Measurement of Adhesive Forces between Soil Particles and Identification of the Factors Affecting Those Forces

Miyake, Koichiro

When sand contains water, it has plastic properties and can assume a variety of forms. In Japan, this characteristic of mud has long been used by children to make doro-dango, or mud balls. Some researchers have suggested that the adhesive force between sand particles is responsible for this effect. However, in slightly moist soil, this force is weaker than the shear strength, which is derived from shift length of sand particles, and is rarely considered in the field of civil engineering involving landslide control. In this study, to clarify how strong adhesive force is necessary for the soil mass to retain its shape, a simple measurement device was developed. The results obtained by collapse experiments were then compared with model calculations of the adhesive force. The four cuboid soil samples, containing liquids with different surface tensions and particles with different hydrophilic properties, were allowed to gradually lose their footings. When cuboid soil samples collapsed, the maximum lengths, which are able to maintain their shapes, were measured. The results showed that the adhesive force increased with both surface tension and number of hydrophilic particles. The intensity variation of observed adhesive force was consistent with my model calculation which simplified the conventional calculation of adhesive force. The methods proposed in this study to measure adhesive force could be employed to avoid disasters, such as mud slides, by ensuring that the water content of soils is maintained to control the surface tension of pore water and hydrophilic properties of particles.

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