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Behavior of compacted gypsiferous sandy Soil during soaking and leaching process

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تصرف التربة الجبسية الرملية المحدولة أثناء غمرها وغسلها بالماء

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الخلاصة:
لدراسة سلوك التربة الجبسية الرملية المجدولة خلال عملية الغمر والغسل بالماء تم اختيار تربة من احد مواقع بعقوبة خالية من الجبس. خلطت بنسب معينة من الجبس وهي ١٠ % ،٢٠%،٣٠%،٤٠% ، لقد أشارت التجارب المنفذة باستخدام فحص بروكتر القياسي أن الكثافة الجافة العظمى تقل بزيادة المحتوى الجبسي وأما المحتوى المائي الأمثل فيقل قليلا في بادئ الأمر ثم يزداد ليصل إلى قيمة ١٨.٤% ثم يقل بزيادة المحتوى الجبسي كذلك بينت التجارب التي أجريت لحساب الهبوط في التربة ان الهبوط الحاصل في التربة نتيجة الانغمار هو أكثر بكثير من الهبوط الحاصل بسبب الغسل وإن نسبة الهبوط \عرض الأساس تعتبر عالية ومن هنا تكمن خطورة التربة الجبسية .

الكلمات الدالة : تربة جبسية ، إغمار ، غسل .

Abstract:

To study the behavior of compacted gypsiferous sandy soil during soaking and leaching process , samples were selected from a site at Baquba city .Soil has no gypsum, mixed with different amounts of gypsum (10%,20%,30% and 40%).

Experiments which are carried out on this soil ,indicated that by using of standard Proctor test, the maximum dry density decreased with the increase gypsum content and optimum moisture content decreased slightly initially and then increase until reached 18.4% and then decreased with increasing gypsum content .

As expected, increasing gypsum content increase the settlement recorded during soaking and leaching process .The settlement obtained by soaking gypsiferous soil is more than that obtained by leaching process .

Key words: gypsiferous soil,soaking ,leaching

Introduction:

Pure gypsum is calcium sulfate formed through geological ages of chemical reaction of some components limestone and acid sulfate in the form of blocks or layers depending on the spread of these materials on site [11] .The most important methods of spreading this salt are wind .Wind works to transfer fine gypsum from one site to another, may move away tens or hundreds of kilometers depending on the size of particles and severity of the wind .The water could be considered as the most important means of spread and distribution of gypsum between layers of soil due to a property that is characterized by .

Due to the structural problems related to construction on gypseous soil, many studies were carried out to understand the soil behavior after soaking with water .The most studies indicated that the gypseos soils lose a great deal of resistance and increase of collapsibility after exposure to water, especially when water flows .Collapsibility increases initially and then decreases with time [4].

Bjerrum[6] ascribed the reduction of undrained shear strength upon leaching to the increase of the pore water pressure coefficient (AF). The leached soil shows an unstable structure with high sensitivity and high compressibility. It is therefore, likely that shear stress will cause a "Partial collapse" of the structure, resulting into high pore pressures.

It is clear that the bonding strength derived from the presence of gypsum can easily be lost by wetting or leaching and this is major implications for engineering works[2]. Al-Layla and Al-Obydi [3]showed that , for high gypsiferous soil, the maximum dry density was slightly affected by the change in gypsum content while the optimum moisture content decreased with increase in gypsum content. Al-Dilaimy[12] obtained from experimental tests on compacted clay mixed with different percentages of gypsum content that the increasing of gypsum content increase the optimum moisture content ,while the maximum dry density increased to a peak value at gypsum content 5%, then decreased with further increase in gypsum content . Kattab[8] , found that the maximum dry density of a granular soil increased with the percent of gypsum content up to 15% after which the density decreased .

Al-Ani et.al. [1] concluded that the maximum dry density and optimum moisture content decreased with the increase in gypsum content. Razouki et.al. [10] showed that the increase of compactive effort from standard to modified Proctor causes a significant increase in the cohesion of gypsiferous soil.

Al-Shakarchi et.al. [9] showed that the gypseous soil with low gypsum content (14.8 %) exhibited significant decreased (5.21 % at 24 hours to 7.16 % at 60 days) in collapse potential with time .

