



On water coefficient of permeability in unsaturated compressible soils

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Abstract

The paper represents data of an elaborate laboratory test program on the water flow behaviour in a variety of soils including clay, silt, and sand. The experimental tests were carried out with a flexible wall permeameter. The water coefficient of permeability of statically compacted samples was evaluated in different net confining stress and saturation conditions. The observed trend showed that the effect of void ratio on water permeability of unsaturated samples is different than the effect of void ratio on water permeability of saturated soils.

Keywords: Unsaturated soils, water coefficient of permeability, matrix suction, net stress.

1. INTRODUCTION

The water coefficient of permeability, k_w , is a measure of soil resistance to the flow of water and is majorly a function of soil water content and pore spaces (Lloret and Alonso 1980; Fredlund 1981; Fredlund and Rahardjo 1993).

Extensive amount of experimental observations (e.g. Mavis and Wilsey 1937; Krumbien and Monk 1942; Loudon 1952; Olsen 1962) and theoretical contributions (e.g. Hazen 1911; Kozeny 1927; Carman 1938; Carman 1956) show a decrease of water permeability of saturated soils when their voids are confined.

For unsaturated soils, experimental attempts have been previously made to examine the effect of soil water content on water permeability (e.g. Burdine 1953; Klute 1965; Fleureau and Taibi 1994; Dane et al. 1998; Gan and Fredlund 2000; Samangan et al. 2003; Bicalho et al. 2005; Lu et al. 2006; Simmens and Blatz 2007). Additionally, equations have been proposed in past for k_w of incompressible soils as a function of soil water content or soil matrix suction (e.g. Brooks and Corey 1964; Mualem 1976; van Genuchten 1980; Fredlund et al. 1994; Leong and Rahardjo 1997). Both experimental and analytical procedures show an increase in water permeability with increment of soil water content.

Relatively few amount of information are available that examine the influence of void ratio on water permeability of unsaturated soils. Barden and Pavlakis (1971) studied hydraulic conductivity of a clay in constant water content in different confining stress. Increment of net stress in constant water content condition increased the pore water pressure. The results showed increasing water permeability values when soil was compressed and matrix suction reduced. Nimmo and Akstin (1988) determined the water permeability of a sand in different void ratios with centrifugal testing and observed that k_w is void ratio dependent. Huang et al. (1998) measured water coefficient of permeability of a sand in different confining stress and observed a different trend for the effect of void ratio on k_w of unsaturated soils than the trend observed in saturated soils. Romero (1999) examined the hydraulic conductivity of a clay in different compaction states and observed that, for a constant degree of saturation, water permeability is increased with increment of pore spaces. Pereira et al. (2005) showed increasing and decreasing water permeability values within compression of a sand in unsaturated and saturated conditions respectively.

This paper presents the results of an elaborate experimental testing program aimed to investigate different effects of void ratio on hydraulic conductivity of saturated and unsaturated soils. Saturated and