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Improvement of Sabkha Soil by Using Geomesh and Addition of Polycoat

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ABSTRACT

Sabkha soil is a rich soil with salt deposited which result from evaporation of water, it is one of the many types of collapsible soils and in turn is one of the many types of problematic soils. This soil totally has good engineering properties when dry ,i.e ,moderately bearing capacity with low settlement. But once is wetted it loses its entire structure (collapse) and undergoes very large instantaneous settlement. A laboratory model test consists of a cylindrical steel container of 270mm diameter and 300mm height, the soil is brought from Al-Khalis discrete. The density of soil is controlled by placing the required weight inside the container of known volume, to the required height. A square footing 40mmx40mm makes from steel is used. The stress is applied from a fixed loading system designed especially for model tests.

In this study two types of improvement are used , the first improvement consists of fine geomesh under footing at different depth (0.5B,B,2B),the second improvement is the addition of polycoat with different concentration to surface of soil .The first method do not give good results of improvement but the second method gives good improvement which reduces the collapsibility to 62% at stress level of 50kPa.

Keywords: Sabkha soil , collapsibility, Improvement

تحسين خواص التربة السبخة باستخدام التسليح بالشبكة الناعمة وإضافة الفلنكوت

الخلاصة

التربة السبخة هي تربة غنية بالأملاح المترسبة نتيجة تبخر المحتوى المـائي مخلفـا وراءه أملاحا مختلفة التراكيب الكيميائية وهذه التربة هي احدى أنواع الترب الانهيارية وتسبب الكثير من المشاكل للمنشات الهندسية المشيدة عليها ,اذ تمتاز بأنها قوية ومتماسكة وهبوطها واطـئ عنـدما تكون جافة ولكن بمجرد وصول الماء إليها فإنها تصبح ضعيفة جدا وتسبب هبوط عالي جدا .

تم استخدام نموذج مختبري يتالف من اسطوانة حديدية ذات ابعـاد 270 mm قطـر x 300mm ارتفاع, التربة المستعملة تم جلبها من احد مواقع منطقة الخالص .تم التحكم بكثافة التربة من خـلال تهيئة وزن التربة المطلوب ورصها داخل النموذج المختبري المعروف حجمه بالكثافة المطلوبة , تم استخداد اساس مربع واجهاد ثابت صمم لهذا البحث .هذه الدراسة استخدمت طريقتان لمعالجة التربة , الأولى هي وضع شبكة ناعمة في أعماق مختلفة هي (0.5B,B,2B) والثانية هي إضـافة الفلنكوت للتربة بتراكيز مختلفة . وأثبتت نتائج المعالجة الأولى لهذه التجـارب عـدم حصـول تحسين ملحوظ لهبوط التربة .أما الطريقة الأخرى وهي إضافة الفلنكوت أعطت تحسنا جيدا حيث قلت الانهيارية بنسبة 62% لمستوى إجهاد (50 Pa) .

الكلمات المرشدة : تربة صبخة , انهيارية , تحسين .

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INTRODUCTION

The distinguished features of sabkha soil are the presence of shallow and highly concentrated brines and variety of its geotechnical characteristics in both the horizontal and vertical directions. These features cause several engineering problems in roads and building constructed on the sabkha soil . Sabkha is an Arabic expression to describe recent coastal sediments with a high salt content and are characterized by very low bearing capacities and low SPT values(1).
Salt flats or sabkhas are salt bearing arid climate sediments covering vast areas of coasts of Middle Eastern and North African countries .The development of this material is due to low wave energy allowing the settlement of silt and clay particles to take place and then be loosely cemented by soluble .Sabkha sediments are characterized by high void ratios and low dry densities .Accordingly ,upon wetting sabkha soil is renowned for being highly compressible material with low bearing resistance and hence considered among the poorest of foundation material [2,3].
Several field stabilization techniques have been implemented to improve the interior saline soil properties including soil reinforcement with geotextile, soil replacement, vibratory compaction ,deep soil densification and stabilization with lime and cement.

The CBR tests(10) shows in saline soil that the most ideal percent of lime for stabilization is 2% and 3% silica fume .

