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Effect of high salinity pore water quality on swell-shrink paths of an expansive soil during drying and wetting cycles

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Abstract

This paper presents the results of an experimental program developed to investigate the effect of pore water with high salinity on the mechanical behavior of an expansive soil during consecutive drying and wetting cycles. Soil specimens were prepared by static compaction with distilled and saline (250 g/L of NaCl) pore water quality. Specimens were subjected to drying and wetting cycles using a modified oedometer apparatus under a surcharge pressure of 10 kPa using distilled water for flooding of wetting cycles. Results indicated that axial and radial deformation in soil specimens reach equilibrium after 5 and 4 consecutive cycles for distilled and saline pore water respectively. Furthermore swell-shrink paths (void ratio versus moisture content) were determined; theses paths were proven to be nearly S shaped curves which show that the majority of deformations are located between the 60% and 80% saturation lines. In addition at equilibrium condition the swell-shrink paths for saline pore water quality shows reduction in swelling potential compared to distilled water.

Keywords: Expansive soil, pore water, drying and wetting cycles, swell-shrink paths

1. INTRODUCTION

Expansive soils are considered a worldwide problem as they cause extreme damage to civil engineering structures such as highways, tunnels, buildings and hydraulic structures (Chen [1]; Nelson and Miller [2]). These soils are found in many parts of the world particularly in arid and semi-arid regions (Gourley et al. [3]) and despite being classified as problematic soils, are widely utilized for civil engineering projects and landfilling municipal, industrial and radioactive waste (Komine and Ogata [4]; Pusch [5]; Siddiqua et al. [6]). As a result, a clear understanding of the behavior of such soils is required for effective design of structures and infrastructures on these soils.

Many researchers such as Chu and Mou [7], Osipov et al. [8], Basma et al. [9], Tripathy et al. [10,11], Alonso et al. [12] and Parsaee et al. [13] stated that expansive soils subjected to consecutive drying and wetting cycles show a significant reduction in swelling potential and plastic deformations of the soil will reduce and finally diminish by repeating the cyclic process of drying and wetting. Other researchers such as Popescu [14] and Tawfiq and Nabantoghlu [15] concluded that cyclic drying and wetting causes increase in soils swelling potential. Estabragh et al. [16] studied the effect of different types of wetting fluids (distilled water, acidic and saline water) on the behavior of an expansive soil during drying and wetting cycles and stated that wetting fluid quality is an important factor which directly influences swelling potential.

In natural conditions, pore water of an expansive soil can vary in terms of quality and chemistry due to various natural (weathering, saline groundwater) or artificial causes. Literature review showed that there has been no specific research in the case of the influence of pore water quality regarding drying and wetting cycles. Therefore in this paper an experimental program was developed to evaluate the effect of pore water with high salinity on the mechanical behavior of an expansive soil during cycles of drying and wetting.

2. MATERIALS AND METHODS

2-1. SOIL

The soil used in this study was prepared from the combination of a typical clay soil with low plasticity (CL) and moderate swelling potential with various percentages (10, 20 and 30%) of bentonite clay. For this