EFFECT OF ADDITIVE SOILS ON SOME GEOTECHNICAL PROPERTIES OF GYPSEOUS SOIL

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Abstract - The Gypseous soil disturbed in Iraq and many countries of the world. There many problems can be occurred to the structures that built on, so the properties of this type of soils must study and improve it. This research deals with the effect of adding soils on some geotechnical properties of gypseous soil. The investigation includes evaluation of properties such as compaction, consistency limits and strength of the gypseous soil after mixing with soils: (SM) and (ML) namely 5%, 10% ,15%,50%,85%,90% and 95% by weight of the dry gypseous soil. The results obtained show that the maximum dry density (γd) increase at 85% of (SM) mixing with gypseous soil while for (ML) soil no significant change on it. It was also observed that mixing two types of soils with gypseous soil, reduce plasticity index. On the other hand, added (SM) soil increase the cohesion (c) of gypseous soil and for soil (ML) added to gypseouse soil the height value for cohesion is obtained at 85% .

keywords: Gypseous soil, Geotechnical properties, Compaction, Consistency limits ,Strength.

1 INTRODUCTION

Gypseous soil is a soil which has enough gypsum content to change or affect its engineering properties, gypsum is a mineral salt represented by Hydrated Calcium Sulphate (CaSO4.2H2O) [1]. The presence of gypsum in soil as bond agent alters its behavior, in other words, there is a large influence of gypsum on the physical and mechanical properties of soil. This influence depends mainly on the amount and type of gypsum presented in the soil [2].

Gypseous soil found in many regions in world and its one of the problematic soils. Therefore, it is necessary to study the geotechnical properties of such soils and improving these properties due to the large damages that affect the structures constructed on or in it [3].

A method to reduce magnitude of damage caused to the structure is excavate and replacement of some part or the whole of the soil foundation [4]. Also several methods are applied to improve the soil. Soil Mixing is a soil improvement technology used to treat soils in situ to improve strength and reduce compressibility. The use of soil mixing methods for the construction of excavation support systems is often the method of choice based on design requirements, site conditions/restraints and economics. The use of soil mixing for providing stabilization to soils is considered a fairly new technology [5]. Numerous studies on improve the gypseous soil are available with used many materials such as Cement , lime, oil, ect. [2, 6,7]. In this study the effect of adding soils on compaction, consistency limits and shear strength characteristics of Gypseous soil is investigated.

2 MATERIALS AND METHODS

The soils have been used for this study are:
Gypseous soil (SP)
Silty sand soil (SM)
Sandy silt low plasticity soil (ML)

The gypseous soil sample used for this study was bring from Tikrit city (180 km north of Baghdad), Iraq and the other two types of soils collected from engineering campus, USM, Malaysia by using the method of disturbed sampling. All soil sieved through 4.75mm aperture before use. The preliminary tests for identification of the soils (results shown in Table 1) as well as the tests for determination of the geotechnical properties of the soils were carried out in accordance with BS1377[8].

The standard Proctor was used for compaction test which used to determine the maximum dry density for the soil mixture. Investigation has been done at the mixing of various concentrations of Silty sand (SM) soil and Sandy silt low plasticity (ML) soil with dry gypseous soil under idealized laboratory conditions. After that the tests were conducted on the soils mixture.

TABLE (1) PROPERTIES OF SOILS USED IN THIS STUDY

Properties	Gypseous soil (SP)	SM soil	ML soil
pH	8.08	5.22	3.37
Gs %	2.4	2.65	2.5
L.L %	32.375	45.7	46.5
P.L %	NP	36.36	37.29
P.I %	32.375	9.34	9.21
γ_d (g/cm^3)	1.792	1.726	1.48
MC opt. %	10.0	17.5	21.3
c (kPa)	20.42	30.36	42.10
Φ (°)	51.20	47.90	26.22

3 RESULTS AND DISCUSSIONS

3.1 Compaction characteristics

Fig. 1 shows the relationship between the maximum dry density (γd) and soil additive contents for two soils added to Gypseous soil. The results indicated that for low percentage of soils additive the (γd) decrease. The reduction may be attributed to the change of particles size in the mixture which has relatively lower specific gravity compared to that of the original soil then for (SM) soil, the maximum dry density(γd) increase at 85%. The rise in (γd) that means addition of percentage of (SM) soil causes the soil to behave like a fine material and consequently increasing the density. While for (ML) soil no significant change on the (γd) after 15%.