Karakush et.al[7] showed that the gypseous soil sample exhibited significant amount of leaching strain , which is larger than the initial settlement and has no definite endpoint upon the continuation of gypsum dissolution and leaching from a soil sample .

The behavior of gypseous soil is considered too complex, therefore ; the present study may make a simple addition to the required knowledge in this area. It is important to know the behavior of compacted gypsiferous soil during soaking and leaching, therefore; this study is to highlight the different percentages of gypsum content soil that it could exhibit collapsing, leaching and to propose an approach for more accurate evaluation of this phenomenon in the light of the published researches .

Soil properties and methods of testing :

This study relied on soil samples free of gypsum taken from a site at Baquba city, the result of grain size distribution showed that the soil contains 21.22 % gravel , 76.15% sand and 2.63 % silt with clay as shown in fig. 2. The soil can not be tested Atterberg limits because it does not contain plasticity , therefore the soil is classified as a sandy soil poorly graded (SP) according to the USCS.

To study the effect of gypsum content on soil compaction different are added percentages (10% ,20%, 30% and 40 %) of the weight of dry soil . To achieve this, we prepare adequate amounts of soil and gypsum proportions and then mixed thoroughly after spraying small amounts of water and then placed in special sack until testing. By using standard Proctor test, we find the relationship between water content and dry density.

After known the maximum dry density and optimum moisture content for all gypsum content samples, four samples of the same dry density and water content were obtained.

We prepare a plastic container with diameter 27 cm and depth 30 cm which is used to compact gypsiferous soil to a maximum density and optimum moisture content .The container has three openings to control water drainage during leaching. The gypsiferous soil is poured into the container in three layers and compacted using the standard Proctor tamper. Eventually the thickness of gypsiferous soil is about 20 cm .The plastic container with gypsiferous soil prepared into it is placed near a large steel table, the steel loading frame is fixed and the dial gauge is attached to the table as shown in fig.1.A small steel plate having dimensions 4x4 cm is placed on the surface of the gypsiferous soil, this plate represents the footing. The loading frame is placed on the steel footing with weights attached on it as to support a pressure of 53 kPa. . The dial gauge is leveled to an initial reading representing the zero point, and readings settlement are recorded. Settlement readings are recorded for a approximately one week, dry stage one day ,soaking stage one day, and leaching stage five days .

Results and discussion :

The result showed that for soil sample free of gypsum, dry density increases with increasing water content until it reaches the highest value 17.7 kN/m^3 , and optimum moisture content 14.5 % , then decreases as shown in fig. 3. For the sample of 10 % gypsum content, we observed the same behavior of sample free of gypsum but after reaching the maximum dry density begins slightly decreases as shown in fig.4. Sample of 20 % gypsum content, we noted that the dry density initially deceases until reaches 13.8 kN/m^3 , and then increases with the increasing water content as shown in fig. 5 .

As for the sample of 30% gypsum content we note the same behavior for free of gypsum soil but it reaches to less maximum dry density and more optimum moisture content as shown in fig. 6, and for sample of 40 % gypsum content , we note that the dry density increases slowly at first until it reaches the highest value 15.5 kN/m^3, and then decreases as shown in fig.7 .

It's noted generally that the maximum dry density decreases with increasing gypsum content as shown in fig. 8, while the optimum moisture content increases slightly at first, then decreases with increasing gypsum content as shown in fig. 9 .This behavior may attributed to the particles of gypsum that are filling the spaces between the soil particles at first and increasing the density.When gypsum is presence in large quantities in soil serves to reduce the particle of soil in unit volume . Gypsum has low specific gravity; therefore a clear drop is noted in maximum dry density. The continuous increase in value of optimum moisture content is due to the increased surface area of the gypsiferous soil and, therefore shows the need for more water.

The results of settlement during three stages for all gypsum contents are shown in fig.10 to fig. 13. It is quite clearly that the settlement obtained when footing is flooded with water, for all models, it is high during soaking stage and begins to decrease during leaching process .All curves have quite similar trend and do go approximately parallel .It can be said that finally settlement stops, having (settlement to the width of footing), s/b (0.1,0.12,0.16,0.18) for (10%,20%,30%,40%) gypsiferous soil models respectively. We noticed that this percent (s/b) increases with increase of gypsum content. It is worthy to mention that these types of settlement are almost considered as instantaneous, so they cause more distress to structure than consolidation settlement even of they were of the same magnitude since consolidation settlement occurs gradually through many years, at that time interval, the structure redistribute or readjust the resulting stress unlike the collapse, settlement which leaves no time for building to do so .

