THE FUNDAMENTAL MECHANISM OF SHEAR OF GRANULAR MATERIAL ALONG AN INTERFACE

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Since the pioneering work by Karl Terzaghi early this century, soil mechanics has evolved to an engineering discipline in which advanced mechanical principles and techniques are employed for solving soil related problems. Soil is a special type of particulate material, which has traditionally been treated as a continuum media. The success of the continuum approach underlines the facts that many engineering problems involving soils are of a large scale, for which the discrete nature of the soil did not seem to play an important role. Some fundamental phenomena like dilation during shear and arching remain unique features of discontinuous materials. Better understanding of the mechanical behavior of particulate material calls therefore to employ a microscopic approach which takes into account the individual particle displacement, and inter-particle interactions as well as the interactions between particles and other structure elements (e.g., foundations, tunnels and geosynthetics). This research aims to investigate experimentally the mechanical behavior of idealized two-dimensional particulate material when sheared along an interface of a solid surface (with different roughness). The kinematics and interparticle interactions of all particles in the model are monitored, measured and analyzed. Correlations are attempted to be made between the global interfacial behavior to the discrete variations of the individual particles. The primary tool implemented in this research is an image acquisition and analysis system, which consists of: two high resolution digital CCD cameras, computers and an image analysis software. The two CCD cameras are synchronized with one acquires images of particle motion and the other acquires photoelastic images. It is found that the normalized roughness of a solid surface determines the shear failure mode along the interface. A smooth solid surface does not mobilize the internal shear strength of the particulate material, and shear failure occurs along the interface. A rough solid surface causes the shear failure to take place within the particulate material and hence the internal shear strength of the particulate material is fully mobilized. Shear mode is another important factor in affecting the interfacial shear strength as well as the mechanism of shear failure.