www.irbas.academyirmbr.com
International Review of Basic and Applied Sciences
December 2019
Vol. 7 Issue.12

Effect of Alkhmhah on Swelling Index Properties of Expansive Soils From Jerash in Jordan

TALAL MASOUD
Civil Engineering Department, College of Engineering, Jerash University, Jerash, Jordan.
Email: t.masoud@jpu.edu.jo

MANAL O. SULIMAN
Civil Engineering Department, College of Engineering, Jerash University, Jerash, Jordan.

SHEHDEH GHANNAM
Civil Engineering Department, College of Engineering, Jerash University, Jerash, Jordan.

HESHAM ALSHARIE
Civil Engineering Department, College of Engineering, Jerash University, Jerash, Jordan.

Abstract

The primary concern of this paper is to understand the engineering properties of the locally expansive soils found in Jerash city when treated by locally available stone cutting powder waste AL-Khamkha. The properties of soil such as liquid limit, plastic limit, plastic index and free swelling index were assessed for addition of AL-Khamkha by proportions of 0%, 10%, 15%, 20%, 25%, 30% and 40% by weigh of dry expansive soil. The soil used in this study is classified as clay of high plasticity, i.e., CH soil. From the analysis of results, it is found that as AL-Khamkha content increases from 0% to 40% the plasticity index and free swell index are decreasing and this is what the structural engineers are preferred when treating expansive soils. For achieving stable soil with zero swelling index, the addition of 40% AL-Khamkha can be recommended.

Keywords: *Clay Soil, Expansive Soil, Atterberg Limits, Free Swelling, AL-Khamkha.*

Introduction

Plastic clays termed as expansive soils or active soils that exhibits volume change when subjected to moisture variations, these soils exist in various forms and may consist of clays or shales or other minerals - Erzin and Erol (2007). Expansive soils absorb water and expand due to increase in moisture content and inversely shrink when the moisture content decreases by drying out. Volume changes of expansive soils due to change of moisture content cause many geotechnical problems in various types of structures in the world.

Different empirical methods are found in literature to predict volume change of expansive soil, in these methods, soil engineering properties like (Atterberg limits, dry density, water content, specific surface area, dry density, and clay fraction,) are used for predicting of expansive soil swelling characteristics, such as swelling index, and swelling pressure.

In recent years various researches all around world are done on utilization of solid wastes to tread the expansive soils. Akshaya and Subasis (2014) provide comprehensive review on stabilization of expansive soil using solid wastes. According to Sumit, Vishvendra and Achary. (2018) also provide comprehensive summaries on the effect of marble dust on geotechnical properties of expansive soil, all these studies based on empirical methods depend on investigations performed on local soils which make them not valid for all types of expansive soils.

Based on this study was conducted to investigate the effects of addition of locally available stone cut powder waste AL-Khamkha on Atterberg limits, and rate of swell of locally expansive soils.

Material Description and Laboratory Investigations

Materials

Expansive Soil

Expansive soils exist in many part of Jordan especially in Amman, Irbid and Jerash provinces. The soil used in this study was a natural clayey soil collected from jerash province. This soil is classified as high plasticity clay (CH) according to the Unified Soil Classification System (USCS).

Waste Stone cutting powder AL-Khamkha

The production of fine particles while cutting building stone is one of the major environmental problems for the building stone industry. Waste stone cutting powder AL-Khamkha was obtained from local stone cutting plant located in Jerash. First AL-Khamkha was dried, then it sieves before usage to get representative samples.

Sample Preparation

Prior to any laboratory tests the samples were prepared in accordance with the method described in ASTM standard. For the uniform soil samples, samples were prepared by No 40 sieve (0.425mm) for Atterberg limits and free swell tests Aruntas Guru and Tekin (2010).

Mixing of Soil and AL-Khamkha

The percentage rate of stabilizers powder based on the dry weight of soil is the common way used in most studies in literatures. For the waste stone cutting powder AL-Khamkha used in this study the rates are given as a percentage of the dry weight of the natural expansive soil Gupta and Sharma (2014).

Laboratory Tests

Atterberg Limits Testing

The consistency limits of the soil were determined by Atterberg limits test based on moisture content. It includes the determination of; the liquid limits, plastic limits and the plasticity index for the natural expansive soil and for (soil + AL-Khamkha) mixtures. The tests are conducted in accordance with ASTM D- 423and ASTM D-424 testing procedures ASTM (2003).