Fig. (1) : Loading frame and settlement control

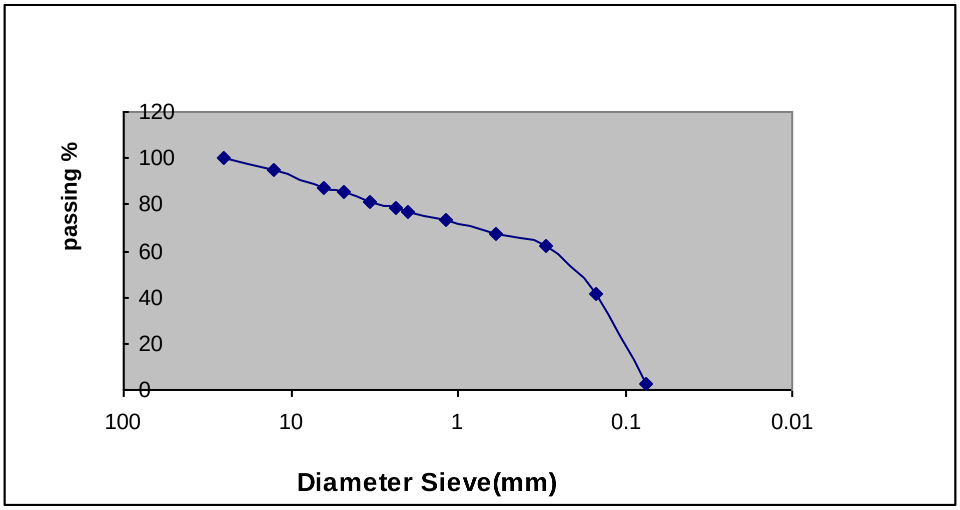

Fig. (2) : Relationship between Diameter and percent passing of soil

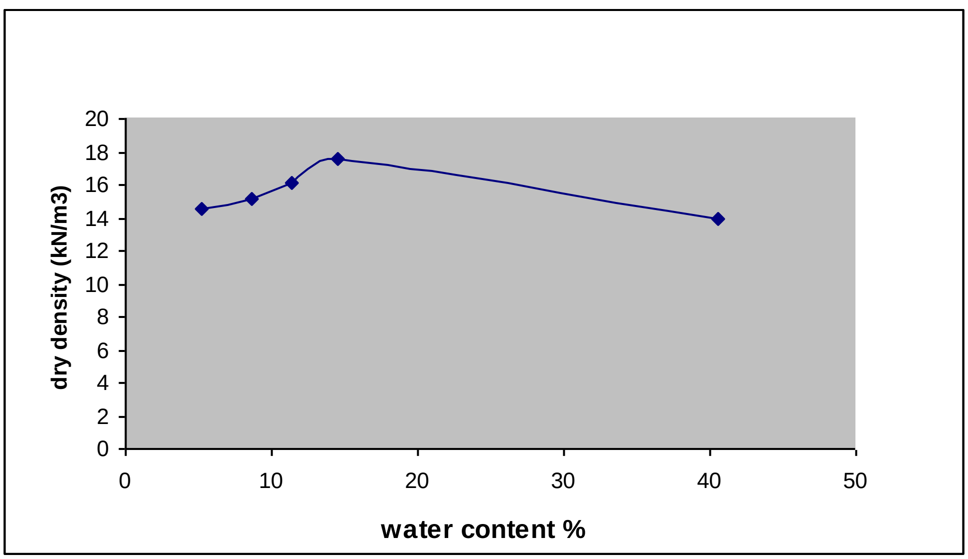

Fig. (3) : Relationship between water content and dry density for natural soil

