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Evaluation the Efficiency of Stabilization Technique of Organic Soil by Comparison Between the Two Stabilizers

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Abstract:- Sewage treatment plants produce large quantities of sewage sludge as by-products, as the sludge contains elements harmful to environment. Such study investigated of utilizing different percentages of sewage (7, 14 and 21%) of soil weight. The stabilization / solidification process was used to improve the properties of the organic soil and meet its requirements. This technique was the use of traditional and non-traditional additives such as cement and styrene acrylic. The major objective of that research is to evaluate efficiency of stabilized soils through comparison of stabilizers. The organic soil was prepared and stabilizers were added in different proportions (3, 6 and 9%) for the purpose of the tests. Mechanical tests (Unconfined Compressive Strength (UCS) and Hardness) were used for the soil sample to estimate the best mixing and obtaining higher strength. Through outcome of the UCS and hardness tests, cement was most effective agent of styrene in terms of improving the properties, strength and hardness of the organic treated soil.

Keywords:- Sewage Sludge, Soil, Stabilzation/Soldification, Stabilizers, unconfined compressive strength.

I. INTRODUCTION

The sewage sludge is addition leads to a change in the physical, chemical and biological properties of soil, so it was requisite to analysis mechanical behaviour of the soil next mixing it with the sewage [1]. There are different applications for stabilized soils such as improving the land, building roads and building the superstructure of buildings (walls in the first place), where the expected characteristics of the settled soil differ rely on engineering application such as CBR value , Compressive, Shear Strength plus Permeability. These were several of properties that have been studied before [2]. So, sludge used stabilization/solidification (S/S) technology of application into the layers plus sub-layers of pavement could help in two aspects, the goodness of roads and disposal of contaminated waste, as one of the main environmental challenges around the world is the safe disposal of sewage sludge. The frequent alternatives for disposing sewage sludge were to use it in the soil, dump it in the sea, or fill in the ground or burn as mentioned [3]. The S / S process could be known as the cleaning technique, included mixture the soil with contaminated sludge and stabilizing materials like lime / fly ash, portland cement, cement / fly ash in order to fix the pollutant inside the soil to prevent its release and leakage to the environment. Stabilization refers to the possibility of reducing the risk via changing soil contaminant; so, that they become low harmful or low mobile [4]. The solidification technique refers to the change in the physical characteristic of the pollutants, such as permeability and compressibility, in addition to encapsulate of the waste through a homogeneous solid material with rise structural integrity [4]. The use of sewage sludge is one of most economical practices to reduce sewage sludge waste [5, 6, 7,8]. However, [1] studied the feasibility of using 10% of sewage sludge by weight in pavement layers. The stabilization technique was the use of additives such as cement, lime and emulsion in various proportions (2, 4, 6, and 8%). The modified soil samples were prepared for stress testing, California bearing ratio, unconfined compressive strength, indirect tensile strength, degradation test and elasticity. The results were the maximum dry unit weight for mixtures containing stabilizers less than those obtained by using pure soil with sludge, as well as an increase in the California bearing ratio when using lime and cement and a decrease when using the emulsifier, and finally, adding 8% of cement as an additive to the soil-sludge mixture, it provides the highest increase in resistance. [9] calculated analysis of the use of sewage sludge ash (SSA) as a raw substance in the concrete formation. This ash represents a serious problem, so its use in the construction sector will exist a big advantage for both economical and environment perspective. A scale was designed with proportion of ash addition in relation to the cement (5, 10, 15 and 20%) and the replacement of sand with this material, as adding an inert substance such as marble dust, in order to understand how these mixtures work in other cement systems, the analysis was performed on mixtures with treatment ages 7, 28 and 90 days, and physical and mechanical tests were performed on the treated slurry for 28 and 90 days. The addition of SSA in concrete used to manufacture 28 d cured blocks has been shown to provide similar density and resistance to the control sample (without SSA) and significantly reduce water absorption.