Saline soils are associated with many geotechnical problems ,due to presence of digenetic salts of different sizes ,shapes and compositions ;and shallow saline ground waters . Therefore ; saline soil is considered to be an inferior construction material. Because of these characteristics ,some of pavements located on saline flats have exhibited various type of deterioration in form of reveling ,cracking ,rutting and formation of landslides in recently built roads .

The susceptibility of these soils to strength loss and collapse upon wetting makes their use in construction very risky and hazardous .Saline soils present high rigidity and high shear strength in natural conditions ,but they change radically in front of water action triggering huge localized settlement in civil works .

Many studies are performed about geotechnical behavior of saline soil in civil projects in different countries .Saline soil posses a high collapse potential attributable primarily to dissolution of sodium chlorides ,leaching of calcium ions and soil grain adjustment[5,6] .

The main purpose of this study is to improve the properties of sabkha soil by reducing the collapsibility using two methods which are using fine geomesh and addition of different concentration of polycoat.

EXPERIMENTAL WORK

Soil used:

The soil used in this study is brought from Al-Khalis discrete from (1-2)m depth of handmade borehole .Natural moisture content for the soil is 10% , grain size analysis is conducted on soil after washing on sieve No. 200 as shown in fig.(3) Classification test is made for the soil include liquid limit and plastic limit which values are 23%,20% respectively; therefore; the soil is SW-SM type .The chemical properties of Sabkha soil are shown in table (1).

LABORATORY MODEL PREPARATION

A cylinder made of thick steel with 270 mm diameter and 300 mm height is used, the soil was oven dried ,pulverized and sieved through sieve No.4 .The soil was placed in the cylindrical container with density 17 kN/m3 .Two methods of improvement are used, the first method is used fine geomesh at depth (0.5B,B,2B) below footing .The dimension of geomesh is taken according to stress distribution 1:1 under footing ;therefore: The mesh used with dimension (80x80)mm at depth 0.5B and (120x120)mm at depth B and so on for other cases .The second method is using polycoat (Emirates product) with different concentration .The addition of polycoat to sabkha soil is used in two cases before and after compaction . A model with no treatment was made for making a comparison with treated one with fine geomesh and polycoat addition .The soil density was controlled by dividing it three layers ;each individually compacted to recoded level until reaching the last layer ,the soil surface was leveled with aid of sharp instrument . A square footing 40x40 mm made from steel, was placed at the center of the model ,over last bed of the soil .

LOADING FRAME AND SETTLEMENT CONTROL

The system of loading frame chosen for all laboratory model tests is of fixed loadings type, to ensure continuous and long term loading application and easy stress controlling and loading additions during test .The model consists of vertical steel shaft of square section (1.2 m length ,10x10 mm cross section) connected as shown in figures(1&2) .

The settlement is measured using 0.01mm sensitive dial gauge ,fixed out of the model with the aid of magnetic holder .The loading frame and settlement control was designed especially for these tests type on model samples to investigate settlement during soaking and leaching of Sabkha soil with water .

The settlement is recorded with time for model tests at dry state ,this state takes about 20 minutes which represents the immediate settlement .At soaking stage (takes two days) ,the water was opened and starting wetting the soil in the model from top to bottom. The leaching process takes 3 days in which the small openings at bottom of container permitted to drained .The loading frame is placed on the steel footing with weights attached on it as to support a pressure on soil of 50 kPa and 75 kPa .This pressure is chosen as it is believed that most domestic houses and small engineering projects may apply a similar pressure on soil .

RESULTS AND DISCUSSION

As mentioned earlier in sample preparation that two methods of improvement are used .The results of first method (using fine geomesh) are shown in fig.(5) .These curves show the time settlement relationship for sabkha soil models contain different cases ,the soil tested at stress level 50 kPa and soil density 17 kN/m3 .The settlement of case of no improvement is continued and does not stop until leveled off at measured quantity of 11 mm ,that is S/B ratio of 0.28 as shown in fig. (4), that is a very high settlement and author believe that there is no such domestic building that can withstand such numerical value. This type of settlement is collapse and not long term one like consolidation settlement. It is noticed that after putting layer of geomesh at depth (0.5B,B) and three layers at depth (0.5B,B,2B) is approximately the same for the case of no improvement ,which is that ratios S/B (0.26 ,0.25 ,0.245) .These ratios are very large which mean that no significant improvement in using geomesh in sabkha soil .

