Biaxial Testing on the Properties of Pre-cracked Partially Saturated Clay

Miftahul Fauziah1) and Hamid Reza Nikraz2)

1) & 2) Civil Engineering Department, Curtin University of Technology.
Perth, Western Australia, Australia
1) Civil Engineering and Planning Faculty, Universitas Islam Indonesia
Yogyakarta, Indonesia

ABSTRACT

This paper presents the result of the biaxial testing on the properties of precrack partially saturated clay specimen. A modification of the conventional triaxial apparatus was used in this study. Cell pressure from the triaxial compression test and a rigid loading platen are used to apply the minor and major principle stresses to the specimen. A high air-entry disc (HAED) was used as the interface between the partially saturated soil and the pore water pressure measuring system. Experimental results proved that the existence of crack or fissure in soil influence the mechanical properties of the specimen tested.

KEY WORDS: Partially saturated; matric suction; pre-crack; biaxial; triaxial.

INTRODUCTION

The behavior of partially saturated soil is quite different from those of fully saturated soil because of the influence of suction. Partially saturated soils form the largest category of materials that cannot be classified by classical saturated soil mechanics concepts. Results obtained with the strength theory of saturated soil could not be directly applied to solve the partly saturated soil problems. Although soils are generally assumed fully saturated below the groundwater table, they may be semi saturated near the state of full saturation under certain conditions. The situation of partial saturation may be caused by several factors, such as variation of water table level due to natural or manmade processes.

Partially saturated soil is generally characterized by three phases, soil solids, water, and air. The presence of a fourth independent phase, a so-called air–water interface or contractile skin was introduced (Fredlund and Morgenstern, 1977). Based on multiphase continuum mechanics, a theoretical stress analysis of an unsaturated soil has been presented (Fredlund and Morgenstern, 1977; Fredlund and Morgenstern, 1976). The analysis concluded that any two of three possible normal stress variables can be used to describe the stress state of an unsaturated soil. This is in contrast to saturated soil, where it is possible to relate the behaviour of the soil to the effective stress only. The presence of matric suction pressure is the main difference between saturated and unsaturated soil mechanics. It has been observed that several stability problems, involving soils used as construction materials, are due to water content changes and therefore to matric suction changes that occur periodically in nature.

For the purposes of evaluating constitutive behaviour and stability properties of soil, most laboratory experiments on soils in particular to the clayey soils are performed under axisymmetric or conventional triaxial conditions. However, most geotechnical field problems such as landslide problems, failure of soils beneath shallow foundations, and failure of retaining structures are truly or close to biaxial situations. Mochizuki-Min and Takahashi (1993) reported that when soil is tested under plane strain conditions, it, in general, exhibits a higher compressive strength and lower axial strain. Behaviour of fined grained sands tested under biaxial conditions has been reported (Alshibli-Godbold and Hoffman 2004; Alshibli and Sture, 2000; Bizzarri, 1995; Han and Vardoulakis, 1991; Hans and Drescher, 1993; Lee, 1970; Marach-Duncan-Chan and Seed, 1984; Mochizuki-Min and Takahashi, 1993). The plane strain testing of clay has only been initiated recently (Fauziah and Nikraz, 2008; Fauziah and Nikraz, 2007; Lo-Mita and Thangayah, 2000; Drescher et.al (1990)) and published data of such tests especially for hard clay material is very limited.

The present modeling of brittle soil and weak rock is based on principles of continuum mechanics in spite of the fact that discontinuities are known to develop when such geological materials are subject to loading. In the case of strong rock, on the other hand, there has been considerable interest in the application of fracture mechanics to account for such discontinuities (Ingraffea, 1987). Many studies have been conducted on detailed aspect of such discontinuities, but these are of limited practical application in an actual situation. The existence of cracks and fissures, which are the result of mechanical, thermal and volume-change-induced stresses, such soils are non-uniform and therefore not amendable to analysis by continuum mechanics. On the other hand, fracture mechanical theory may be used to advantage to replicate their behavior.