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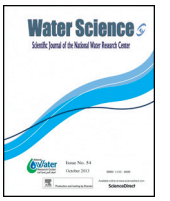

Research Article

Improving the geotechnical behavior of sand through cohesive admixtures

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Abstract

Irrigation projects in Egypt have been facing tremendous challenges, mostly is the scarcity of irrigation water. The current research presents the effect of different cohesive admixture on the conductivity of siliceous sand in general and its other geotechnical properties. Two different types of conventional swelling clay from (Toshka, 6th of October) as well as bentonite were used to construct the irrigation canals and embankment. The results indicated that increase in the plasticity properties of the treated soil also decrease the permeability and infiltration. Moreover, the dry density of 2.08 t/m^3 was obtained from sand and 20% 6th of October mixture, also the CBR of 31.20% were obtained from sand and 8% 6th of October mixture. Increasing the bentonite ratio increases the cohesion and decreasing the permeability. The swelling ratios of sand 6th of October Clay mixture is equal to 0.28%, and the fictitious stress at which the swelling ratio is nil, is equal to 16 kPa.

Keywords: Sand; Swelling clay; Bentonite; Compaction test; Consolidation test; Triaxial test

1. Introduction

Plastic mixtures used for soil improvement to increase the earth slopes stability, and decrease the permeability of the excavated water channels. Furthermore, the study focused on examining a possible treatment technique through carrying out an experimental program to improve the geotechnical performance of siliceous sands by mixing with cohesive different admixtures, namely two different types of conventional swelling clay and bentonite, and to account for the optimum mixing ratios. Albusoda and Salem (2012) used cement kiln dust (CKD) to stabilize Affek dune sand. Moreover, the effectiveness of adding different mixing ratios of (CKD) was studied. Adding of 8% CKD, for example, increased the ultimate bearing capacity of shallow foundation to 250%. The variation in shear strength

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parameters became almost constant after fourteen days of curing. Fattah et al. (2016) concluded that the treatment with Lime-Silica Fume Mix shows a general increase in the maximum dry density. Wayal et al. (2012) investigate the use of bentonite and lime in stabilizing dune sands for possible uses in geotechnical engineering. Wherein, the bentonite added to the mix was helping in making a cohesive bond in the mixture. Furthermore, the results showed some improvements in unconfined compression strength with addition of 15% bentonite and 3% lime. Further addition of bentonite and lime in dune sand causes difficulties in the compaction process as the mix becomes sticky. The minimum values of unconfined compressive strength were found in the mixture 5% bentonite and 1% lime. Aksoy and Gor (2011) studied on sand dunes properties are stabilized by using Portland cement, fly ash and silica fume. In order to find out which additive caused maximum dry density, soil samples were prepared by using four different replacement amounts of 0%, 3%, 5% and 10% by weight of soil. Maximum dry densities and optimum moisture contents were determined for all mixtures. It is concluded that dune samples have adequate density when compacted with 10%. Sharma and Trivedi (2016) studied the shear strength parameters of sandy silt soil by blending with fly ash in different proportion. Soil is mixed with fly ash at 5%, 10%, 15%, and 20%. It was concluded that the Optimum Water Content increases and Dry Density decreases with increases in fly ash due to progressive increasing silt particles in soil. The shear strength of the soil enhance due to presence of fly ash. So, fly ash has a potential to improve engineering characteristics of sandy silt soil. Elmashad and Tetsuya (2006) concluded that the bentonite is an effective material for improving the plasticity properties, where it increased the liquid limit, plastic limit and the OMC, but the maximum dry density and the CBR ratio were decreased. Bentonite should have been used in small amount to keep plasticity, CBR, and economy, and hence 5% or less was recommended through the experiments. Panwar and Ameta (2013) studied the strength characteristics of dune sand of western Rajasthan stabilized with cheap and readily available material like lime and bentonite. The investigation was an attempt to stabilize this soil with the aid of lime and bentonite. Standard Proctor test, unconfined compressive strength, in addition to some preliminary tests was conducted for assessing the suitability of lime bentonite mix with dune sand. Review of the literature shows that many previous studies assessed the geotechnical behavior of dune sands stabilized using many cementitious admixtures as cement, cement kiln dust (CKD) and lime, whereas there is paucity of data regarding the geotechnical behavior of treated dune sands stabilized with swelling clay. Furthermore, this research discusses the possibility of using cohesive admixtures as a stabilizing agent to the dune sands (Hafez et al., 2010). Sand itself cannot be used as a base or sub-base material for road construction, for it is susceptible to move by wind and water, and its shows non-plastic activity (Elmashad and Hashad, 2013). Soil improvement is one of the most economic engineering solutions to overcome soil problems.

2. Materials

2.1. The sand samples

The sand samples used in this study were obtained from a natural deposit located at Abu Rawash, 28 Km Cairo-Alexandria Desert road, second industrial zone, 8 km to the North of Giza, Egypt. The area lies between Latitude 29° 40′ 15″ N and Longitude 31° 14′ 1″ E. The soil samples used for this study were collected at average depths of 0.5–1.0 m by the method of disturbed sampling.

2.2. The used admixtures characteristics

Siliceous sands stabilization using cohesive admixtures may be considered an effective and economic alternative for global stability of the mixtures, increasing the CBR value, and lowering the permeability. In this study, several clay admixtures, of different mineralogy, were used namely two different types of conventional clay and bentonite.

The first admixture used is Toshka conventional clay where obtained from a natural formations at Toshka, 256 km to the upstream of Aswan High Dam, New valley in Upper Egypt from about 1.50 m depth. The soil formation extended from the surface up to 30 m depth is clayey soil. The second admixture used is 6th of October conventional clay where was obtained from a natural deposits at 6th of October city, Giza Governorate in Egypt taken from about three meter depth. The area lies between Latitude 29° 59′ 32″ N and Longitude 30° 58′ 10″ E. Moreover, the third admixture used is bentonite, industrialized, which presents very strong colloidal characteristics and its volume increases several times when coming into contact with water, creating a gelatinous fluid. The used bentonite is delivered from Borg El Arab; Alexandria in Egypt.

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