The results of second method of improvement (addition of polycoat) are shown in fig.(6). It's noticed that the curves which belong to water/polycoat ratio (0.6:1,1:0.6) .In this case polycoat is put on the surface of sample after compacted it to density of 17 kN/m3 , it's noticed that the settlement time curve is very high and the same case of no improvement ,that is S/B (0.25,0.26) which are very large ratios .Also , it's noticed that the change of concentration of polycoat don't effect on improvement at this case .This is because the polycoat do not penetrate the sabkha soil of high density (17kN/m3) ,the penetration of polycoat to soil is (4mm,8mm) .Therefore ; it is followed second method for putting polycoat which is firstly poured the sample in container in low density of 12 kN/m3 and put the polycoat on the surface ,after period of time (2 hours) ,compacted the sample to density of 17 kN/m3.

Fig.(6), show the settlement time curves for this case ,it is noticed that the settlement is decreased and S/B became (0.11,0.13) for water/polycoat ratios (1:1,1:0.6) respectively .The percentages of improvement are approximately 62%,52% .In this case polycoat penetrates soil 30 mm and 35 mm for two models of water/polycoat ratios(1:1,1:0.6) .The increase of penetration caused the soil more strengthened and prevent water to seep to soil which prevent salt from dissolution by water ..The sample of water/polycoat ratio 1:1 give more improvement than of ratio 1:0.6 .

Fig.(7), show the time settlement curves same case as mentioned above except increasing the stress level to 75 kPa ,it is noticed that the settlement is high and the S/B ratios are (0.2,0.21) for water/polycoat ratios (1:1,1:0.6) respectively .Therefore ;the percents of improvement are 33%,29% .The penetration of polycoat to soil is 3.1mm and 3.7mm for water /polycoat ratios of (1:1,1:0.6) respectively .the degree of improvement is decreased with increased of stress level .

Figures(5,6) show the curves for data accumulation of soil specimens soaked and leached with using fine geomesh and addition of different concentration of polycoat for stress level of 50 kPa. Fig. (7), shows the curves for data accumulation for soil specimens soaked and leached with using different concentration of polycoat for stress level of 75 kPa. From these figures(5,6,7) it can be seen clearly that the addition of polycoat did not only reduced S/B ration but give " delay for settlement" as well. Although this delay seems small in time for situation of this study, but for large (full) scale footing it can be a significant factor. It simply means that may have a reasonable elapsed of time to take counter measures for any flood reaction opposite to the case of very instantaneous settlement in case of no addition of polycoating. The only drawback of this method of improvement is the penetration of the coat to soil. Of course , if soil has very low permeability, this method may be questionable .

Finally, it must be mentioned here that the sabkha soil is a problematic soil and in general not easy to handle which method of improvement to use ? is a question that needs an answer which depends on many factors such as , type of soil , strength properties of soil , location, loading rate and condition and so forth, but the most important factor is the finance and working facilities available . This goes for any improvement method and not fixed to this study. The most important factor to this study is to extend the limits for today for the benefits of tomorrow . Author believes that due to the shrinkage of water resources and lower late of rainfall, sabkha soil may continue to grow in Iraq and may be in similar climate countries . The results of this study is due to a small footing prototype , and may defer somewhat from the full scale footing, but author believes that the results obtained are really indicative and can be used in future studies , at least as an indicating reference point.

CONCLUSIONS

The following points are drawn from this study :

1. The method of using fine geomesh in improvement of sabkha soil is not Effective and give high settlement .
2. The method of using polycoat in improvement of sabkha soil gives good Improvement, reduced the collapsibility to 62% for stress level of 50 kPa .
3. The procedure of putting polycoat to sabkha soil is very important and the best approach is pouring polycoat on soil with low density ,then compact the soil .
4. The degree of improvement of sabkha soil changes with percent ratio of water/polycoat, the best ratio which gives good improvement is 1:1 .
5. The degree of improvement of sabkha soil by using addition of polycoat decreases with increasing stress level .

