Civil and Environmental Research www.iiste.org
ISSN 2224-5790 (Paper) ISSN 2225-0514 (Online)
Vol.9, No.1, 2017

Improvement of Unconfined Compressive Strength of Natural Organic Soil

Adel H. Majeed[1], Abbas A. O. Al Zayadi[2], *Jasim M. Abdul Abbas[3]

1. Asst. Prof., Civil Engineering Department, Al-Esraa University College, Baghdad, Iraq.
2. Ph. D., Civil Engineering Department, Al-Mustansiriyah University, Baghdad, Iraq.
3. M.Sc Student Civil Engineering Department, Al-Mustansiriyah University, Baghdad, Iraq.

Abstract:
The aim of this paper is to investigate the possible improvement of unconfined compressive strength of natural organic soil by using cement dust and fly ash. Natural organic soil with different percentage of organic content (0, 5, 10.15 and 20 %) is used. Three different percentages of cement dust and fly ash (3, 6 and 9 %) are used to improve the strength characteristics of the organic soil. The effect of curing time is investigates. The result show that unconfined compressive strength of organic soil decreased with increasing the organic content. The addition of cement dust increased the unconfined compressive strength for all percentage of organic content, while the addition of fly ash improved the strength characteristics of organic soil for samples with organic content greater than 10 %.
Keywords: *organic content, unconfined compressive strength, cement dust, fly ash.*

1. Introduction

Organic soil is characterized by low shear strength and high compressibility. This soil causes serious foundation problems and constitutes one of most difficult ground condition for the construction of civil engineering structure.

Organic material affects the properties and behavior of soil depending on many factors such as percentage origin, fibrousness, degree of decomposition…..etc. of organic material. In general, the maximum dry density decreases and optimum water content increases with increasing organic content.

The shear strength decreases with increasing of organic content, while it may increase for fibrous non decomposed low content organic material. Improvement of organic soil is essential to use such soil for civil engineering constriction. Different chemical materials have been used to improve the characteristics of organic soil.

Yunua (2007) studied the stabilization of natural organic clay having 14.4% organic content using lime. It was found that the addition of lime causes decrease in the maximum dry density and an increase in the optimum water content.

Rafizul et.al.(2012) investigate the behavior of natural organic soil collected from four location at Khulna region in Bangladesh. They mixed the soils with different percentage of bentonite, lime and cement. They found that, the optimum moisture content decreases, while the maximum dry density increases with the increase of the admixture content.

Huat et.al.(2011) used the kaolinite and cement-sodium silicate grout to increase the undrained shear strength of reinforced peat. The peat soil was brought from kampong Jawa, Selangor in Malaysia. The samples were cured for 28 days before tested using unconsolidated undrained triaxial compression test. The result showed that the ordinary Portland cement sodium silicate and kaolinite.

Boobathiraja et.al (2014) used hydrated lime and ordinary Portland cement to improve the unconfined compressive strength of organic soil. They concluded that the unconfined compressive strength of organic soil increases significantly with the increase and lime contents and the improvement obtained by cement is better than hydrated lime .

Sadiq, (2016) , studied the effect of adding quick lime (CaO) to model organic soil of different percentage of organic content . Direct shear test was adopted in this study. the result showed that the cohesion and angle of friction increased with increasing of lime content for samples with organic content greater than 5%. In the present study natural organic soil with (10 %) organic content is used to investigate the effect of cement dust and fly ash as treatment material on the unconfined compressive strength of this soil.

Civil and Environmental Research
ISSN 2224-5790 (Paper) ISSN 2225-0514 (Online)
Vol.9, No.1, 2017

2. Experimental Work:

2.1. Materials:

1. Soil: Natural organic soil taken from the city of Balad north of Baghdad, Iraq is used, the soil containing (10%) of organic material which mainly composed of plant residues and tree roots.
2. Cement dust: Is by products material brought from Lafarge Cement Company in Erbil. Iraq.
3. Fly ash: Is by products material brought from fiery bricks factory in Diyala, Iraq.

