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Experimental Investigation of the at Rest Lateral Pressure of an Artificially Prepared Sand-Bentonite Mixture

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Abstract

Sand-bentonite mixtures are usually utilized as a liner of municipal waste disposal facilities. These widespread liners are constructed in thin layers and therefore, indicate an oedometric behavior. Hence, experimental study of at rest lateral pressure of these soils is an important step for understanding the hydro-mechanical behavior of the abovementioned barriers.

In this paper a novel oedometer is introduced to determine the coefficient of lateral pressure of soil. The almost rigid ring of the modified apparatus has three circular diaphragms with the diameter of 15mm and the thickness of 0.35mm. Three LVDTs are installed in contact with these diaphragms to measure the horizontal deformation of the thin diaphragms induced by the horizontal pressures. The diaphragms are calibrated using the water hydrostatic pressure and the pressure and deformations are correlated.

Twenty five percent of the studied material is composed of bentonite and the rest of soil is the Estahban well graded sand. Coefficient of at rest lateral pressure of the material is determined at various stress states and the results at normally and over-consolidation conditions are discussed in details.

Keywords: At Rest Lateral Earth Pressure, Sand-Bentonite, Normally Consolidated soil, Over-Consolidated Soil.

1. INTRODUCTION

To better understand the hydro-mechanical behavior of expansive clays numerous experimental studies have been performed to date (Alonso et al. (1995), Shuai (1996), Day (1999), Subba Rao (2000), Sharma and Wheeler (2000), Attom et al. (2001), Tripathy et al. (2002), Lloret, et al. (2003), Sridharan and Gurtug (2004), Cuisinier and Masrouri (2005), Laird (2006), Nowamooz and Masrouri (2008), Avsar et al. (2009), Ferber et al. (2009), Ajdari et al. (2010)). In particular, Basma et al. (1996) examined the clay microstructure under the Scanning Electron Microscope (SEM) before and after cyclic swelling. The results indicated that upon wetting, the plate-shaped particles showed a tendency to take a horizontal orientation. This formation results in greater forces of repulsion between particles leading to the swelling behavior. The results also signified the different behavior of the material under partial and full swell-shrinkage tests.

Liangton (2003) directed numerous experiments on the lightly expansive clays associated with rainfall induced slope instability. The outcomes showed that suction increases the pre-consolidation pressure.

Saiyouri et al. (2004) studied the hydration mechanism in the single structure clays by imposing the specific values of suction on the compacted bentonite. Two types of bentonite were used in the study and three methods were employed in controlling suction. Based on the experimental results, they found that the placement of water molecules is a function of suction.

Also, Alonso et al. (2005) performed several drying-wetting tests on the compacted sand-bentonite mixture in oedometric condition under different applied stress. The results indicated that hydraulic loading induced accumulated shrinkage results in an increase in the over-consolidation ratio.

Despite the huge amount of research on the oedometric volume change of expansive clays, little work has been done to date on the K_0-coefficient of these soils and the effect of the hydraulic loading on their mechanical behavior (Montanez, 2002). Therefore, additional experimental program is necessary to investigate the hydro-mechanical behavior of expansive clays in the oedometric condition. In this paper, a novel osmotic oedometer apparatus is introduced to study the hydro-mechanical behavior of an artificially prepared sand-bentonite mixture under mechanical and hydraulic loading. Effective stress is determined utilizing the volume change behavior and coefficient of at rest lateral pressure of the material is determined at various suctions. The effect of hydraulic loading and suction value on this parameter is discussed in details.