Capillary in Heterogeneous Ground

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1 Introduction

Capillarity of water in ground, which is due to surface tension, is common phenomenon in nature, which is referred to the water move to a height, which is higher than groundwater level. It is an important effect, which can drive sap into plants or bring landfill leachate back to ground surface or influence the depth of frozen soil and so on. Basic understanding of the capillary law was reported almost one century ago. The equation, which is developed by Washburn, has been used as basis for describing the capillary phenomenon. Many research works were performed to get the mechanism of capillarity in homogeneous soil, while the report about the performance of capillarity in heterogeneous condition is not so much. This study have checked the characteristic of capillarity in heterogeneous ground and compared the results with numerical simulated results.

2 Summary of Experiment

The model ground was prepared in a acrylic acid resinous column (Φ = 25.5 cm). Each column is 30 cm in height, and can be connect with each other by using screws. A rubber ring and silicone were used to seal the gap between two columns, in order to stop water goes out or air comes in. The ground was made by using two kinds of soils, namely k-7 and k-8 separately. K-8 is in the center of column with a radius, r. It was surrounded by k-7 soil. The dry density of both soils are 1.58g/cm^3. The ground was prepared by using vibration and compaction method at dry condition. The whole view of apparatus and prepared ground were shown in Fig. 1. The soil was oven dried at 105°C. The grain size distribution of two soils, which were used in this research, was shown in Fig. 2. From the Fig. 2 we can seen that, k-7 is a kind of fine sand, while k-8 is a kind of sandy silt.

3 Results and Discussion

Fig .3 shows a serious of test results. From the fig we can see that,

1) Compare the result of any cases with the result of k-7, from the height, which is higher than 60 cm, the water content of heterogeneous ground is higher than homogeneous ground.

2) Compare the result of case 1 with case 3 or case 2 with case 4, the improved effect (result 1) will be depend on the diameter of a higher water retention materials considerably.

3) Compare the result of case 1 with case 4 or case 2 with case 3, the improved effect (result 1) will be depend on the condition of soil-atmosphere interaction considerably.

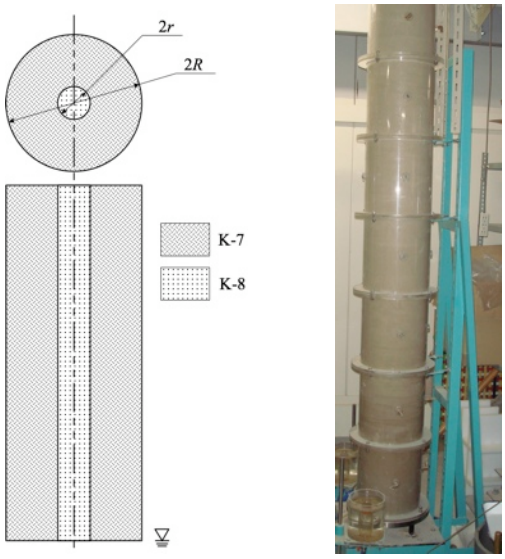

Fig. 1 Apparatus of experiment

Table. 1 Condition of test

No.	Radius of inner soil column r (cm)	Height H (cm)
1	1	100
2	1	180
3	3	100
4	3	180