2.2. Sample Preparation

Natural soil of organic content equal to (10 %) is used as the source of soil samples of different organic content (0, 5, 10, 15 and 20 %). The organic material was separated and collected from the soil to use it in preparing samples with 15 % and 20 % organic content. While the other samples with 0 % and 5 % are prepared by sieving the soil to separate the organic material and produce clean soil sample with 0 % organic content.

2.3. Experimental Program

The experimental program adopted in this study includes

a. Physical and classification tests on the natural soil, the results of these tests are shown in table (1).

Table (1) Physical and classification properties results of nature organic soil

Properties	*Value*	*Standard*
Specific Gravity (G_s)	2.825	ASTM D 854-00
Liquid Limit (L.L.)%	54	B.S.1377:1975
Plastic Limit (P.L.)%	25	B.S.1377:1975
Plasticity Index (P.I)%	29	B.S.1377:1975
Standard Compaction Test Maximum dry unit weight $\gamma_{d\ max.}$ (kN/m^3)	15.34	ASTM D698-78
Optimum moisture content (%)	22	ASTM D698-78

b. Chemical tests on the natural soil, cement dust, fly ash and organic material. The results are presented in tables (2), (3), (4) and (5) respectively.

Table (2) Chemical composition of natural organic soil

Chemical Compound	*CaO*	*Na_2O*	*SO_3*	*TDS*	*CO_3*	*Fe_2O_3*	*SiO_2*	*Al_2O_3*	*L.O.I*
Percent (%)	17.2	0.62	0.22	0.61	0.23	6.2	24.2	45.37	5.36

Table (3) Chemical composition of cement dust

Chemical Element	*CaO*	*Na_2O*	*SO_3*	*Al_2O_3*	*K_2O*	*MgO*	*SiO_2*	*Fe_2O_3*	*L.O.I*
Percent (%)	58.49	0.3	2.6	5.87	3.28	4.58	17.4	2.86	4.65

Table (4) Chemical composition of fly ash

Chemical Element	*CaO*	*Na_2O*	*SO_3*	*Fe_2O_3*	*SiO_2*	*MgO*	*Al_2O_3*	*L.O.I*	*K_2O*
Percent (%)	4.99	0.41	0.56	14.68	48.45	3.81	23.17	2.54	1.39

Table (5) Chemical composition of the organic material

Chemical Element	*O.M*	*SO_3*	*TDS*	*CO_3*	*Fe_2O_3*	*K_2O*	*Al_2O_3*	*CaO*
Percent	33	0.26	Turbid	0.28	2.5	27	5.96	31

c. Ignition test method is used to determine the actual organic content of prepared samples. The actual organic content of the prepared samples are (4.855 %, 10.24%, 14.75% and 19.96%).

d. Compaction tests: the standard compaction effort is used according to ASTM D689-78. Samples with organic content approximately equal to (5%, 10%, 15% and 20%) are compacted without and with treatment by (3%, 6% and 9%) of cement dust and fly ash separately. The result is presented in table (6).

e. Unconfined compression test: this test was conducted according to ASTM D2166-06. Samples with organic content approximately equal to (0, 5, 10, 15 and 20 %), were tested. Another group of the same samples treated with (3, 6 and 9 %) of cement dust and fly ash were tested. All mentioned samples were test after curing period of 7 days and 28 days. A third group of the mentioned sample were prepared and left under applied stress equal to 20 kPa for 6 months to investigate the effect of time on the performance of the treatment. All samples were prepared at maximum dry density and optimum water content.

Table (6) Value of maximum dry density and optimum water content for organic soil with different percentage of cement dust and fly ash

Organic content (%)	*Treatment material (%)*	*Cement dust*		*Fly ash*	
		Maximum dry density (kN/m^2)	Optimum moisture content (%)	Maximum dry density (kN/m^2)	Optimum moisture content (%)
5	0	16	19	16	19
	3	15.43	22.9	15.4	23.28
	6	15.02	26.67	14.4	24.31
	9	14.81	27.64	14.36	28.8
10	0	15.34	22	15.34	22
	3	14.7	26.53	14.9	25.64
	6	14.56	28.5	14.22	28.7
	9	14.29	29.25	14.02	32.92
15	0	13.9	29.54	13.9	29.54
	3	13.3	30.99	12.94	31
	6	13.14	31.51	11.98	32.46
	9	13	32.16	11.02	33.92
20	0	13.1	32	13.1	32
	3	12.43	32.5	12.03	33.24
	6	12.37	35.54	11.06	34.48
	9	12.25	36.28	10.09	35.72