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Table (1) Chemical properties of Sabkha Soil.

SO_3 (%)	T.S.S. (%)	pH value	Organic content (%)	Carbonates content (%)	Chlorides content (%)
0.5	21.2	8.27	0.75	39	10.9

Figure (1): Laboratory model test and equipments.

Figure (2): Cross section of sample after test .

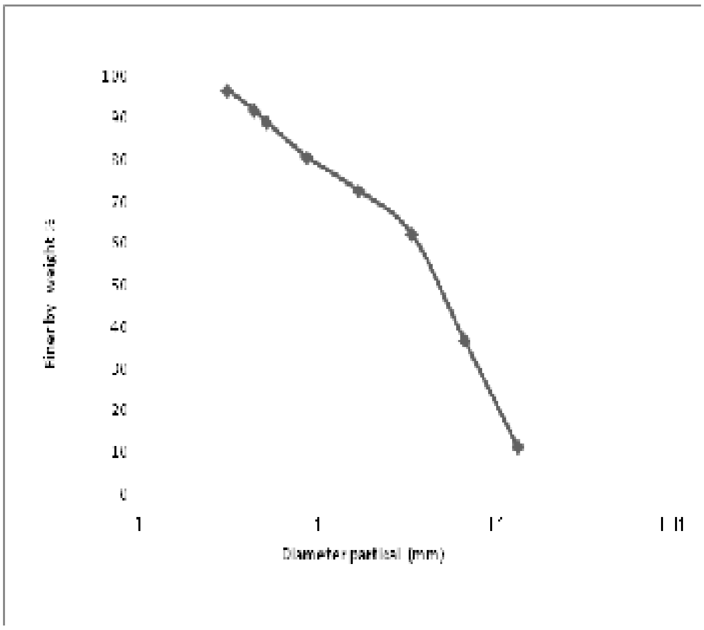

Figure (3):Partical size distribution curve of sabkha soil .

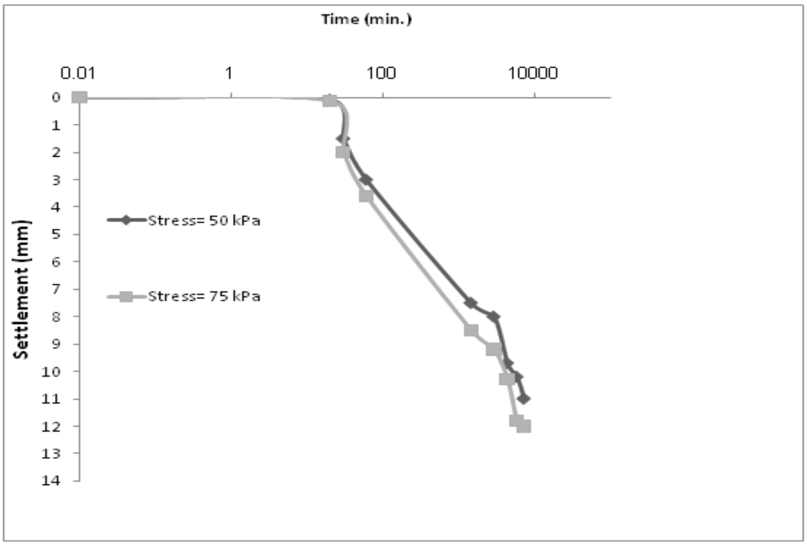

Figure (4): Time- settlement curves for sabkha soil without treatment.