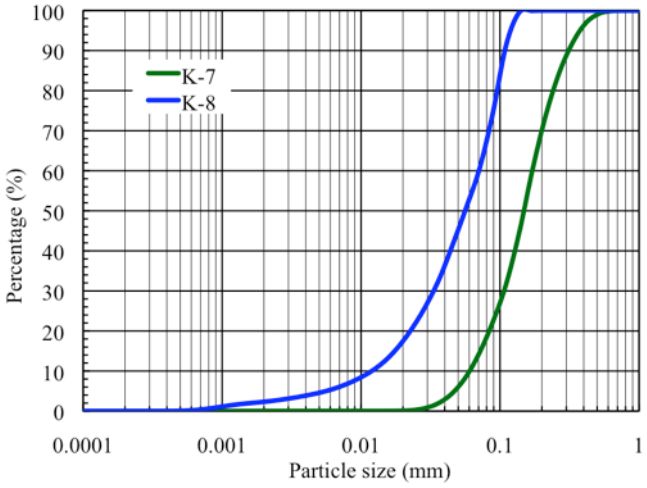

Fig. 2 grain size distribution curve

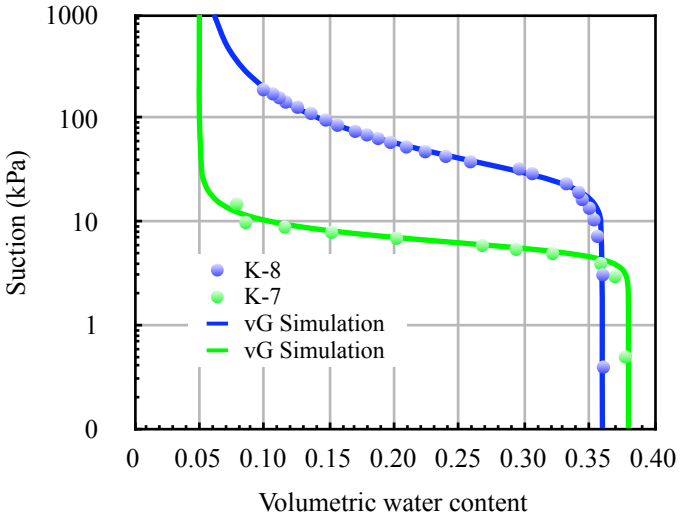

Fig. 3 Soil water retention curve of the soils

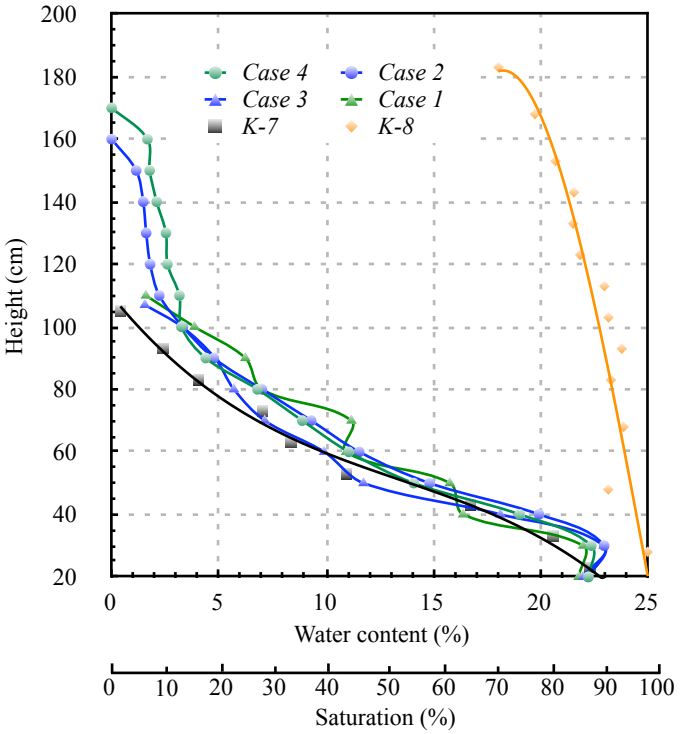

Fig. 4 Test results

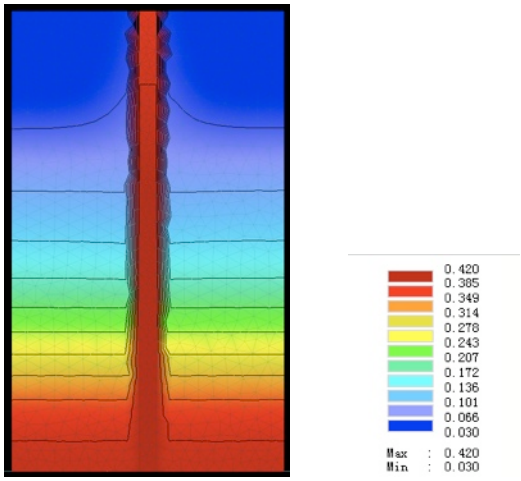

Fig. 5 Numerical simulation of capillarity in heterogeneous ground

Fig. 6 shows an idealized effect of flow in heterogeneous ground. The real line stands for the difference of water content with the height between two kinds of soils, which is called 'Background' value here. The doted line stands for the situation when the water transports from the material with lower water potential into a higher one, which is called 'Improved'. Such kind of effect is not infinite, the maximum hight, which has this effect will be definite as, *h*. So two important factors becomes the key evaluation items of the whole system, the maximum supply height and the relative difference of water content.

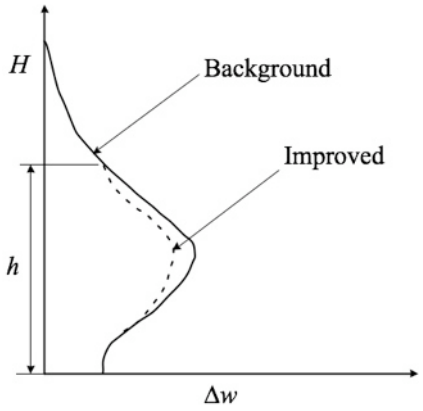

Fig. 6 Idealized effect of water flow in heterogeneous ground

4 Conclusions

In this research, the characteristic of capillarity in heterogeneous ground has been checked by both experimental method and numerical method. According to the results, the conclusions can be concluded as following,

1) The water will transport from the material, which has lower potential to the material, which has higher potential.

2) The soil-atmosphere interaction is a important factor for water balance in heterogeneous ground.

3) The effects of water transportation was highly dependent on the saturation, permeability, and also the contact area.

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