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II. MATERIAL AND EXPERIMENTAL DETAIL

A. Material

Materials utilized in this study are the natural soil that was collected from the Al-Qurayat area in Baghdad, as well as the organic material, which is sewage sludge, Samples were taken from the Rustumiya area in Baghdad and the stabilizers used, which are cement (C) and styrene acrylic (ST), were taken from the market. These materials were transferred to the soil mechanics laboratory at College of Engineering, Al-Mustansiriya University. The following is a listing of the properties of soil, sewage sludge as well as stabilizers.

Physical Properties	Value
Partical size distribution Sand (%) Silt (%) Clay (%)	 3 45 52
Liquid limit (%) Plastic limit (%) Plasticity index (%)	39 25 14
Maximum dry density (g/cc) Optimum moisture content (%)	1.85 18.5
Specific gravity	2.6
pH	6.9
Soil classification USDA	Silt Clay

Table 1:- Physical properties of soil

structure of Chemical	proportion through weighing
oxide calcium %	16.54
SiO2 %	15.85
Al2O3 %	3.454
Fe2O3 %	3.415
Na2O	1.928
SO3 %	4.299
MgO %	2.026
P2O5 %	0.889
Other elements %	1.629
Total	**50.03**

Table 2:- chemical composition of sewage sludge

Properties	Values
Colour	White
Particle Size (micron)	0.2 – 0.5
Density (g/cm3)	1.02-1.06 (gm/ml)
Solid Content %	50±1
pH	7-9
Viscosity	10000 – 20000 Pa.s
Stabilizing System	Anionic – Noanionic

Table 3:- Physical properties of styrene acrylic

B. Experimental Detail

Contaminated organic soil samples were prepared by mixing soil with sewage sludge in proportions (7, 14 and 21%) by weight. The mixture was mixed for a short period in order to homogenize the mixture and then the contaminated organic soil was kept in a closed bucket and left to allow interference between the sludge and the soil. After a period of time, the polluted soil is dried, milled and screened, and stabilizers, which are cement and styrene acrylic, are added in proportions (0, 3, 6 and 9%) to the contaminated soil because these stabilizers are able to retain pollutants inside a solid matrix, as well as to assess the mechanistic effective of each stabilizer into mixture.

➢ *Unconfined Compressive Strength and Hardness Test*

Unconfined compressive strength (UCS) and hardness were used as a measure of strength characteristic of stabilized samples, which is an indication of the formation cementitious materials in the context of contaminated soil. Initially each binder were thoroughly mixed with contaminated soil in clean beaker, then the water in demand amount known as best moisture content (OMC) is specific to every soil of individual. Next, for samples of cement and styrene acrylic, before into the increment of water, the dried organic soil plus stabilizer mixed first completely. After that, the solution of water (OMC for each content of stabilizer) was added to mix with the dried material until a homogeneous mix was obtained. The mixture was statically compacted in three layer inside cylindrical made from steel with diameter of 38mm and length 76mm which is specified under standard BS1924:part2:1990. Immediately after moulding, the specimens were extracted using hydraulic jac, then, they were enveloped by plastic overlay and aluminium foil above it to avoid the moisture losing during the time of casting.

III. RESULTS

A. Unconfined Compressive Strength

Through the following figures 1, 2 and 3 the outcomes of unconfined compression strength of organic soils with different added contents and curing periods. The tests were conducted on compaction organic soil samples taking into account the optimum moisture content to achieve the dry density equivalent for each mixture.

