Form 2

Dissertation Abstract

Report no.	(Course-based) No.1187	Name	Tang Junfeng
Dissertation title	Influence of capillary barrier on water movement and stability of multi-layered slope (多層地盤を持つ斜面の水分移動と安定性にキャピラリバリアが与える影響)		

Abstract

※ The abstract should be in keeping with the structure of the dissertation (objective, statement of problem, investigation, conclusion) and should convey the substance of the dissertation.

Rainfall-induced slope failure is one of the most destructive natural disasters that occur in shallow natural slopes. These recurring natural hazards still result in many significant casualties and economic losses. This study deals with a slope consisting of a fine layer and an intermediate coarse layer. The presence of soil layers with different unsaturated hydraulic conductivities in a shallow depth of soil affects the process of water infiltration, distribution, and pore water pressure in the slope, which results in different failure modes.

To assess the influence of an intermediate coarse layer on the slope stability during heavy rainfall, knowledge about water movement and how slope failure occurs is important. To investigate the infiltration process in a multi-layered slope in simplified and known geometrical and boundary conditions, physical model experiments have been performed by previous researches. For example, a capillary barrier at the upper interface of a coarse layer could have developed, favoring the accumulation and a lateral distribution of infiltrating rainfall and a possible diversion of flow down the slope, thus leading to a localized increase in the water content and loss of strength. However, how the capillary barrier effect influences the slope stability in different conditions, such as inclined angle and rainfall intensity, are still not clear.

At first, Soil-water characteristic curves (SWCC) of fine sand and coarse sand were measured to explain how the capillary barrier works. The results of hydraulic conductivity show that the unsaturated hydraulic conductivity K in the coarse layer is

lower than that in the fine layer in a lower suction condition (0.4 kPa), which results in the development of the capillary barrier at the interface of the fine-coarse layer.

In this study, series of multi-layered and single layer slope model have been conducted to investigate the influence of intermediate layers on water movement in the slope, especially after the breakthrough of the capillary barrier. The results of model experiment indicated that the inclined intermediate coarser layer formed a capillary barrier, resulting in a significant amount of water being diverted to the downward slope and causing piping failure at the toe of the slope that resulted in earlier failure, which has a negative influence on the slope stability.

To investigate the influence of capillary barrier effect in different conditions, multi-layered slope models were put in different inclined angle and rainfall intensity. By using the blue color to trace the water flow and the breakthrough point at the capillary barrier interface with continuous time lapse measurements helps to analyse flow pathways within the layers. Additional volumetric water content sensors and pore water pressure sensor put along the bottom of slope were used to show the difference of increase of pore water pressure when slope failure occurred. The results indicated that Three different failure modes occurred in multi-layer slope considering the effect of capillary barrier: sliding , piping failure at bottom and sliding above the interface. Low rainfall density and small tilt angle, sliding occurres at the toe of slope; high rainfall and higher tile angle, piping occurred at the toe of slope; when tilt angle increase (>22 deg), sliding occurred above the capillary barrier interface.

These findings show that capillary barrier effect influence the water flow deeply in different conditions. Slope instabilities may be predicted based on the change of suction and water content.

Keywords: *Slope failure; Unsaturated soil; water infiltrate; capillary barrier effect; suction; piping; Multi-layer slope;*