Engineering Properties of Undisturbed Gypseous Soil Percolated by Olive Oil

Nada Sami Alwan[1] [1]Civil Engineering Department, College of Engineering, Tikrit University, Tikrit, Iraq.

Akram Hasan Abd[1*] [1]Civil Engineering Department, College of Engineering, Tikrit University, Tikrit, Iraq.
ahabd@tu.edu.iq

ABSTRACT

This study investigates the effect of olive oil percolation on the shear strength of undisturbed gypseous soil upon wetting. Three samples of soil were taken at depth 1.5m from different locations at Saladin province in Iraq: Tikrit city sample (S_1) with gypsum content 26.6%, Al Alam area sample (S_2) with 42.2% gypsum and Al Door area sample (S_3) with 61.7% Gypseous content. The main aim is to explore the effect a non-destructive additive that maintains the structure of gypsum soil and to check the possibility of forming water-resistant gypsum soil. Direct shear tests were conducted for four cases: semi dry soil in its natural water content (untreated), soil soaked in water, soil soaked in olive oil (treated), and finally the treated soil soaked in water after left in ambient temperature for 10 days (soaked in water after treated). One sample is left for 8 months to examine the long-term effect of oil. Results show that on average the soil cohesion is reduced by 70% when soaked in water, 20% when soaked in olive oil, and 35% when treated soil soaked in water. However, the angle of internal friction exhibits differently with less reduction of 4%, 6% and 15% respectively. For the samples that were treated and left for 8 months, soil cohesion and angle of internal friction were reduced by 24%, and 27% respectively.

Keywords: Gypseous soil, soil improvement, Olive oil, soil shear strength, undisturbed soil.

1. Introduction

Gypseous soil is one of the problematic soils that may cause considerable damage to related structures once water arrives. This type of soil is common in arid and semi-arid regions including Iraq as it covers approximately 28.6% from the soil of Iraq area (4). Gypseous soil is found in many formed - hydrated gypsum (CaSO4.2H2O) - Anhydrate gypsum (CaSO4)(5). Gypsum soils in the world are considered natural bases for foundations and structures and many problems occur for them as a result of gypsum solubility when exposed to moisture or water. The solubility accrues in pure water at (2.41) gm per liter (6). Gypsum soil in dry condition is well known of its high cohesion, shear resistance and compressive strength but exposing to water causes solubility of Sulfate salts, which result in problems in projects that constructed on this type of soils (7). The main problem of gypsum soil in Iraq when the water seeping and moving throw the soil could be causing serious cavities and rise in ground water table that lead to loss of shear strength and increased settlement (8) That sometimes lead to building cracks or collapses. Several

studies have been conducted to reduce the effect of water on gypsum and keep the properties of soil .Gypsum soils can be defined in civil engineering as the soil that contains a sufficient percentage of gypsum effect on the engineering properties of that soil, and it is generally defined as unsaturated soil with water exposed to decrease in volume when water reaches it due to the rearrangement of particles with or without additional loading. Several studies have been conducted to improvement the properties gypsum soil and increase shear strength and reduced permeability some of them (physical treatment) such as compaction and Addition of Cement(9) or replace the soil of site and (chemical test) by using additives such as Silicon oil(10), clinker additive(11) and Fuel oil (12)all treatment search to obtain good results with lower cost. In this study, the olive oil is poured on the undisturbed soil samples and tested for shear strength. This study differs in its technique avoiding mixing the gypsum soil consequently reduce its natural shear strength.

2: Materials and Sample preparation

Soil specimens used in this study were taken from three different places: Soil 1 (S_1) from Tikrit, Soil 2 (S_2) from Al-Alam and Soil 3 (S_3) from Al-Door, all located in Saladin government in Iraq. This means three different percentages of gypsum content (26.62% ,42.23% and 61.7%) respectively. The samples were prepared by cutting and trimming soil blocks into cuboid shapes with dimensions (6*6*2.5) cm.

3: Laboratory test

All tests (physical and chemical) were performed in labs of college engineering of Tikrit university. Tests includes water content, Atterberg limits, sieve analysis and direct shear. Table (1) show part of the laboratory results.