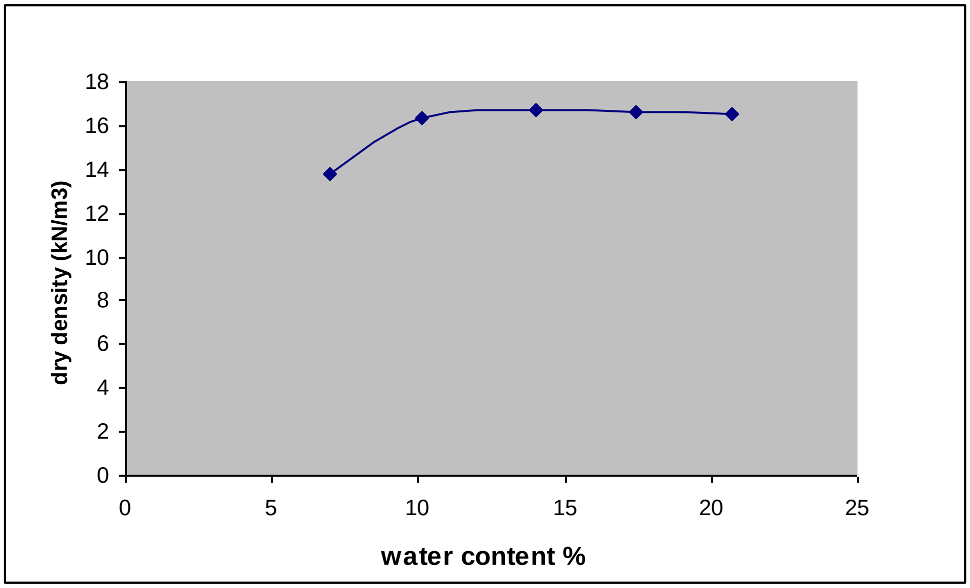

Fig. (4) : Relationship between water content and dry density for soil with 10%gypsum content.

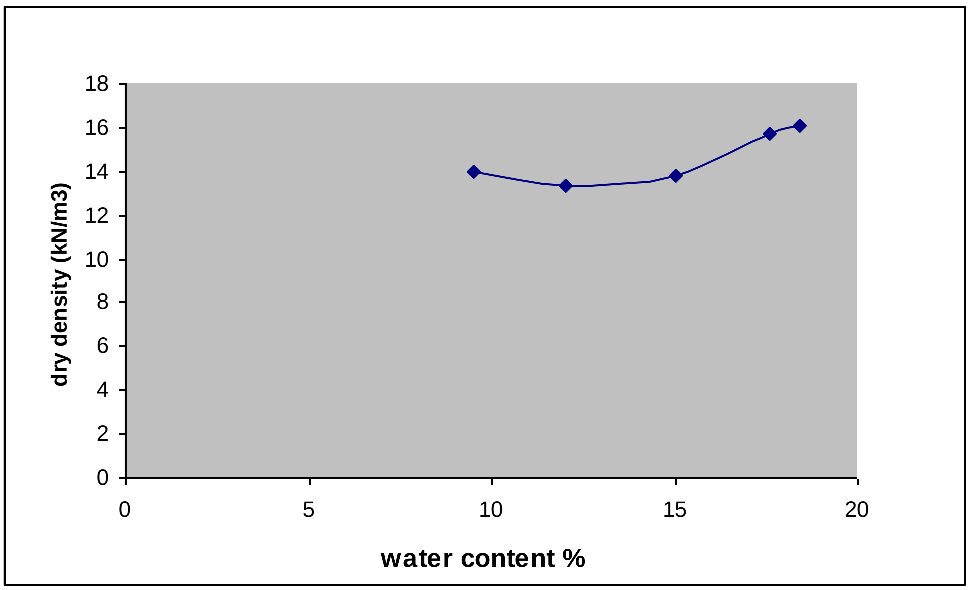

Fig. (5) : Relationship between water content and dry density for soil with 20%gypsum content.