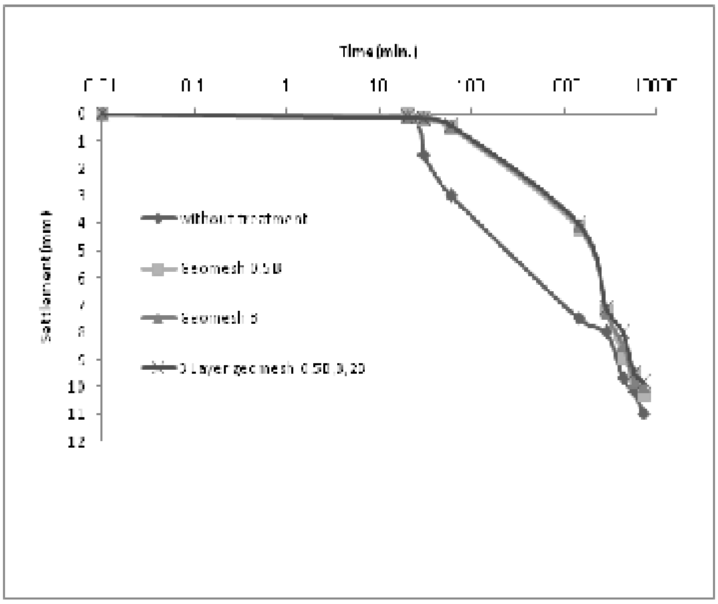

Figure (5) Time-settlement curves for sabkha soil without treatment and with treatment using geomesh method (Stress=50kPa.).

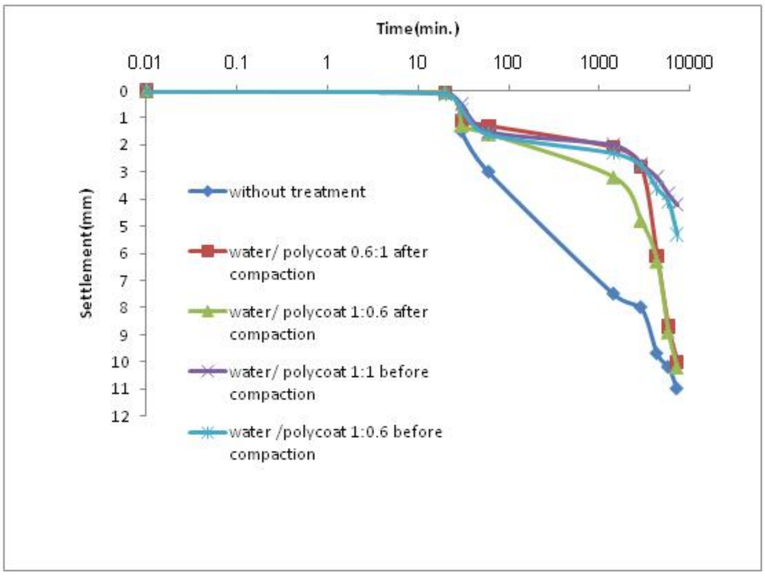

Figure (6): Time-settlement curves for sabkha soil without Treatment and with addition of polycoat (Stress=50kPa.).

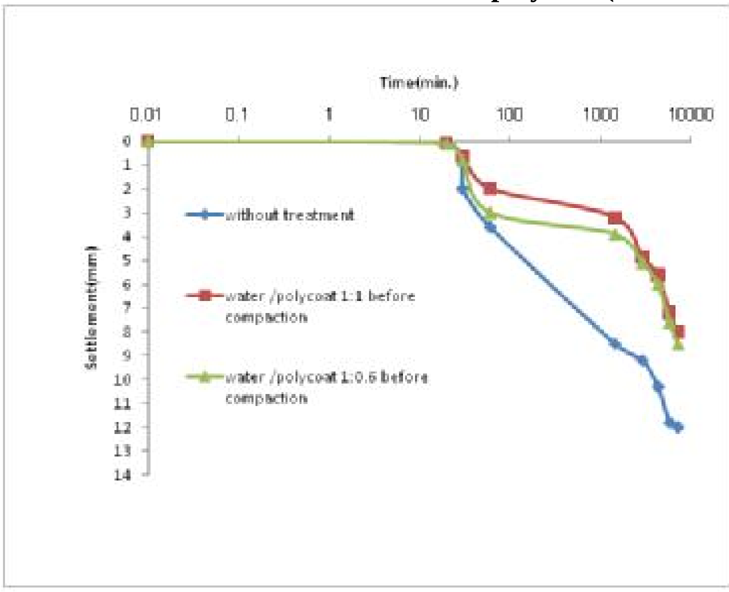

Figure (7): Time-settlement curves for sabkha soil without Treatment and with addition of polycoat (Stress=75kPa.).