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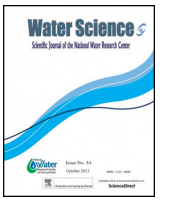

Research Article

Effect of chemical additives on consistency, infiltration rate and swelling characteristics of bentonite

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Abstract

Problems associated with expansive soils in Egypt are predominantly related to the presence of montmorillonite clay minerals in the soil with fresh water. In this paper we are trying to solve the swelling problem of bentonite by using the chemical additives such as ammonium chloride, sodium chloride sodium carbonate and lime. This paper presents the results of an experimental investigation performed to quantify the effect of mixing bentonite which represent the swelling soil in homogenies phase with chemical additives such as ammonium chloride, sodium chloride sodium carbonate and lime on the consistency and swelling characteristics of bentonite. The results showed that the increase of the chemical concentration to about 20% of the total sample weight of the mixing water leads to major decrease in the liquid limit and swelling characteristics of the bentonite. The reduction in the swelling of the bentonite is also proportional to the rate of chemical water infiltration into the bentonite. As the increase of the ammonium chloride and lime leads to significant increase of the infiltration.

Keywords: Swelling soil; Swelling ratio; Infiltration; Bentonite; Improving

1. Introduction

The word “swelling soils” has been commonly used as the generic description of all clayey soils containing montmorillonite mineral. Swelling soil deposits are mainly found near the arid of Egypt including the regions extended around the Nile valley in Upper Egypt. The fundamental geotechnical features of the swelling soils are theirs tendency to swell, or shrink when theirs water content increase or decrease producing either heaving or settlement which lead to much damage to the structures whether built in or on these soils. It is worth mentioning that the aforementioned problems affect development of projects; such as the lining of water channels with light weights, roads and railways. Moreover, building the structures which are deteriorated whether due to the lifting effect or settlement of the swelling soils during the wetting and drying periods, respectively. These problems are usually standing as challenges for the

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Table 1
Shows the bentonite, additives weights.

Sample	Water type	Bentonite (g)	Sodium chloride (g)	Lime (g)	Sodium carbonate (g)	Ammonium chloride (g)
1	Distilled	320		0	300	
2	Distilled	3250		150	300	
3	Distilled	3250		300		100
4	Distilled	3250		300		200
5	Distilled	3250		300		300
6	Distilled	3250	300		100	
7	Distilled	3250	300		200	
8	Distilled	3250	300		300	
9	Distilled	3250	300		400	
10	Distilled	3250	300			100
11	Distilled	3250	300			200
12	Distilled	3250	300			300
13	Distilled	3250	100			300
14	Distilled	3250	200			300
15	Distilled	3250	300			300
16	Distilled	3250	0	0	0	0

geotechnical engineer when deciding to use swelling soils in earth works and foundations. In many cases, the clay deposits in these applications are subjected to salty water. On the other hand, distilled or potable water are usually used in the procedure of standard laboratory tests. Furthermore, a faulty interpretation of the actual in-situ consistency and volume change behaviors of the swelling soils is found (Ajalloeian et al., 2013).

Different experimental programs have been carried out to explore the geomechanical performance of clayey soils mixed with fluids other than distilled water. These studies reported that the salty water causes major changes in the swelling characteristics of clays, e.g., El Sharif et al. (2013), Kaya and Fang (2000), and Ören and Kaya (2003).

Shirazi et al. (2011) found that when the mixing water "added to the bentonite" changed, a number of geotechnical parameters changed leading to the improvement of soil properties. These geotechnical parameters include liquid limit and plastic limit. Wherein, the liquid limit of bentonite remarkably decreased from 497% to 112% when the mixing water changed from distilled water to 0.5 M of NaCl solution, but it gradually decreases when the NaCl concentration increased from 0.5 to 4. One other hand, plastic limit is slightly increased respect to the increasing salt concentration. Other studies provided attempts to investigate the behavior of this type of soil when subjected to different types of water, such as for saline water in south western Kyushu Island of Japan (Don et al., 2006).

Therefore, more comprehensive investigation on the effect of chemical additives on the consistency limits and the swelling characteristics of bentonite is needed. Accordingly, the main objective of this study is investigating the effect of chemical additives including ammonium chloride, sodium chloride, sodium carbonate and lime on the performance of bentonite, which represents the swelling soil in a homogenies state.

2. Soil samples, additives, and mixing water

(a) The samples used in the research were obtained from a factory in the Borg El-Arab bentonite (industrialized) factory in the area of Alexandria which represent the swelling soil in homogenies phase, and the mineralogy of this bentonite are montmorillonite, quartz, Albite with ratio 43.9%, 12.2%, 43.9% respectively.
(b) The used additives are commercial materials as following: Lime, sodium carbonate, ammonium chloride, and sodium chloride.
(c) Water used for this research is distilled water (D.W.).
(d) Table 1 shows the weights of additives with bentonite.

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