Self-potential approach to understand groundwater condition for rainfall-induced landslide forecast : A flume experiment with 2 layered soil

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In recent years, the number of occurrences of landslide is increased as the frequency of torrential rains are increased. In order to mitigate landslide risks, monitoring the groundwater condition under the slope and estimation of the occurrence time of the main collapse are essential. In this sense, we are struggling to develop the early warning system for rainfall-induced landslides using self-potential (SP) approach. We have accumulated the knowledge using the flume tests and sandbox experiments. We found the SP changes are controlled by the electro-kinetic effects. In the previous experiments, we utilized a uniform and a single layered soil for experiments. In this study, we performed a flume test with 2-layered soil with different consolidations but the same sand, weathered granite. The total soil thickness is 70 cm and the depth of the soil boundary is 40 cm below the surface. We installed 16 Pb-PbCl2 electrodes at 8 points with intersensor distance of 1 m. At each point, we put them at 20 cm and 50 cm depth from the surface and the reference electrode is set at depth of 40 cm on the most upper side of the flume. 19 pore pressure meters are also set at 7 points with horizontal distance of 1 m and we put them at 10, 40, and 65 cm and 40 cm depth from the surface The horizontal distance between electrodes and pressure meters is 50 cm. The intensity of rain is 80 mm/hour and the elapsed time to the main collapse was 7776 sec.
In the initial 30 min, water flow under the slope is vertical. After 30 min elapsed, the partial saturation began near the boundary of the two layers in the middle part of slope, where the gradient slope changes; the upper part is steep and the lower, calm. It is considered due to difference of soil consolidation. After 40 min from the start, the saturated area expands and lateral flow increases gradually. For electric properties, in general the area of the lower potential expands with increase of the saturated area. After 30 min passed from the beginning, intense electric field is generated at the boundary of 2 soil layer at the middle part of the upper slope. It seems to correlate with the pore pressure changes or partial saturation. This electric field looks like maintain until the main collapse. In addition, near the slip surface, there is also intense electric field, this is the similar tendency what we had got for the single layer experiment. Further consideration will be required but this is highly suggestive of the more complexity of the groundwater flow under the slope in the 2 layered test. Details will be shown in our presentation.

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