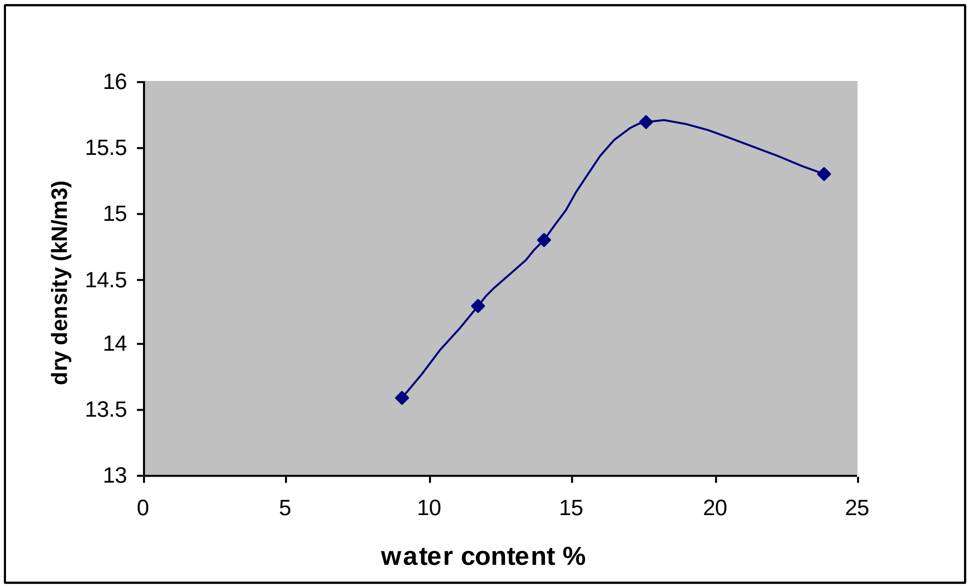

Fig. (6) : Relationship between water content and dry density for soil with 30%gypsum content.

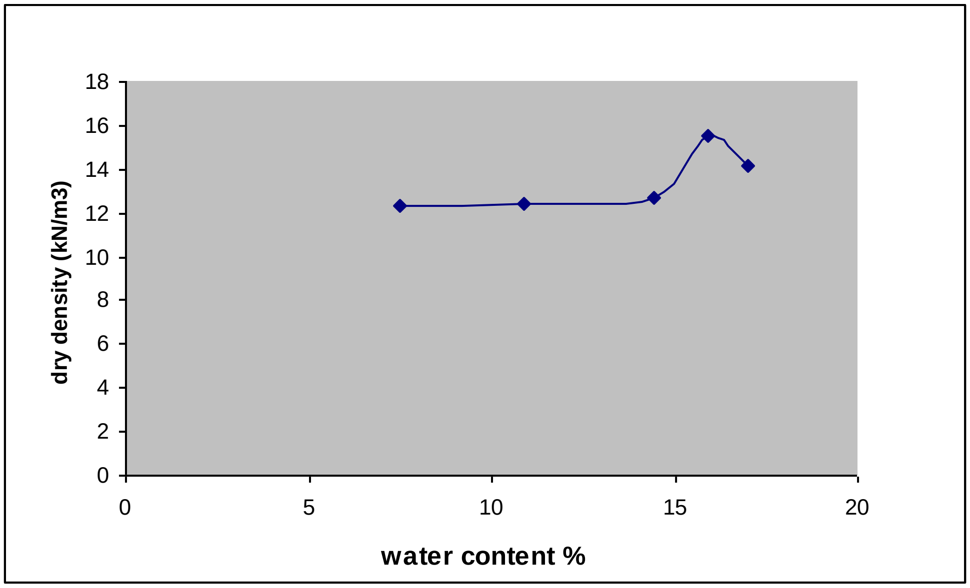

Fig. (7) : Relationship between water content and dry density for soil with 40%gypsum content.