Table (1) laboratory test results

Properties		Soil 1 (S_1)	Soil 2 (S_2)	Soil 3 (S_3)
Gypsum content %		21.01	42.23	61.7
Specific gravity, (Gs)		2.43	2.49	2.53
Atterberg limits	Liquid limit (L.L) %	29.2	34.2	32.9
	Plastic limit (P.L) %	N.P	N.P	N.P
M.I.T Classification	Gravel	2.1	0.49	1.9
	Sand	90.12	93.93	94.4
Coefficient of uniformity (CU)		4.5	5.12	6.25
Coefficient of curvature (CC)		0.81	1.07	0.7
Unified Soil Classification		SP	SP	SP
Field unit weight, (γf) (kN/m^3)		13.45	14.34	14.89
Field moisture content, (ω)%		3.1	4	4.7
Total Soluble Salts (%)		29.35	44.72	65.31
pH value		7.81	7.86	7.86
Organic Matters (%)		0.09	0.16	0.11

3-1: Grain Size Distribution

The grain size distribution was performed according to (ASTM_D2484). All three soils where found to be poorly graded sand (SP) according to the Unified Soil Classification. Figure (1) shows the grain size distribution for the three soils.

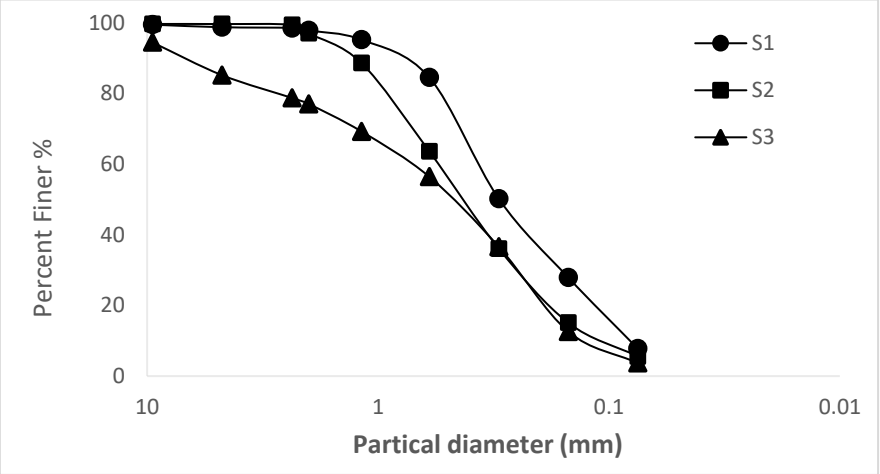

Figure (1) Grain size distribution

3-2: Direct shear test

The test was carried out using a direct shear device according to the specification (ASTM-D 3080-90). The shear strength is defined as the maximum shear resistance stress of the soil or the value of the shear stress affecting the length of the collapse plane at the time of the failure. The purpose of this test is to determine the two shear parameters, cohesion (c) and internal friction angle (ø).

4: Test program

This study includes undisturbed soil samples with three percentage of gypsum S_1 (Gypsum content=26.62%), S_2=42.23% and S_3=61.7%. Direct shear tests were conducted for four cases: semi dry soil in its natural water content (untreated), soil soaked in water, soil soaked in olive oil (treated), and finally the treated soil soaked in water after left in ambient temperature for 10 days (soaked in water after treated). One sample is left for 8 months to examine the long-term effect of oil.

5: Results and discussion

Direct shear tests were conducted for four cases of undisturbed samples: semi dry soil in its natural water content (untreated), soil soaked in water, soil soaked in olive oil (treated), and the treated soil soaked in water after left in ambient temperature for 10 days (soaked in water after treatment). Results in figures (5-2) to (5-5) show that on average the soil cohesion is reduced by 70% when soaked in water, 20% when soaked in olive oil, and 35% when the treated soil soaked in water. However, the angle of internal friction exhibits differently with less reduction of 4%, 6% and 15% respectively. For the samples that were treated and left for 8 months, soil cohesion and angle of internal friction were reduced by 24%, and 27% respectively.