3. Result and Discussion:

3.1. Compaction test

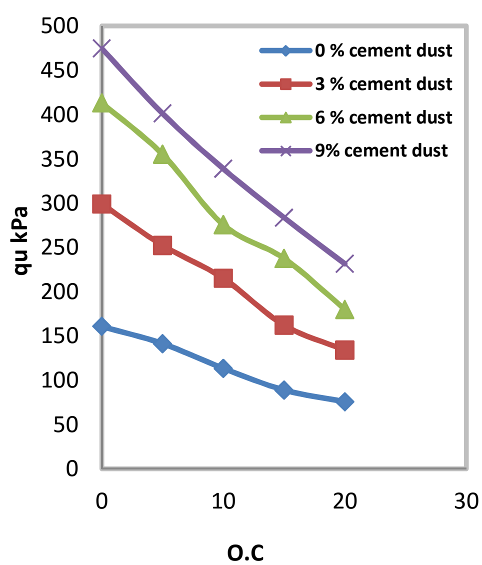
Table (6) presents the result of compaction test on samples of natural soil with different organic content (5, 10, 15 and 20 %). The samples are treated by different percentage (0, 3, 6 and 9 %) of cement dust and fly ash suavely. The result indicate that the maximum dry density decreased with increasing organic content, while the optimum water content increased with increasing organic content. This result agree with previous studies (Abbas,et.al (1985),Tariq (1998), Habbi (2005) and sadiq (2016)). For each percent of organic content, the maximum dry density decreased, while the optimum water content increased with increasing the percent of treated material (cement dust and fly ash). This behavior is due to:

1. The organic material has a specific gravity less than that for soil particle. This decrease the dry density of organic soil, while the organic material has the ability to suck water which causes the increase in optimum water content
2. Cement dust react with water and soil particle. This reaction produced cementing material prevents the soil to compact easily. On the other hand this reaction need more water to complete the reaction.
3. Fly ash has a specific gravity less than that for soil particle. It behaves like organic material in reducing the density and increasing the water content.

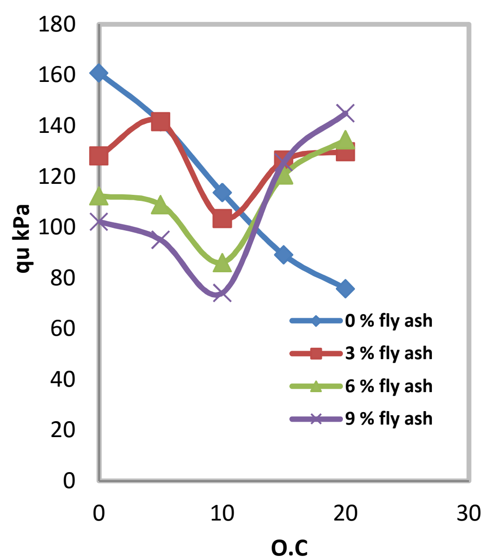
3.2 Unconfined compression test:

Three groups of samples for each treated material were tested. The first group was tested after 7 days curing. The second group was tested after 28 days curing. While the third group was left under applied stress equal to 20 kPa for 6 months. Figure (1) shows the result of tested samples treated with (3%, 6% and 9%) of cement dust. The unconfined compressive strength decreased with increasing organic content. While, for each percent of organic content the unconfined compressive strength increased with increasing the percentage of cement dust. The sample of the three groups show the same trend of behavior, but the sample of the second group (cured for 28 days) has values of unconfined compressive strength greater than that of samples of the first and third group.