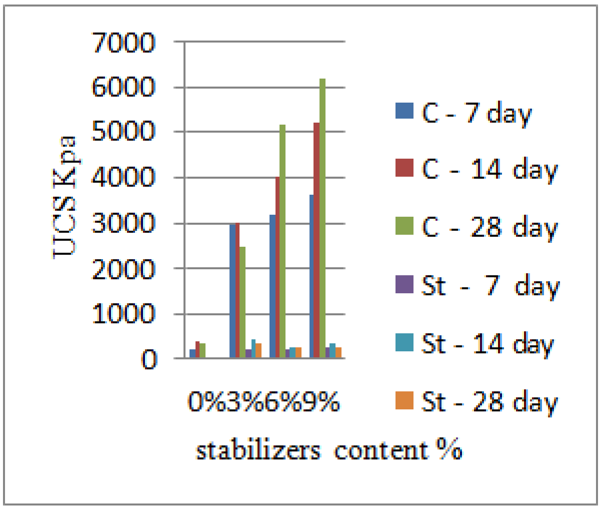

Fig 1:- Comparisons between stabilizers content and 7% of OS content

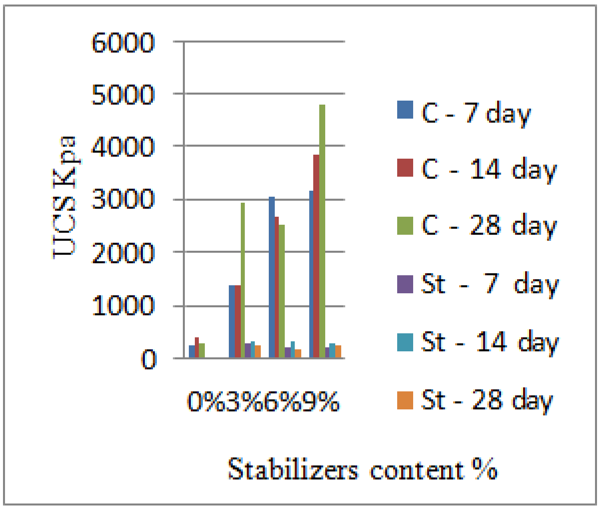

Fig 2:- Comparisons between stabilizers content and 14% of OS content

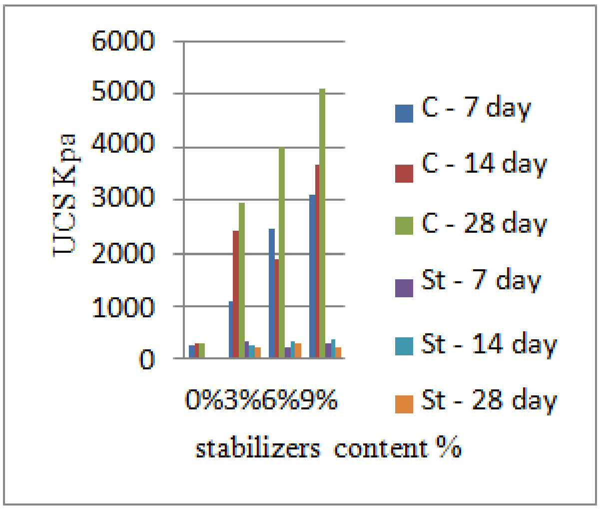

Fig 3:- Comparison between Stabilizer Content and Organic Mixture –21% OS

Through the previous figures, it was found that the UCS values obtained by adding cement were higher than styrene. The highest UCS value was at 7% organic soil and 9% cement, with the increase reaching 6190 Kpa at 28 days. Soils with a reduced surface area need large quantities of cement in order to provide more durability and strength, as mentioned [10]. As for the increase in the organic matter percentage, the UCS value decreases. It is known that the organic material affects the action of cement in the soil, as it works to delay the reactions of pozzolanic that produce strength and this is in agreement with [11]. For styrene, there was an increase in UCS, but by a small percentage, compared to the more effective cement, where the highest value of UCS was 435 Kpa at 7% organic soil and 3% styrene within 14 days. [12] mentioned for both emulsion concentrations, mixtures with wet treatment appeared to present less strength than mixtures with dry treatment.

B. Hardness Test

It was applied the Digital Shore-D durometer in this research for hardness test. The specimens were prepared for organic soil mixture with addition of different contents of both of cement and styrene acrylic at (0%, 3%, 6%, and 9%) along curing times (7, 14, and 28 days). The results of this test are shown in the figures 4, 5 and 6.

