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Collapsibility and Compressibility of Gypseous Soils

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Abstract: Gypseous soils are disturbed in many regions in world. It is necessary to study the properties of such soils due the damage caused by these soils to building on or in it. This paper presents the results of experimental studies on the compressibility and collapsibility of Gypseous soil and show the effect of mixing other soils with Gypseous soil on those properties. Three types of soils: Gypseous, (SM) and (ML) soils are used in this study. Seven percentages of (SM) and (ML) soils namely: (5%, 10%, 15%, 50%, 85%, 90% and 95%) from dry weight of Gypseous soil were mixed. A series of Odeometer tests under maximum dry density and optimum moisture content were performed and the collapse potential (CP) evaluated. The relationships between compression index (Cc) and percentages of (SM) soil and (ML) soil in mixture soils investigated were established. Results of the study showed that the soils and mixture from soils are classified as a slightly problematic in term of collapsibility. The collapse potential (CP) of the gypseous soil decrease when added (SM) soil but the high value at 50%, while for (ML) soil the height value for (CP) at 10%. The compression index of the gypseous soil increases with added (SM) soil, after that when the content of (SM) increases the (Cc) value decreases. For (ML) soil, the value of compression index has small value at 50%.

Key words: Gypseous Soil, Collapsibility, Compressibility, (SM) soil, (ML) soil

INTRODUCTION

Gypseous soils are disturbed in many regions in world especially in arid and semi-arid regions, where the annual quantity of rainwater is insufficient for leaching the gypsum form these soils, (Al-Emami, 2007).

Gypseous soil are soils which has enough gypsum content to change or affect its engineering properties. Gypsum is a mineral salt commonly known as Hydrated Calcium Sulphate (CaSO4.2H2O), Ahmad *et al*. (2012). The soil is strong when it was dry but loses its strength when exposed to water causing collapse and distortions. Many attempts (laboratory and field investigations) have been made to understand the behavior and the characteristics of these soils cause problem observed when construction on it (Abid Awn , 2010; Mansour *et al*. 2008 ; AlNouri and Saleam,1994).

Collapsible soil is defined as any unsaturated soil that goes through a radical rearrangement of particles associated with great loss of volume upon wetting with or without additional loading, (AYadat, T. and hnna, 2005).

The main objective of this study is to investigate the collapsibility and compressibility characteristics of gypseous soil and effect of mixing other soils with gypseous soil on those properties.

Experimental Investigation:

The soils used in this study were relatively disturbed samples gypseous soil (SP), (SM) soil and (ML) soil the first one obtained from IRAQ and two other from MALAYSIA . All the soil were sieved through 4.75mm aperture before use. Preliminary tests for identification of the soils (results shown in Table (1)) as well as other investigations for determination of the properties of the soils were carried out in accordance with BS1377-1990 .

Laboratory investigation were conducted done at the mixing of various concentrations of (SM) and (ML) soils i.e: 5%, 10%, 15%, 50%, 85%, 90% and 95% by dry weight of Gypeous soil separately. After that the tests were conducted on the soils mixture respectively in order to determine its compressibility and collapsibility properties.

Testing Program:

Collapse Tests also called single oedometer collapse test was suggested by Knight (1963). The test was performed similar to the standard consolidation test except that the sample loaded to 200 kPa then inundated and the strain reading was taken after 24 hours. Jennings and Knight (1975) defined the collapse potential (CP) as:

$$CP = \frac{\Delta e}{1 + e_o} * 100\% \quad (1)$$

where:

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Δe = change in void ratio due to wetting under a pressure of 200 kPa.
e_o = natural void ratio.

They gave the following values of (CP) as expectation of collapsing, as shown in Table (1).

Table 1: The severity of collapse potential at 200kPa stress level after (Jennings and Knight (1975))

Collapse Potential (%)	Severity Of Problem
0	No problem
0.1-2	slight
2.1-6	moderate
6.1-10	Moderately severe
>10	severe

Standard Consolidation Tests these tests were conducted according to ASTM Test Method (ASTM, 2010) for One-Dimensional Consolidation Properties of Soils (D 2435-80) using a front loading consolidation apparatus.

