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Effect of Compactness Degree on the Hydraulic Properties for Coarse Soils of High-Speed Railway Embankment

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Abstract

Stability of the high-speed railway embankment is highly influenced by moisture content, the determination of which needs its hydraulic property. The embankment consists of coarse soils with high compactness degree. Till now, hydraulic properties of such coarse soils are not fully studied. In this article, a large scale column, which could measure the volumetric water content and suction, was adopted to study the hydraulic properties of three types of coarse soils. The compactness degrees of soil samples were 0.85, 0.90 and 0.93 respectively. The soil-water characteristic curves (SWCCs) could be gained directly and the hydraulic conductivities could be calculated through instantaneous profile method. The SWCCs and unsaturated conductivities of different soils were presented and compared. The results showed that compactness degree had an influence on SWCC (e.g., the air-entry value, the slope and the residual matric suction) and the unsaturated permeability.

Keywords: Railway embankment, Coarse soils, Compactness degree, Instantaneous profile method, Hydraulic property.

1 Introduction

Embankment constructed with a mixture of coarse soils and fines (silt and clay) is widely used in high speed railway (HSR) infrastructure. According to Chinese Code for Design of High Speed Railway (Industry standard of PRC 2009), the proportion of fines is less than 30% by dry mass, and the compactness degree of the main body of the embankment is larger than 0.92. During the service life of the HSR, water might flow into the embankment through the cracks of upper pavement slab in rainy days, influencing its performance. That is because mechanical properties of coarse soils (Babic et al. 2000; Huang et al. 2009; Duong et al. 2013) greatly rely on the water content. Thus, identifying

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the water distribution in the embankment is essential, which needs the knowledge of hydraulic properties of this kind of coarse soils.

Compactness degree (Li et al. 2009) and fines content (Indrawan et al. 2006; Rahardjo et al. 2008; Duong et al. 2014) are regarded as two main factors that affect hydraulic properties of coarse soils. Compactness degree is the focus of this article. However, up to now the influence of compactness degree on the heavily compacted coarse soils in the HSR embankment has not been studied. In this study, a large-scale infiltration column was adopted to determine the hydraulic properties of the coarse soils with different compactness degrees. The SWCCs could be gained directly and the hydraulic conductivities be calculated through instantaneous profile method. Finally, the influence of compactness degree was evaluated through the experimental results.

2 Materials

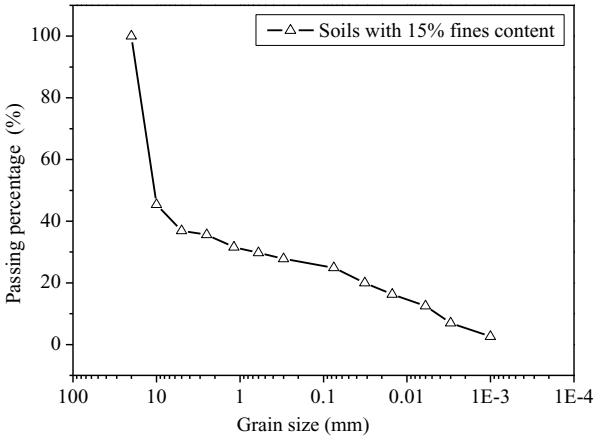

Figure 1 Grain size distribution curve of soils studied

The experimental soils in this study were prepared by mixing Dolomite rock and fines from Hangzhou, China, which were also adopted as the fill for the HSR full-scale model constructed in Zhejiang University. The fines content ($d \leq 0.075$mm) is 15% and the largest particle diameter could reach 60mm. For practical reasons, soils with diameter larger than 20mm were cut off. The grain size distribution curve of such soils was shown in Figure 1. Standard soil compaction tests (ASTM 2012) were conducted. A maximum dry density of 2.33 g/cm^3 at an optimum water content of 6% was identified.

3 Setup and Procedure

A large-scale infiltration column with an inner diameter of 300mm and a height of 650mm similar to that developed by Duong et al. (2013) was adopted here. At the bottom of the column there are two valves, with one connected to a device supplying the injecting water at a constant water head, and the other used for drainage. There is a hole in the center of head cover, allowing air expulsion. Five TDR probes and tensiometers were used. The TDR sensor is composed of three rods. The diameter is 6mm and the length 200mm. Before experiment, the calibration curve of TDR which defines the relationship between dielectric constant K_a and volumetric water content θ was gained. Therefore, during the experiment the volumetric water content could be determined via the directly gotten