Lunar and Planetary Geomechanics: Toward the Establishment of a Lunar/Planetary Soil Mechanics Theory

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Lunar and planetary surface explorations will involve various soil-related operations including module landing, mobile robot locomotion, earth-moving, mining and foundation works for extraterrestrial facilities. It can easily be imagined that the soil behaviors have a great impact on those operations and therefore soil/geo-mechanics study, a branch of civil engineering that deals with physical and mechanical behavior of soil, is of great importance in designing and operating the modules/robots.

Conditions and constraints on the lunar and planetary surfaces are quite different from a terrestrial environment. Besides differences in the material properties, the surfaces are subject to harsh environmental conditions such as low gravity, high vacuum, extreme temperatures and radiation. From the viewpoint of the soil mechanics, it can be said that physical properties of the materials and the reduced gravity condition will significantly affect soil behaviors. However, there are still many questions regarding in-situ physical and mechanical characteristics of the lunar and planetary soils to establish a theoretical framework for predicting the behaviors.

So far we have conducted some experiments using simulated lunar/planetary soils to explore the mechanical behaviors of the materials. This presentation will cover some important results obtained from our past studies which include: 1) uniqueness of deformation and strength characteristics of the lunar soil (triaxial compression tests) and 2) gravity dependence of bearing characteristics of soils and mobility performance of a rigid wheel (experiments using a reduced-gravity aircraft). A future path for establishment of a soil/geo-mechanics theory for lunar/planetary explorations will also be presented.

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