The Effect of Pre-used Oil of Cars Mixed with Salt Resistance Cement on Collapsibility of Gypseous Soil

Asst. Lect. Asa'd Hafudh Al-Deffa'e
Civil Engineering Department, College of Engineering
Wassit University, Wassit, Iraq

Abstract

The purpose of this research is to investigate the effect of pre-used cars oil and cement (Salt resistance) mixture (i.e. the effect of emulsified pre-used cars oil-cement mixture) on the collapsibility of gypseous soil. The soil used in this research has been brought from Bieji City (About 200 Km) north of Baghdad, with gypsum content of (64%).

Series of collapse tests is performed on the soil in its natural state and after treatment by emulsified of pre-used oil of cars-cement mixture, two percentages of pre-used cars oil are employed and four different percentages of mixture of pre-used cars oil and cement are employed also.

The results of collapsibility tests show that:

1. ***Collapsibility of treated soil samples decreases upon increasing all the percentage of pre-used cars oil. Better results were obtained when treated with pre-used cars oil-cement mixture.***
2. ***The results of collapse tests show almost the same behavior with increasing the percentage of pre-used cars oil and cement.***

الخلاصـــــــة

إن الغرض من هذا البحث هو لمعرفة تأثير إضافة دهن السيارات المستخدم والسمنت المقاوم (هذا يعني تأثير خليط مستحلب دهن السيارات-السمنت المقاوم) على انهيارية التربة الجبسية. إن التربة التي استخدمت في هذه الدراسة تم جلبها من مدينة بيجي (٢٠٠ كم شمال مدينة بغداد) وبمحتوى جبسي ٦٤%.

سلسلة من فحوصات الأنهيارية أجريت على التربة في حالتها الطبيعية، وبعد معالجتها بمستحلب (دهن السيارات المستخدم-السمنت المقاوم). نسبتين من مستحلب دهن السيارات المستخدم قد استخدمت (٣% و ٥%) وأربعة نسب أخرى بإضافة نسبتين من السمنت المقاوم للأملاح (٢% و ٤%) مرة لنسبة المستحلب الأولى ومرة أخرى لنسبة المستحلب الثانية.

نتائج فحوصات الانهيار بينت:

١. انهيارية عينات التربة التي تم معالجتها تتناقص بزيادة نسب مستحلب دهن السيارات المستخدم والسمنت المقاوم، نتائج أفضل تم الحصول عليها عند معالجة العينات بخليط دهن السيارات المستخدم-السمنت المقاوم.

٢. نتائج فحوصات الانهيار بينت في معظمها سلوك مشابه بزيادة نسب دهن السيارات المستخدم والسمنت المقاوم وخليطهما.

في النهاية بقي أن نذكر بأن العينات التي عولجت بخليط دهن السيارات المستخدم-السمنت المقاوم قد تركت قبل إجراء الفحص عليها لمدة أسبوع للسماح بالاماهة الكاملة لمركبات السمنت.

1. Introduction

Gypseous soil are widely distributed in the basin of Iraq (from north of Baghdad to south of Kirkuk) recognized as one of the unpredicted soil, which case many problems concerning civil works because there properties change significantly upon wetting and leaching [1].

In Iraq, great development in the areas of gypseous soils took place during the last two decades due to the need of constructing many strategic projects, i.e., hydraulic structures, industrial and civil building in these areas. When hydraulic structures are constructed in the gypseous soil, severe predicament may occur.

When water seeps through cracks in hydraulic structures and all civil works, gypsum will be dissolves, thus causing a subsidence of ground level and this lead to the collapse of the structure.

Gypseous soils are unstable structure, since the gypsum acts as a binder and the soil is very hard when dry and becomes very soft of high compressibility, and losses its strength among leaching out of gypsum due to wetting, Hence it undergoes structural collapse with or without an additional increase in the stress in excess of over-burden pressure [2].

Because of these characteristics, the gypseous soil must be treated or stabilized by many materials and methods before construct the structures to increase the shear strength and become more resistance of water

In this research, the pre-used car's oil mixed with cement is used in stabilization of the gypseous soil. The present study includes determination of collapse potential by Oedometer collapse test.

Finally, the aim of this research is to investigate the effect of pre-used car's oil on the collapsibility of gypseous soil to be come more resistance of water.

2. Collapse Mechanism

Collapse is the reduction in volume of fill material or natural soil deposit on inundation, with no change in applied stress. In inundation may be caused by downward infiltration of surface water, rising ground water level, bursting of underground water supply line [3], on the other means, **Fig.(1-a)**.

Figure (1-b) shows the collapse of soil structures upon inundation. the associated ground movement can have series effect on structures that have previously been built on the fill.

Al-Deffaee [2] pointed that the reduction in volume of collapsible soil is due to dissolution of gypsum particles in water, then, sudden collapse occur.