Discussion of Test Results:

Classification Tests:

The summary of the results of preliminary tests for the soils samples are given in Table 2.

Table 2: Summarized Characteristics of the Soil Samples used

Soil properties	Gypseous soil (SP)	(SM) soil	(ML) soil
Mechanical analysis (%)			
Gravel (> 2mm)	7.819	3.06	0
Sand (2-0.06mm)	90.492	52.07	18.14
Silt (<63µm)	1.689	44.87	81.86
Physical:			
Liquid Limit (%)	31.96	40.8	46.26
Plastic Limit (%)	NP	35.836	36.9
Plasticity index	31.96	4.96	9.36
Max. Dry density (gm/cm^3)	1.792	1.726	1.48
Optimum Moist Content (%)	10	17.5	21.3
Specific gravity	2.4	2.65	2.5

4.2 Collapsibility test:

Figure (1) and Figure (2) show the result of CP with percentage of (SM) and (ML) soils mixing with gypseous soil respectively. From the results shown in Figures and according to Table (1) the soils could be classified as a slightly problematic soil in term of collapsibility. The height value for (CP) at 50% (SM) mixed with gypseous soil and the value reduced with increase percentage of (SM) content. While for (ML) soil the height value at 10% (ML) mixed with gypseous soil and the lower value at 90% and 95% (ML) content. That may be because the fine particle fills the void in gypseous soil.

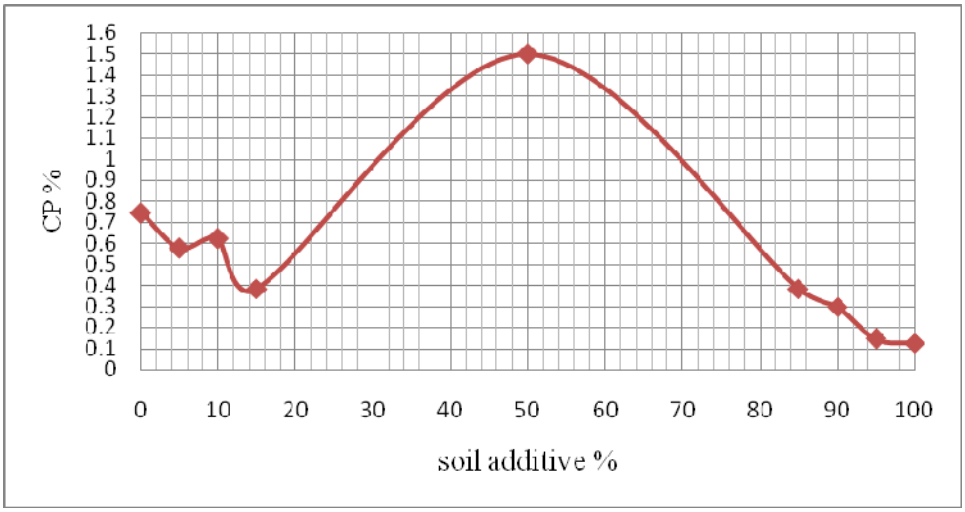

Fig. 1: variation (SM) soil content with collapse potential (CP) for mixture soil.

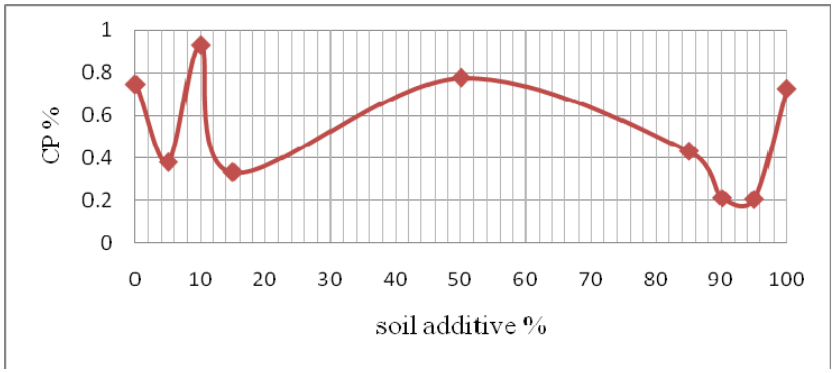

Fig. 2: variation (ML) soil content with collapse potential (CP) for mixture soil.

