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Incorporating an electro-magnetic view into a hydrological study on shallow landslide prediction - Laboratory experiments focused on soil displacement and subsequent shallow landslide initiation induced by rainfalls -

T. Terajima (1), H. Miyajima (2), K. Hattori (3), H. Kohno (4), H. Ochiai (5), Y. Okada (5), and I. Uchida (4)

(1) Disaster Prevention Research Institute, Kyoto University, Uji, 611-0011 Japan (terajima@slope.dpri.kyoto-u.ac.jp), (2) Yokohama Rubber Co, LTD., Hiratsuka, Japan, (3) Graduate School of Science, Chiba University, Chiba, Japan, (4) Graduate Student, Chiba University, Chiba, Japan , (5) Forestry and Forest Products Research Institute, Tsukuba, Japan

Understanding the mechanism of precursors related to shallow landslides, such as small soil displacement occurring commonly prior to shallow landslide initiation, must be useful to advance a predictive accuracy of shallow landslide initiation and mitigate subsequent sediment disasters. The small soil displacement, so called soil creep which is well-known empirically as an indication of shallow landslide initiation, was focused on understanding the effect of subsurface hydrology on soil displacement and shallow landslide initiation. Soil displacement, pore water pressures, and self potential, which occurred prior to shallow landslides, were measured in two flume experiments consisted of an artificial sandy slope of 9 m long, 1 m wide, 0.7 m deep, and the slope of 32 degrees with the rainfall intensities of 100 and 80 mm/h. Following 4 findings were obtained.

In subsurface hydrology:

#1) the direction of subsurface flow in the deep part of landslide masses began to change parallel to the slope at around 30 min before the shallow landslide initiation. This timing almost coincided with the start of the soil displacement;

#2) Stress paths with an increase in the soil weight by rainfall infiltration did not exceed failure envelopes which were obtained from simple shear tests under saturated and un-drainage conditions.

#3) In contrast, adding seepage force of subsurface flow to the normal and shear stresses in the landslide masses made the stress paths be possible to exceed the failure envelopes.

These things signify that the soil displacement and shallow landslides could not be induced by the weight change in the soil accompanied with rainfall infiltration. Therefore, the seepage force controlled by the changes in the direction and magnitude of subsurface flow provided the changes in the normal and shear stresses of the soils, and must have been one of the main causes of the soil displacement and shallow landslide initiation in the experiments.

In the electro-magnetic view:

#4) The change in the self potential in the slopes showed similarity to behavior of the soil and subsurface flow, representing that the change in the self potential coincided well with the shallow landslide mechanism described above.

This indicates that observations of self potential must develop both a predictive technology on the timing of shallow landslide initiation and some preventive measures on sediment disasters around hill slopes.

Key word: Shallow landslide, Soil displacement, Seepage force, Subsurface hydrology, Flow direction