Free Swell Index Test

Free swell test is simple test, commonly used to estimate the swelling indices of expansive soils. This test measures the volume change in clay at saturation condition. Free swell test was performed to determine the

free swell index of the natural expansive soil and (soil + AL-Khamkha) mixtures Nelson and Miller (1992). The test is performed by pouring, 100g of oven dry soil passing sieve No. 40 size of (0.425mm), into graduated cylinder filled with water and also another 100 g of each sample was added into a graduated cylinder filled with locally available kerosene, three graduated cylinder contain water sample were used for each soil mixtures. Kerosene is non polar liquid causing no swelling of the soil. The level of the soil specimens in the graduated cylinder containing kerosene therefore is recorded as the original volume of the soil samples ($\mathbf{V_O}$)

The volume of swelled expansive soil in each cylinder is observed and recorded daily until the volume become constant for three days then the final volume is recorded, and the average reading of final volume of the three cylinders (VF) is used to calculated the free swell index (Fs) from Equation shown below

$$\textbf{free swell index\%} = \frac{\mathbf{V_F} - \mathbf{V_O}}{\mathbf{V_c}} \times \mathbf{100}$$

Test Results and Discussions

Effect of AL-Khamkha on expansive soil Atterberg Limits

The effect of AL-Khamkha on the plasticity index of the soil is shown in table 1 and in Figures 1 and 2

Table 1: Liquid limit, plastic limit, plasticity index for the different content of AL-Khamkha

Atterberge limit	AL-Khamkha Content (%)						
	0%	10%	15%	20%	25%	30%	40%
Liquid limit %	69	60.59	56	52	46	40	29
Plastic limit %	21.9	21.66	21.66	21.66	25	25	25
plasticity index %	47.1	39.29	34.34	30.34	21	15	4
Soil sample expansively predicted according to Holtz and Gibbs (1956)	Very high	Very high	high	medium	medium	low	low
Soil sample expansively predicted according to Chen (1975).	Very high	Very high	high	high	medium	low	low