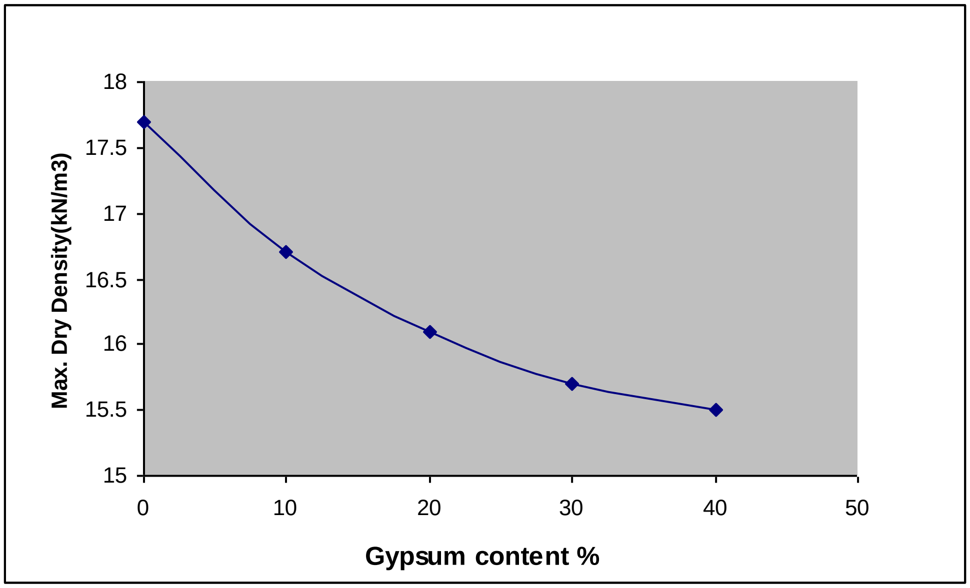

Fig. (8) : Relationship between Gypsum content and max. dry density of soil .

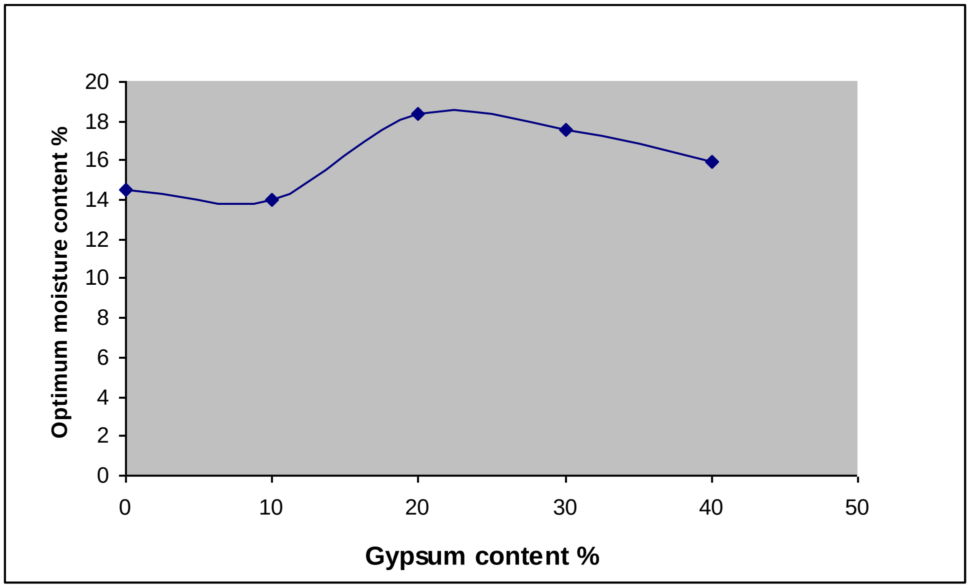

Fig. (9) : Relationship between Gypsum content and optimum moisture content of soil .