According to Dudley [4], and Pereira and Fredlund [5], the following factors produce collapse in soil:

1. An open, partially unstable, unsaturated fabric;
2. A high enough net total stress that will case the structure to be metastable.

3. A bonding or cementing agent that stabilized the soil in the unsaturated condition which is reduced on addition of water causing the inter aggregate or inter granular contacts to fail in shear, resulting in a reduction in total volume of the soil mass.

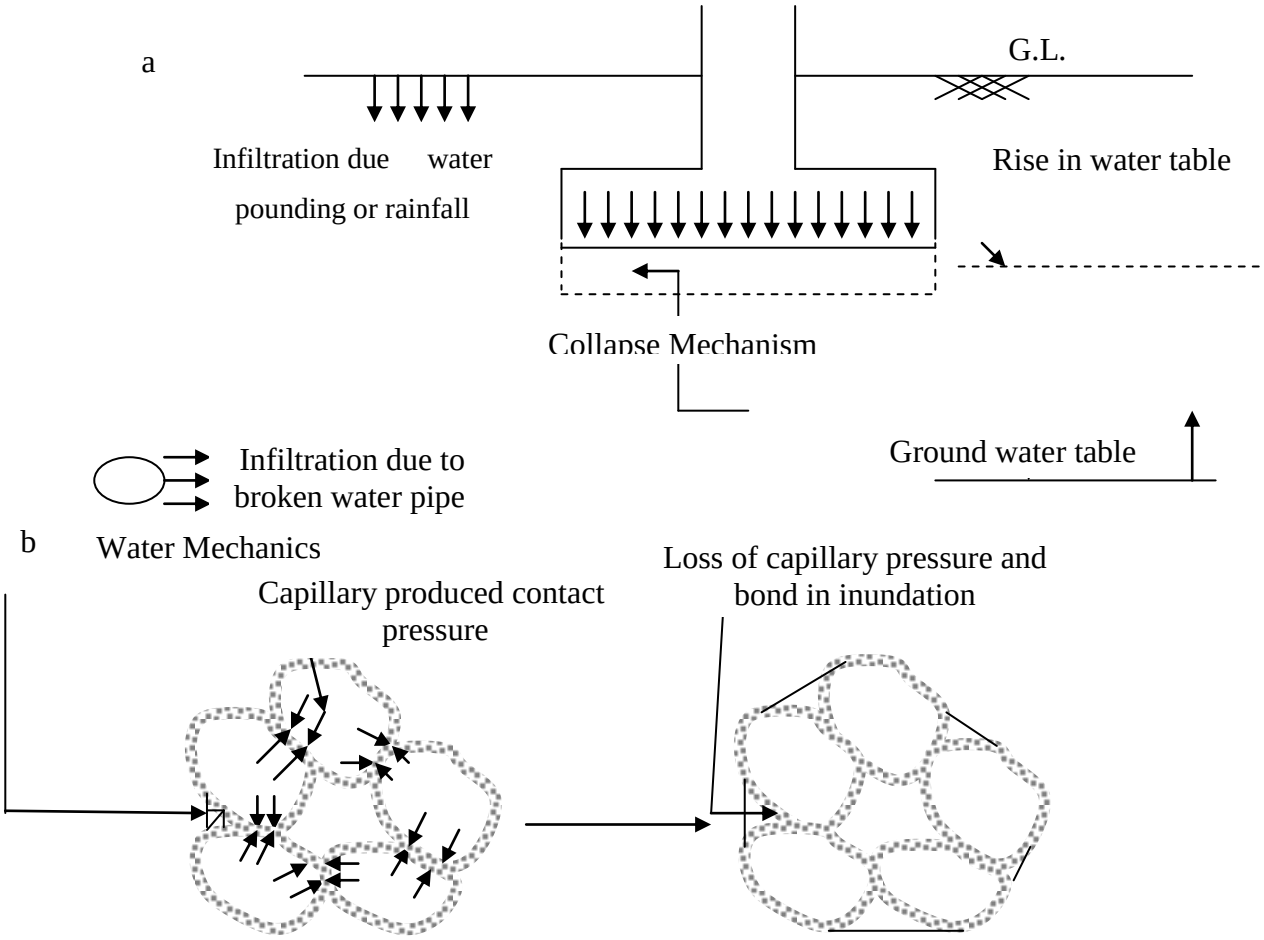

Figure (1) Occurrence of collapse phenomenon

Wetting induced collapse has occurred in compacted fills such as earth dams, highway embankments, and filled canyons. Embankment of compacted soils experience wetting induced collapse settlement, primarily due to loss of soil suction upon wetting problems associated with collapse settlement in compacted fills include damage to structures and foundations, slope failure with in fills. Damage to pavement, and sub-grade placed on highway embankment, piping, seepage losses and failure in earth dams.

Potential for collapse in a fill can be controlled during the placement and compaction process [5,6].