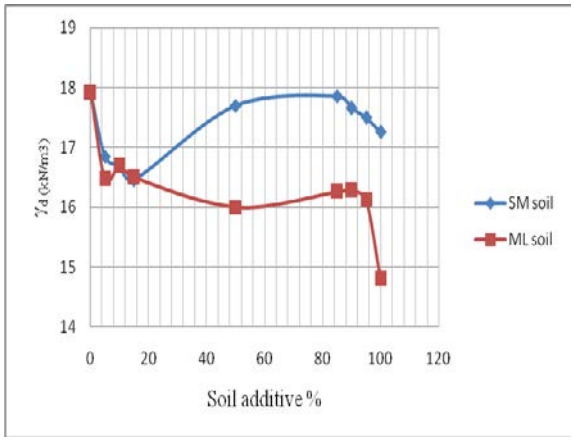
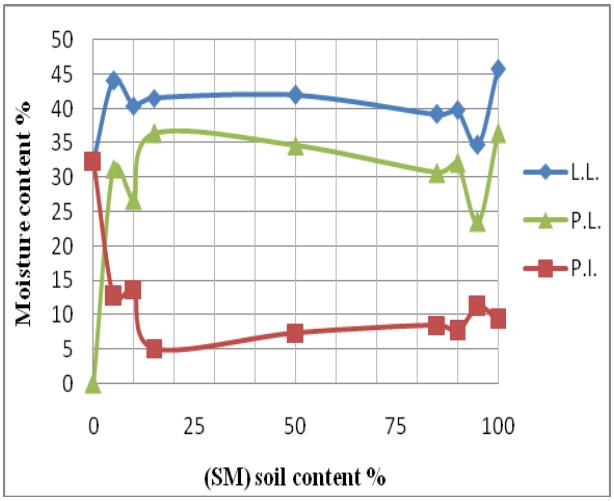


FIGURE 1. VARIATION OF COMPACTION CHARACTERISTICS FOR MIXED SOILS

3.2 Consistency limits

Variation of Liquid Limit, plastic limit and plasticity index for different (SM and ML) soil content added to gypseous soil is shown in Fig. 2. It can be seen that liquid and plastic limit increased with increasing in additive soils while the plasticity index is decreasing. This can be considered to be as a result of the replacement of the soil fines by additive soils , causing decreasing in water content of mixture of soils.



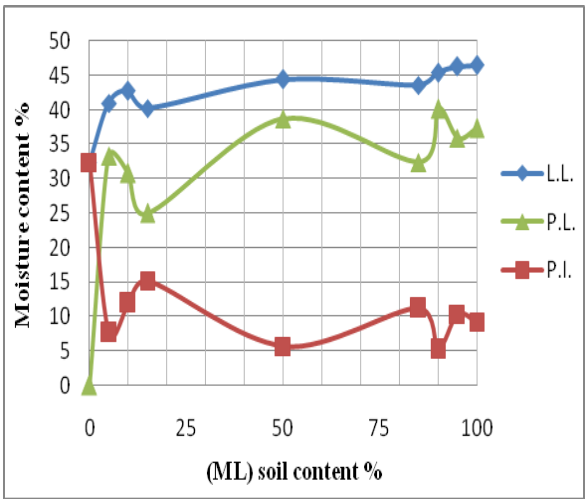


FIGURE 2. VARIATION OF PLASTIC BEHAVIOR OF GYPSEOUS SOIL WITH (SM AND ML) SOIL CONTENT

3.3 Strength characteristics

Table (2) and Table (3) show the values of cohesion (c) and angle of internal fiction (ϕ) for different percentages of soils (SM and ML) mixed with gypseous soil. The result shows that added 5% or 15% percent of (SM) soil decrease the cohesion (c) of gypseous soil while when added 50% and above values of (c) increase and (ϕ) decreased. The reason for decrease in cohesion because the (SM) soil content coarse particle (sand) and gypseous soil (SP) also have more coarse particle so the mixture become not homogeneous. For soil (ML) added to gypseouse soil the height value for cohesion at 85%, this increment may be because the interaction between the coarse and fine particles affects the behavior of the mixture of soils[9].

Table (2) Results of c and ϕ for soil (SM) mixed with Gypseous soil

% of (SM) soil from Dry weight of Gypseous soil	C (kPa)	ϕ (°)
0%	20.42	51.20
5%	18.04	40.18
10	31.91	34.84
15	12.05	35.93
50	25.49	34.77
85	35.89	45.73
90	34.27	38.95
95	33.08	50.50
100%	30.36	47.90

Table (3) Results of c and ϕ for soil (ML) mixed with Gypseous soil

% of (ML) soil from Dry weight of Gypseous soil	C (kPa)	ϕ (°)
0%	20.42	51.20
5%	15.04	42.71
10	16.90	40.42
15	16.90	40.89
50	27.01	37.45
85	44.30	38.04
90	34.52	47.24
95	36.43	59.79
100%	42.10	26.22

CONCLUSIONS

The following conclusions may be drawn from the study:

1- (SM) soil increased the maximum dry density (γ_d) but (ML) soil no significant change on the (γ_d) .
2- The increase in (SM) and (ML) content decreased the plasticity index of gypseos soil.
3- The mixing of (ML) soil to gypseous soil improved the strength.
4- 85% (ML) content was observed to be the optimum content.

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