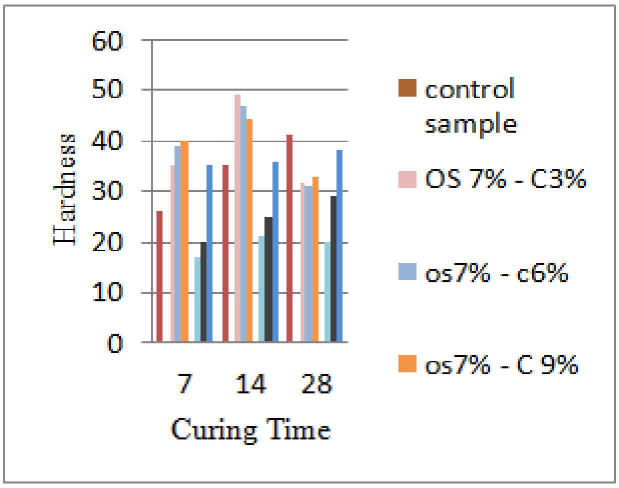

Fig 4:- the hardness of 7% OS with both stabilizers percentage.

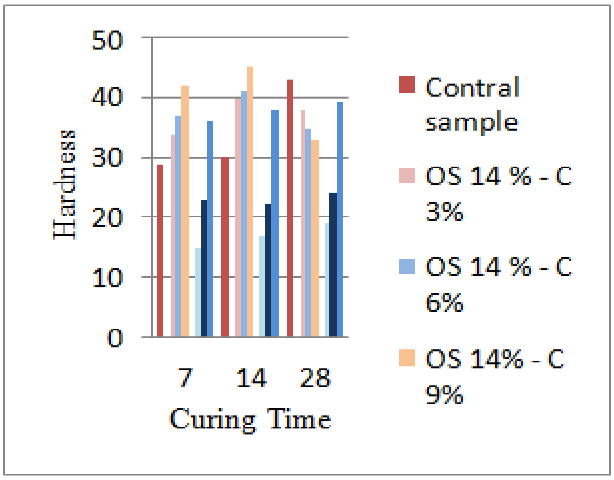

Fig 5:- the hardness of 14% OS with both stabilizers percentage.

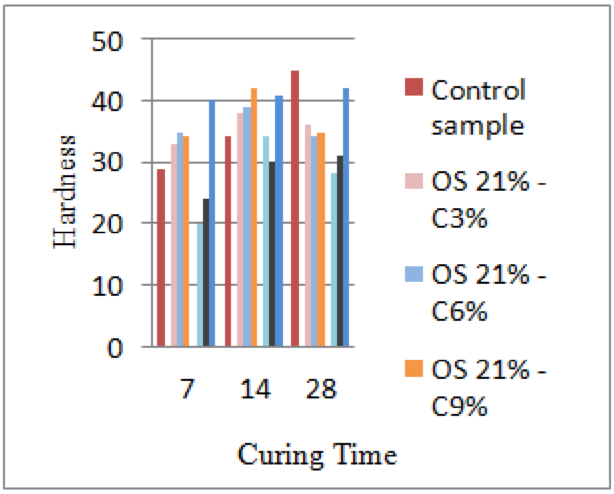

Fig 6:- the hardness of 21% OS with both stabilizers percentage.

From the previous figures, it can be seen that the cement stabilizer gives high values in the hardness test for all ratios (3, 6, 9%) while the styrene fixer gives the lowest ratios Through it was mentioned that the cause of the cement increased hardness is the pozzolanic reaction that results in a cement bond between the materials in addition to the fact that the cement works on the cohesion of the soil particles.