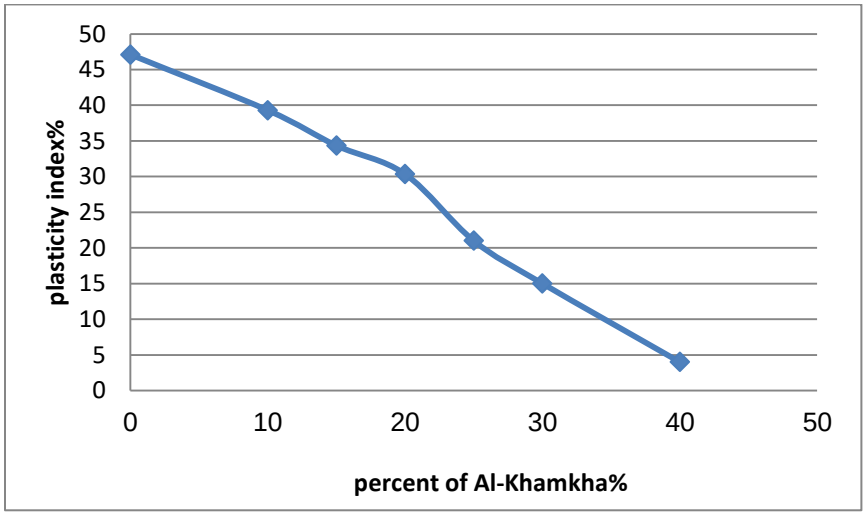

Figure 1: Variation of plasticity index with different content Of AL-Khamkha

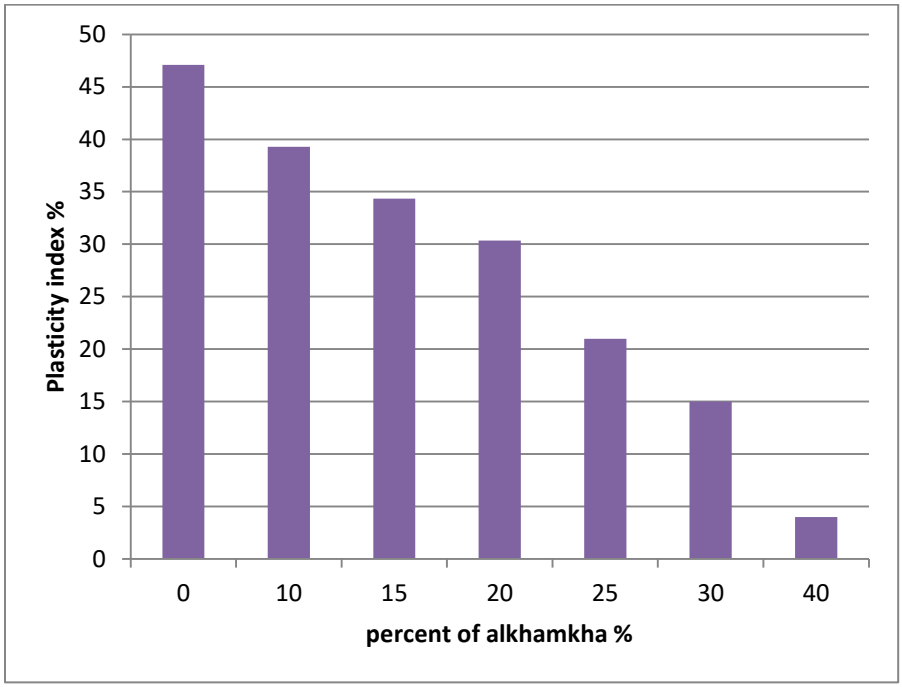

Figure 2: Variation of plasticity index with different content of AL-Khamkha

Generally from the table and figures , for all percentages of AL-Khamkha used (from 10% to 40%) the plasticity index showed lower value than for the natural expansive soil. slight decrease with increment of AL-Khamkha content is observed for lower percentage of AL-Khamkha content then as AL-Khamkha content increase the rate of decrease of plasticity index increase.

Effect of AL-Khamkha on free swelling index

Table 2: Free swell index and for different content of AL-Khamkha

Soil sample	Free swell index%	Classification of soil samples according to Casagrand et al (1992) and Dumbleton (1968).
Natural soil	60	High swelling
Natural soil+ 10% AL-Khamkha	45	Medium swelling
Natural soil + 15% AL-Khamkha	35	Medium swelling
Natural soil + 20% AL-Khamkha	25	Low swelling
Natural soil + 25% AL-Khamkha	15	Non swelling
Natural soil + 30% AL-Khamkha	5	Non swelling
Natural soil + 40% AL-Khamkha	0	Non swelling

The results of free swell for different percentage of AL-Khamkh are shown in table2 and Figures 4and 5, as can be seen in these figures, the effect of AL-Khamkha on the free swell index of the natural expansive soil sample show significant variation.

For the (natural expansive soil +AL-Khamkh) samples free swell index varies from 60% to 0% for different AL-Khamkh contents this drop in swelling index indicates the reduced surface activates of natural expansive soil and 0% free swell index indicates the stable condition of expansive soil.