4.3 Compressibility Test:

Figure (3) shows the effects of increasing (SM) soil content on the compression index (Cc) of gypseous soil. The results show that increase (Cc) when added small percentage of (SM) and the (Cc) decrease when (SM) soil content become high especially at 95%, that means increase (SM) soil reduced the compressibility cause fine particles occupy the voids between coarse particles.

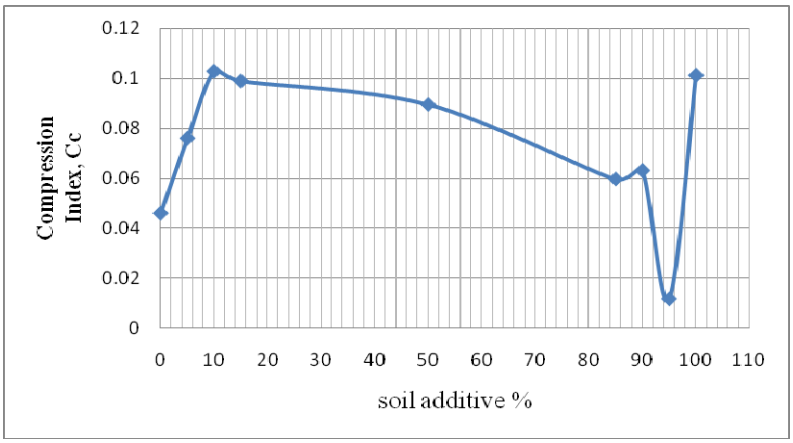

Fig. 3: variation (SM) soil content with compression index (Cc) for mixture soil.

Figure (4) shows effect of increase (ML) soil content on the (Cc) of gypseous soil. From this figure, it can be observed when increasing (ML) soil, increase the Cc value but reduce at 50% .

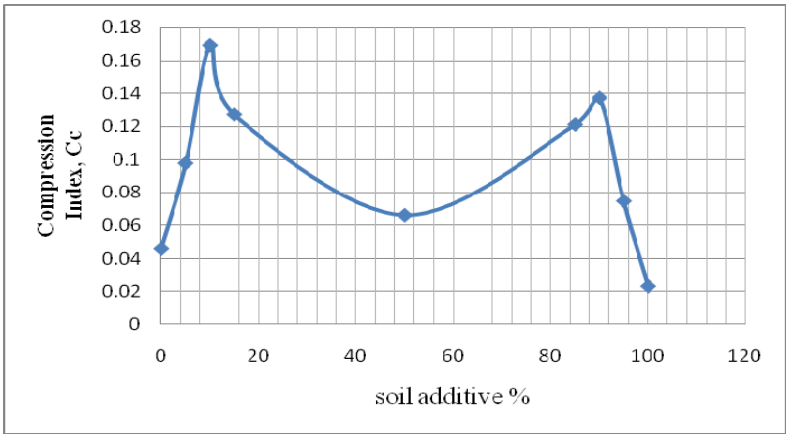

Fig. 4: variation (ML) soil content with compression index (Cc) for mixture soil.

Conclusions:

From the results of experimental investigations carried out on the evaluation of compressibility and collapsibility of Gypseous soils, the following conclusions are drawn:

- In term of collapsibility, the soil is classified as a slightly problematic soil.
- The height value for collapse potential (CP) at 50% (SM) mixed with gypseous soil and the value reduced with increase percentage of (SM) content.
- For (ML) soil the height value for (CP) at 10% mixed with gypseous soil and the lower value at 90% and 95% (ML) content.
- collapsibility for (ML) soil less than (SM) soil
- When added (SM) soil to gypseous soil the compression index increases after that when the content of (SM) increase the (Cc) value decreases, the lower value at 95% .
- For (ML) soil, the value of compression index increases with increasing (ML) content and the value of (Cc) decreases at 50%.

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