The value of cohesion reduced when soaked dry sample in water because solubility and softening gypseous in soil. Considerable reduction in shear strength parameters is noticed for Soil (S_3) when soaked in water because of high gypsum content. For treated soils in oil for 10 days and then soaked in water, the soil cohesion is reduced by 26% for $soil_1$, 30% $soil_2$ and 33% $soil_3$. Better results is noticed for the 8 month treated soil which provide reduction of 19%, 23%, and 30% respectively. The angle of internal friction is reduced when the soil is soaked in water by 6%, 3%, and 5% for S_1, S_2, and S_3 respectively. These percentages increased to 11%,5%, and 12% respectively when treated in oil for 10 days, and increased to 17%, 27%, and 36% respectively when treated for 8 months.

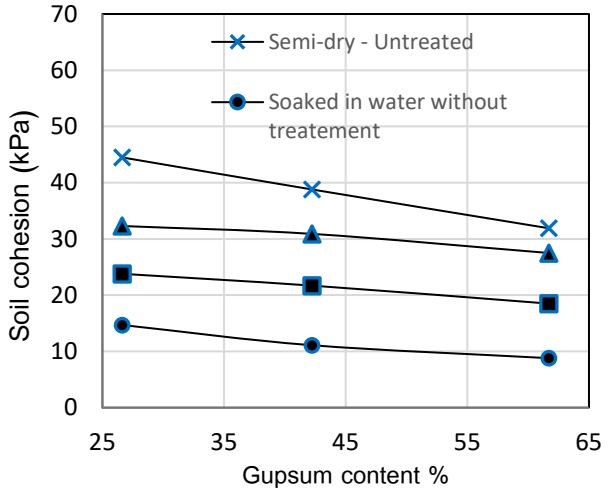

Figure (3-2) Relationship between cohesion and gypsum content for soil treated and left 10 days before tested.

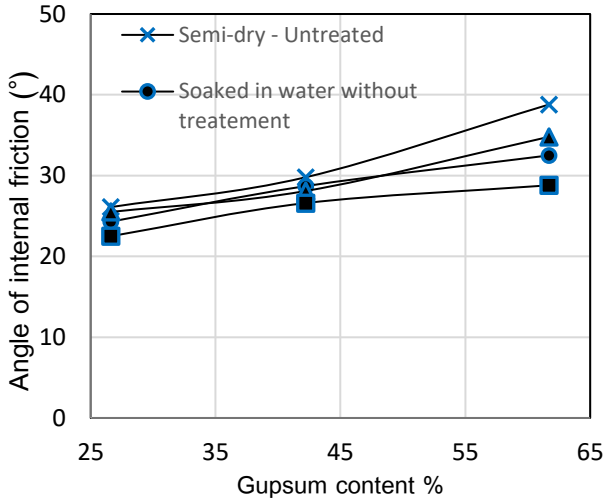

Figure (3-3) Relationship between angle of internal friction and gypsum content for soil treated and left 10 days before tested.

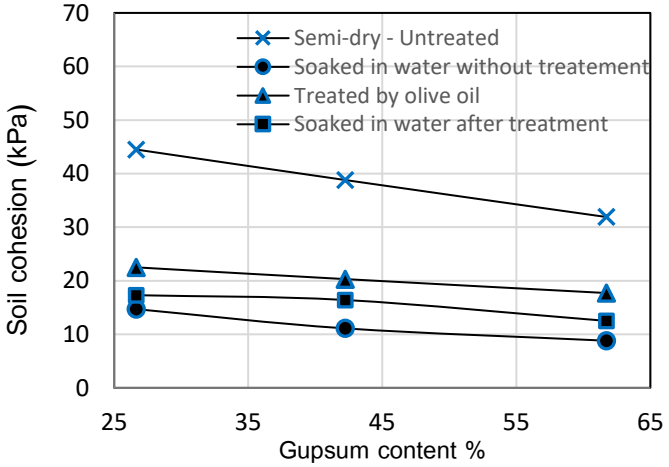

Figure (3-4) Relationship between cohesion and gypsum content for soil treated and left 8 months before tested