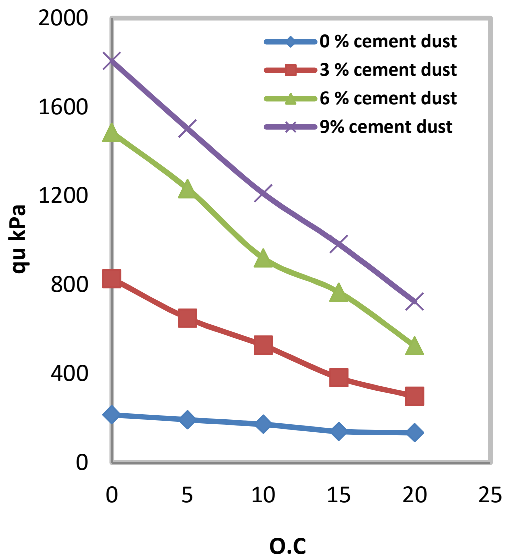
It was assumed that the samples of the third group exposed to the same natural condition that roads exposed to. This result pointed to main conclusion that the performance of soil stabilization should be determined according to the real natural conditions the soil was exposed to. We don't have definitive interpretation for this result. Figure (2) shows the results of tested samples treated with (3%, 6% and 9 %) of fly ash. The unconfined compressive strength decreased with increasing organic content up to 10% organic content, then the strength increased with increasing organic content. The behavior of samples is similar for the three groups. The increasing in strength beyond 10% organic content increased with increasing fly ash content and with increasing curing time. This result suggests that there is certain reaction between fly and soil particle will developed with time and it need longer time than that needed for cement dust to be completed. Comparing the strength gained from cement dust with that gained from fly ash, it can be concluded that using cement dust is better than using fly ash especially for soil containing organic content less than 10%.



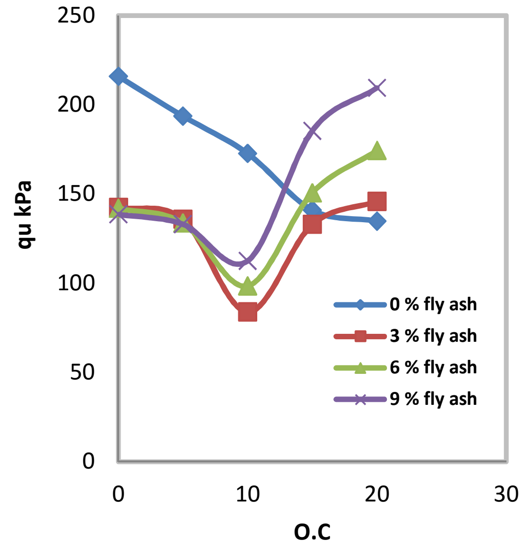
(a) 7 days curing



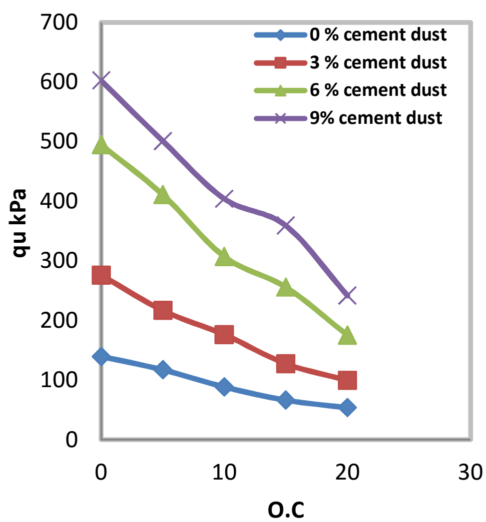
(a) 7 days curing



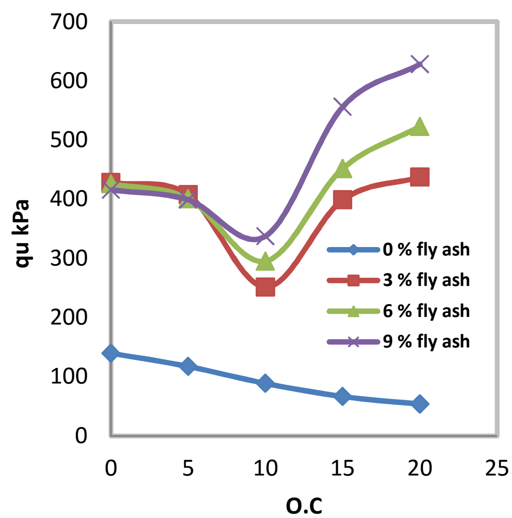
(b) 30 days curing



(b) 30 days curing



(c) Left for 6 months under 20 kPa stress



(c) left for 6 months under 20 kPa stress

Figure (1) variation of unconfined compressive strength with organic content at different percentage of cement dust