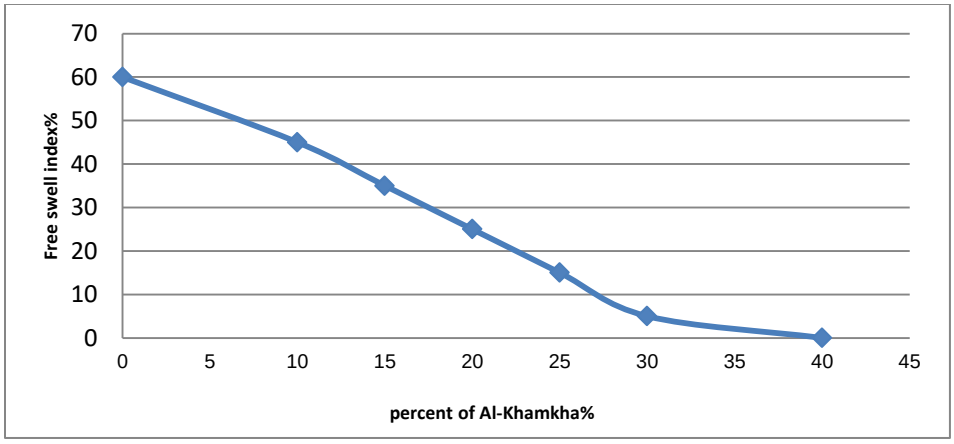

Figure3: Variation of free swell index with different content of AL-Khamkha

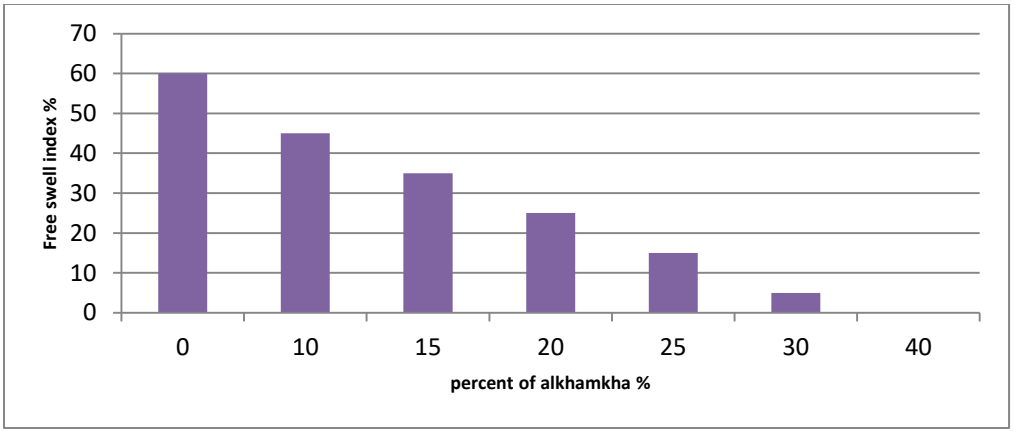

Figure 4: Variation of free swell index with different content of AL-Khamkha

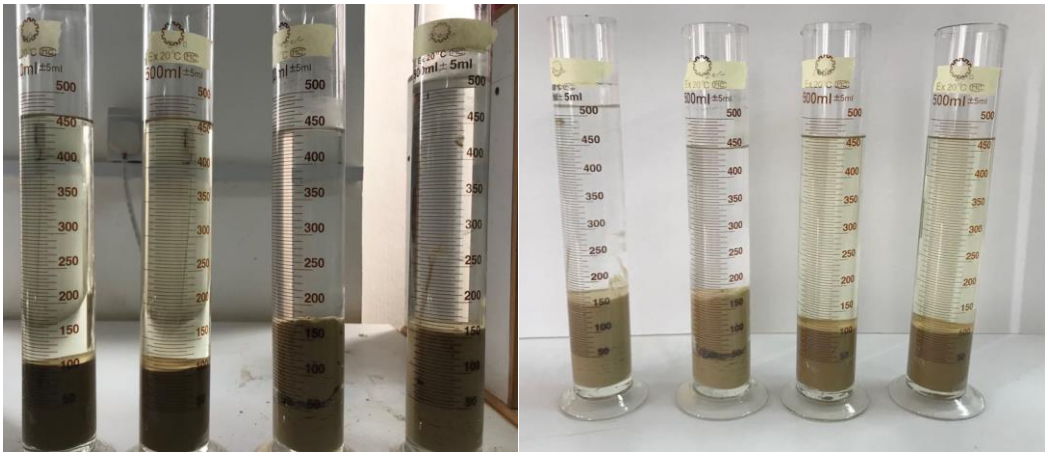

Figure 5: Free swelling test

Conclusions

The results for (natural local expansive soil + AL-Khamkh) used in this study, indicate that as % AL-Khamkh content increases from 0 % to 40 % the plasticity index is decreasing a lot and this is what the construction engineers are preferred when treating expansive soils.

From the swelling indices analyzed in this study, it is observed that as the content of AL-Khamkh increases, the swelling indices decreasing and this reduce the adverse effects of expansive soil on construction projects. It is further found that use of 40% AL-Khamkh is cause effective reduction in the swelling index of natural soil (0% swelling index) which indicates the stable condition of expansive soil. The effect of AL-Khamkh on the compaction Characteristics, shear strength and bearing capacity of natural local expansive soils can be investigated in the future studies.

References

Akshaya K. S., Subasis .P. (2014) "A Review of Literature on Stabilization of Expansive Soil Using Solid Wastes," EJGE, Vol. 19, Bund. U, 6251-6267.

Annual Book of ASTM Standards. Volume (04.08). Soil and Rock; Dimension Stone,"Geotextile.

Aruntas H, Guru M, Dayı M, Tekin I (2010). "Utilization of waste natural stone dust as an additive in cement production", Materials and Design 31: 4039–42.

ASTM (2003). American Society for Testing and Materials Casagrande A. Classification and identification of soils. Transactions of ASCE, 1948, 113, 901-992.

Chen F. H. (1975) Foundations on Expansive Soils.Elsevier, Amsterdam.

Erzin, Y., and Erol, O. (2007). "Swell pressure prediction by suction methods." Engineering Geology, 92(3): 133-145.

Gupta Chayan and Sharma Ravi Kumar (2014), "Influence of Marble Dust, Fly Ash and Beas Sand on Sub-Grade Characteristics of Expansive Soil", Journal of Mechanical & Civil Engineering, pp. 13

Holtz W. G. and Gibbs H. J (1956)." Engineering properties of expansive clays," Transactions of ASCE, 121, 641-663.

M. S. Dumbleton, (1968). "The Classification and Description of Soil for Engineering Purposes, a Suggested Classification of British System," RRL Report LR 182. U.K.

Nelson, J.D. and Miller, D.J. (1992). "Expansive Soils: Problems and Practice in Foundation and Pavement Engineering,". John Wile & Sons, INC. New York.

Sumit S., Vishvendra S., B. Achary. (2018) "review on effect of marble dust on geotechnical properties of expansive soil," International Journal of Advance Research in Science and Engineering, (IJARSE). ISSN: 2319- 8354 Vol. 7 No. 02. January 2018.