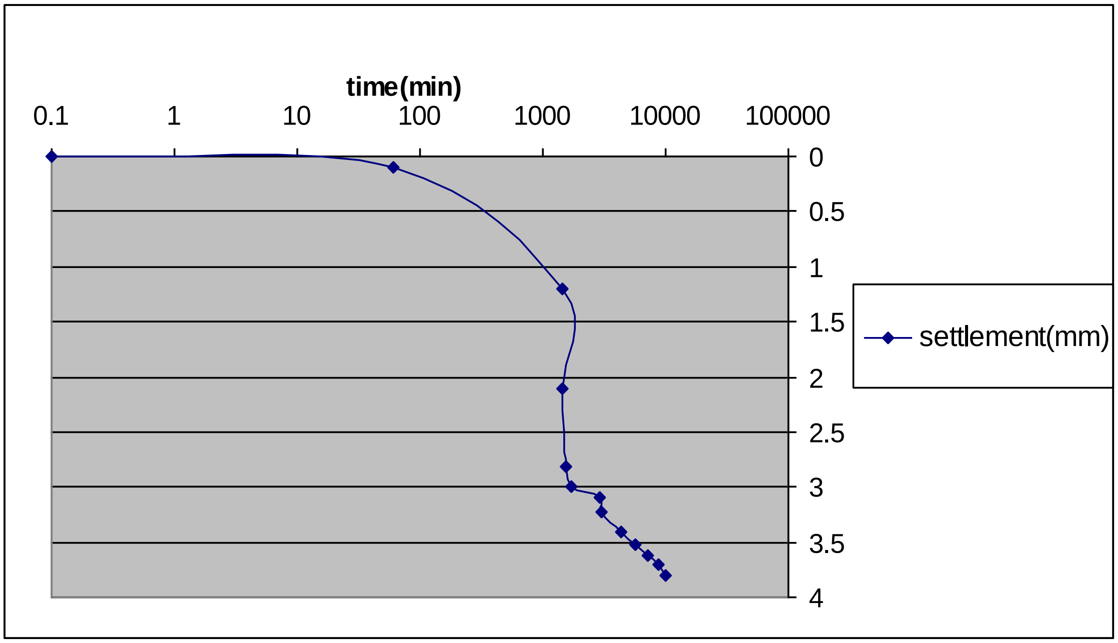

fig.(10): Time settlement curve for 10% Gypsum content of soil

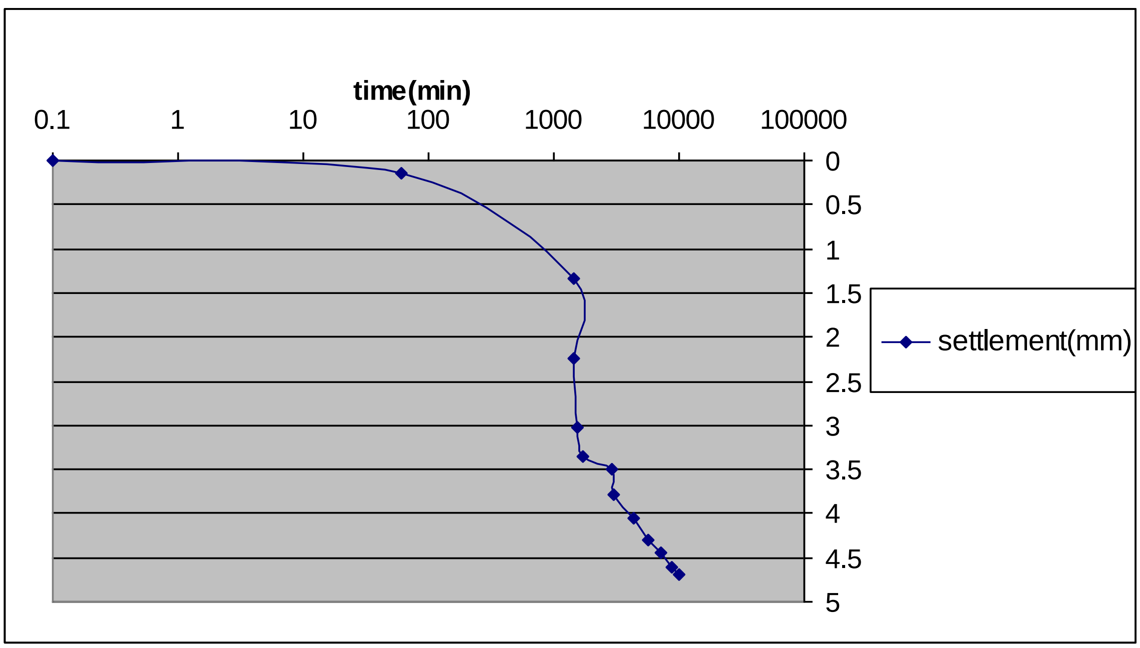

fig.(11): Time settlement curve for 20% Gypsum content of soil

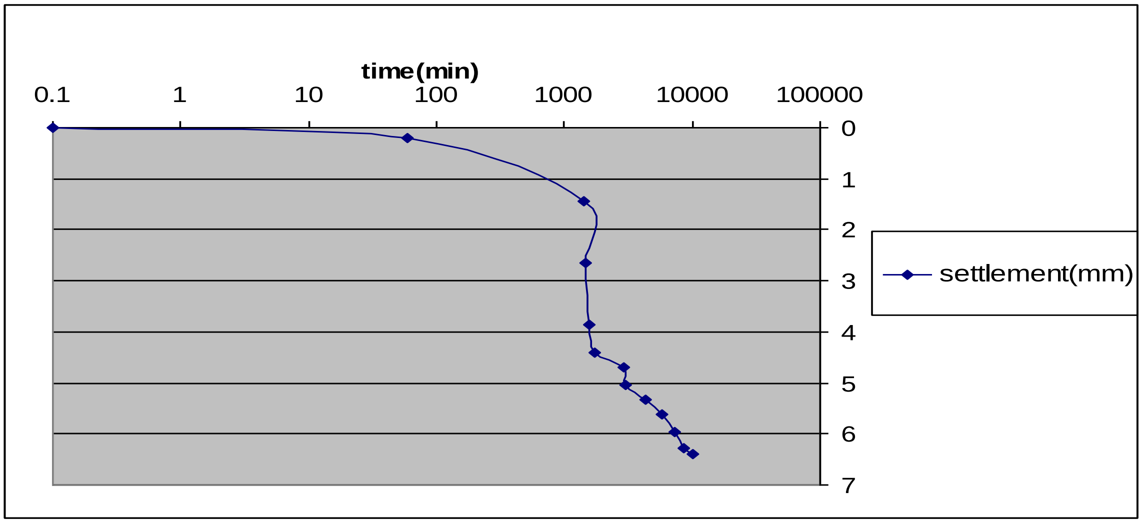

fig.(12): Time settlement curve for 30% Gypsum content of soil

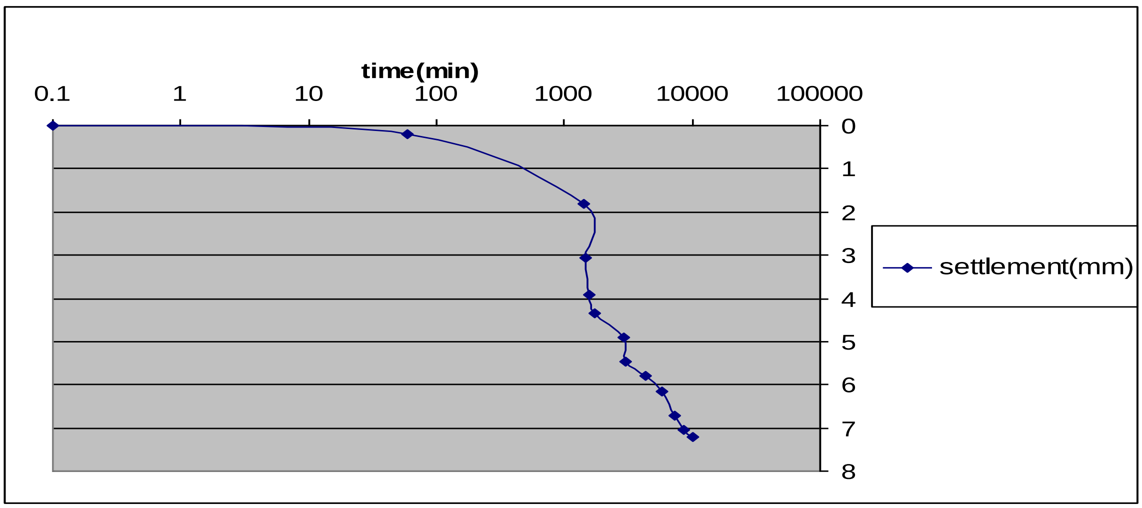

fig.(13): Time settlement curve for 40% Gypsum content of soil

Conclusions:

The present study leads to the following conclusions :

1. The maximum dry density of sandy gypsiferous soil decreases 13% with increasing gypsum content from 0% to 40% .
2. The increase of gypsum content of sandy gypsiferous soil increases 10% the optimum moisture content .
3. As expected increasing gypsum content increase the recorded settlement during soaking and leaching process .
4. The settlement obtained from soaking sandy gypsiferous soil is more than from leaching process .
5. (The total settlement/width of footing) ratios are (0.1 – 0.18) which are relatively high and means that is a problematic soil .

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