Figure (2) variation of unconfined compressive strength with organic content at different percentage of fly ash

4. Conclusion

From the results of testing program conducted in this study the following conclusion may be drawn:

1. Maximum dry density decreased and optimum water content increased with increasing organic content.
2. Maximum dry density decreased and optimum water content increased with increasing the percentage of cement dust and fly ash for each percentage of organic content.
3. The unconfined compressive strength decreased with increasing organic content.
4. For each percentage of organic content, the unconfined compressive strength increased with increasing the percentage of cement dust
5. The unconfined compressive strength decreased with increasing organic content up to 10 %, and then it was increased for samples treated by fly ash. Increasing the fly ash content will increase the unconfined compressive strength especially for sample having organic content greater than 10%.

5. Acknowledgments

The Authors would like to thank Al –Mustansiriyah University (www.uomustansiriya.edu.iq) Baghdad-Iraq for its support in the present work.

6. References

1. Abbas, A., Majeed, A. H., and Hassan, I. M., 1985, "Compaction and Strength of Slightly Organic Soil", Journal of Building Research Center, Vol.4, No.1, Iraq, PP. 1-19, May.
2. ASTM D 2166-06. (2006) "Standard test method for unconfined compressive strength of cohesive soil." Annual Book of ASTM Standards, West Conshohocken, PA, pp. 1-6.
3. ASTM D 2435 – 96. (2006), "Standard Test Method for One-Dimensional Consolidation Properties of Soils1" American Society for Testing and Matterials , 100 Barr Harbor Dr., West Conshohocken, PA 19428.
4. ASTM D 2487-06, (2006) "Standard practice for classification of soils for engineering purposes (unified soil classification system)." Annual Book of ASTM Standards, West Conshohocken, PA, pp. 1-12.
5. ASTM D 3080-72. (2006) "Standard test method for direct shear test of soils under consolidated drained conditions." Annual Book of ASTM Standards, Philadelphia, 0408, pp. 1-7.
6. ASTM D 698-78., (2006), "Test Method for Laboratory Compaction Characteristics of Soils" Annual Book of ASTM Standards, ASTM, Philadelphia, USA. vol. 04.08, pp. 69-76.
7. ASTM D 854-00 (2006), "Standard Test Method for Specific Gravity of Soils" Annual Book of ASTM Standards, ASTM, Philadelphia, USA. vol. 04.08; pp. 80-83.
8. ASTM D2974. (2006) "Standard test method for moisture content, ash and organic matter of peat and other organic soils." Annual Book of ASTM Standards, West Conshohocken, PA, pp. 33-37.
9. Boobathiraja S., Balamurugan P., Dhansheer M. and Adhikari A., 2014, "Study on Strength of Peat Soil Stabilised with Cement and Other Pozzolanic Materials" International Journal of Civil Engineering Research.ISSN 2278-3652Volume 5, Number 4, pp. 431-438.
10. BS 1377 (1975), "Methods of Test for Soil for Civil Engineering Purposes", British Standard Institute, London.
11. Habbi, Z. M., 2005, "Compressibility and shear strength characteristics of model organic soils", Master Thesis of Science in Civil Engineering, Al-Mustansiriyah University.
12. Kazemian S, Prasad A, Huat BBK, Bolouri BJ, Farah NAA, Thamer AM (2011c), effect of Aggressive pH Media on Peat Treated by Cement and Sodium Silicate Grout. J. Central South Univ. Technol., 17(3): 309-318.
13. Rabbee T., Rafizul I. M., 2012, "Strength and Compressibility Characteristics of Reconstituted Organic Soil at Khulna Region of Bangladesh", International Journal of Engineering and Technology Volume 2, No.10, October, pp.1672-1681.