shear box was found to be a function of the solid surface roughness and the grain size (through normalized roughness). These tests are extremely accurate for representing non restricted interfacial friction conditions especially when shear takes place along the interface (opposed to internal shear in the granular material). The boundary effects that lead to these results were magnificently elucidated by the images obtained through the new sensing technology depicting substantial loading in the front (relative to the direction of motion) combined with unloading at the back.