IV. CONCLUSION

Through the results of previous tests of stabilized organic soils with added proportions (0, 3, 6 and 9%) of cement and styrene, we conclude the following:

- According to mechanical tests with organic soil contaminated, the loss value of strength increased with the increase of the organic content. As it is known that these organic pollutants delay formation of cementitious materials responsible for improving properties of soil treated with cement and styrene
- An increase of 9% of cement and 3% of styrene in the mixture of soil with sewage sludge resulted in an increased in the strength.
- Hardness test indicates that degree of hardness of the organic soil sample increases with increase in the percentage of stabilizer as increase in cement was higher than the proportion of styrene about 1%.
- Note that the cement stabilizer was more effective than styrene-acrylic.
- This research revealed that sewage sludge addition in soil can also be used effectively as the base materials for roads, back filling, and the improvement of soil bearing capacity of any structure.

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REFERENCES

[1]. Lucena, L.C.D.F.L., Juca, J.F., Soarres,J.B and Portela, M.G., “Potential Uses of Sewage Sludge in Highway Construction”. Journal of Materials in Civil Engineering, ISSN 0899-1561/04014051(7), 2014.

[2]. Reddy, B. V. V., and Kumar, P. P.,“Cement stabilised rammed earth. Part A: Compaction characteristics and physical properties of compacted cement stabilised soils.” Mater. Struct., 44(3),681–693, 2011.

[3]. Sa´nchez-Monedero, M.A., Mondini, C., Nobili, M.D, Leita, L., Roig, A., “Land application of biosolids. Soil response to different stabilization degree of the treated organic matter”. Journal of Waste Management 24 (2004) 325–332, 2004.

[4]. U.S. Army Corps of Engineers “Treatability Studies for Solidification/Stabilization of Contaminated Material”. ETL 1110-1-158. 1995.

[5]. Laturnus F, Von AK, Gron C., “Organic contaminants from sewage sludge applied to agricultural soils - False alarm regarding possible problems for food safety” Environ Sci Pollut Res 14:53–60, 2007.

[6]. Singh R.P., Agrawal M., “Potential benefits and risks of land application of sewage sludge”, Waste Manag, Volume 28, Issue 2, 2008, Pages 347-358 , 2008.

[7]. Suhadolc M, Schroll R, Hagn A, Dörfler U, Schloter M, Lobnik F., “Single application of sewage sludge Impact on the quality of an alluvial agricultural soil”, Chemosphere doi:10.1016/j.chemosphere.2010.08.024, 2010.

[8]. Silva, J.D, Leal, T.T, Araújo, A.S, Araujo, R.M, Gomes, R.L, Melo, W.J, Singh, R.P., ‘Effect of different tannery sludge compost amendment rates on growth, biomass accumulation and yield responses of Capsicum plants”. Waste Manage 30:1976–1980, 2010.

[9]. Baeza-Brotons, F., Garces, P., Paya, J., Saval, J.M.,“Portland cement systems with addition of sewage sludge ash. Application in concretes for the manufacture of blocks”., Journal of Cleaner Production,http://dx.doi.org/10.1016/ j.clerpo.2014.06.072, 2014.

[10]. Goodary, R., Lecomte-nana, G. L., Petit, C., and Smith, D. S.,“Investigation of the strength development in cement-stabilised soils of volcanic origin.” Constr. Build. Mater., 28(1), 592–598, 2012.

[11]. Tremblay H., Duchesne J., Locat J., and Leroueil S., “Influence of the Nature of Organic Compound on Fine Soil Stabilization with Cement”, Canadian Geotechnical Journal 39, pp. 535-546, 2002.

[12]. Micelli, G., Jr., Motta, L. M. G., Oliveira, J. R. M. S., and Vieira, A.,“Comportamento Resiliente de Solos do Estado do Rio de Janeiro Estabilizados com Emulsão Asfáltica.” XXI Congresso de Pesquisa e Ensino em Transportes, Anais, Rio de Janeiro, 2007.

[13]. Rashed R. R., “Stabilizing the Eroded Pb-Polluted Soil with Local Materials”, M.Sc. Thesis, University of Mustansiriyah, 2017.