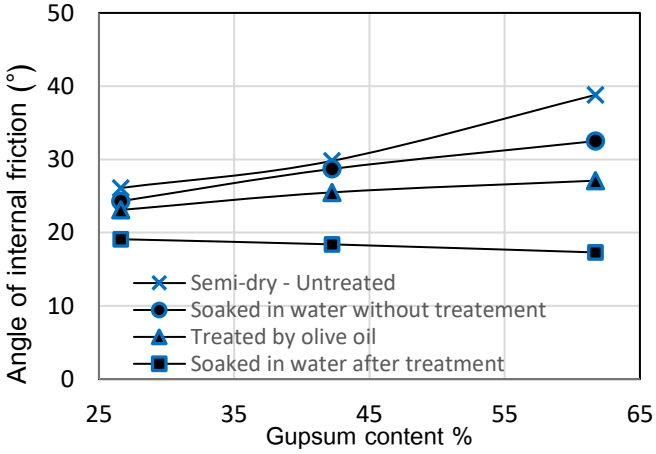

Figure (3-5) Relationship between angle of internal friction and gypsum content for soil treated and left 8 months before tested.

7: Conclusion

Direct shear tests have been conducted on undisturbed gypseous soil samples and their results have been presented and analyzed to reach the following conclusions:

- On average the soil cohesion is reduced by 70% when soaked in water, 20% when soaked in olive oil, and 35% when treated soil soaked in water.
- The angle of internal friction exhibits differently with less reduction of 4%, 6% and 15% respectively.
- For the samples that were treated and left for 8 months, soil cohesion and angle of internal friction were reduced by 24%, and 27% respectively.
- Oil treatment can be provide good improvement to soil cohesion but it can be have slight negative effect on the angle of internal friction.

Reference:

1. Jafarzadeh AA, Zinck JA. Worldwide distribution and sustainable management of soil with gypsum. 2000. ISD Ana sayfasi. FAO (1990), "Management of Gypsiferous Soils", Soils Bulletine,

2. No.62, FAO, Rome, Italy.
3. Al-Kaabi, F.S., (2007), "Distribution of the Gypsiferous Soil in Iraq".State Company of Geological Survey and Minning", Report No. 3044,
4. Iraq, Baghdad, (in Arabic).
5. Buringh P. 1960. Soils and soil conditions in Iraq. Ministry of Agriculture . Baghdad. Iraq
6. Al_Saudi,N.K.S,,Al_Khafaji,A.N.,&Al_Mosawi,M J(2013,September).Challenging
7. Problems of gypseous soils in Iraq.In Proceedings of the 18 the International Conference on soil Mechanics and Geotechnical Enginerring(pp.479_482)
8. Al-Deffaee, A. H., (2002), "The Effect of Cement and Asphalt Emulsion Mixture on the Engineering Properties of Gypseous Soils", M.Sc. Thesis, Department of Civil Engineering, Al-Mustansiriya University.
9. Robert, C.W., (1974). "Handbook of Chemistry and Physics", 54th Ed.,CRC-Press Co., Ohio.
10. Nashat, I. H., (1990). "Engineering Characteristics of Some Gypseous Soils in Iraq", Ph.D. Thesis, Civil Engineering Department, University of Baghdad, Baghdad,Iraq.
11. Improvement of Gypseous Soil by Compaction and Addition of Cement Safa Hussain Abid Awn ,Waad Abd-Alsattar and Hassan Obaid Abbas University of Dyala Journal of Engineering and Development, Vol. 16, No.2, June 2012 ISSN 1813- 7822
12. Ali Nasir Ibrahim, -Gypseous Soil Improvement by Silicone Oil Geotechnical Engineering College of Engineering Al-Iraqia University Baghdad, Iraq, Vol 20 No 1 (2017): AlNahrain Jouranl for Engineering Sciences
13. Al-Neami, Mohammed A. Mahmoud. "Improvement of gypseous soil by clinker additive." Eng. & Tech. Journal 28.19 (2010)
14. Hussein Yousif Aziz, Jianlin Ma, Gypseous Soil Improvement using Fuel Oil, International Journal of Civil, Environmental, Structural, Construction and Architectural Engineering Vol:5, No:3, 2011