3. Collapse Potential in Soil

The collapse potential (C.P.) expressed in percentage is:

$$C.P. = \frac{\Delta e}{1+e} x100\%$$

where:

Δe = *change in void ratio in an oedometer test on inundation at a given stress*

e = *void ratio of the oedometer test specimen at the given stress before inundation.*

Jennings and Knight [7] have suggested criteria to assess the severity of the problem associated with collapse, based on values of collapse potential according to **Table (1)**.

Table (1) Collapse potential and severity of collapse (after Jennings and Knight 1975) [7]

Collapse potential (CP) %	Severity of collapse
0-1	No problem
1-5	Moderate Trouble
5-10	Trouble
10-20	Severe Trouble
>20	Very Severe Trouble

4. Experimental Work

The experimental work is divided to physical and chemical tests.

1. Physical Tests: it's contained:

a) Unit Weight and Water Content:

These tests are conducted accordance with ASTM (D2927-71) and (D2216-80) standards respectively [8]. Water content in all tests is determined using oven drying at (45^{o} C) not to let the crystallization water of gypsum is lost. This would not affect water content value, as the soil has not significant clay fraction.

b) Specific Gravity:

The specific gravity of the soil determined in accordance with BS-13377: 1976 [9], test No.(6), But "Kerosene" is used instead of water due to the dissolving action of water in gypsum.

c) Grain Size Distribution:

The grain size distribution of the investigation soil is determined by sieving analysis which was conducted in accordance with ASTM D422-72 [8] but with dry sieving, the grain size distribution curves of the soil shown in **Fig.(2)**.

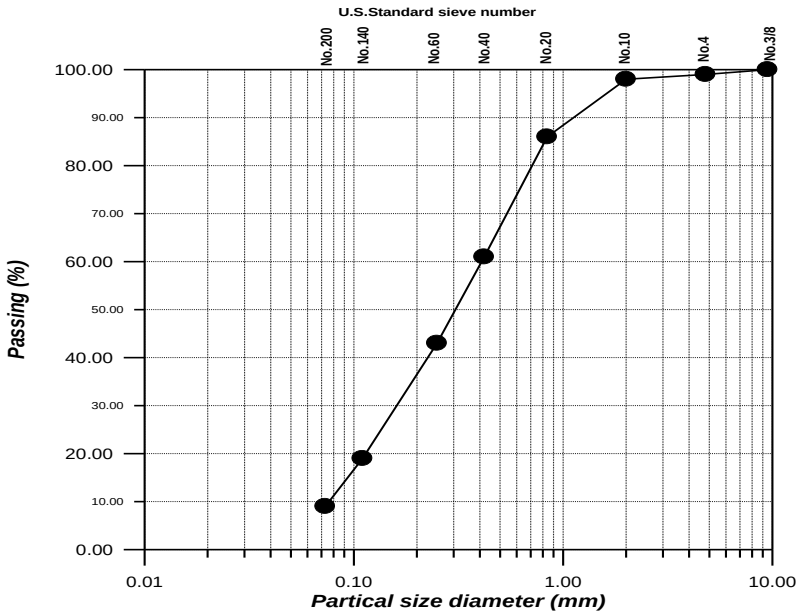

Figure (2) Grain size distribution

d) Atterberg Limits:

The liquid limit was carried out in accordance with BS-1377-76 [9], test No.(2), A, using the cone penetrometer method. The plastic limit is determined in accordance with BS-1377-76 [9], test No.(3).

The liquid limit and plastic limit are carried out on natural soil, on passing sieve No.(40), and on passing sieve No.(200). The drying temperature in all tests is maintained at (45^{o} C) because of the significant amount of gypsum percent. The results of consistency tests are summarized in **Table (2)**.

Finally, the **Table (2)** below show the index properties for the natural soil.

Table (2) Index properties for the natural soil

Site	Grades
Depth (m)	(0.5-1)
Specific gravity (Gs)	2.37
Gypsum content (%)	69
Atterberg limits Liquid limit (%) Plastic limit (%) Plastic index (%)	 33.5 N.P. N.P.
Standard compaction properties Maximum dry density (KN/m^3) Optimum moister content (%)	 14.3 13.5
Passing sieve No.200	9.3
According to USCS classification	SP-SM

2. Mechanical Tests:

The test those conducted on all specimen is single collapse test, this test was suggested by Knight [7], Three groups of specimens are tested, the first group includes the specimen of soil at natural state while the second group includes specimens treated by Pre-used car's oil while the third group contains specimens treated by pre-used car's oil-salt resistance cement mixture as well as soil in its natural state.

For each group, and for each test, the specimens is loaded progressively until (200 Kpa) is reached, then it is left until equilibrium is maintained under this load, then its flooded with water and left for (24 hrs). For the second group, the specimens are left for 7 days before loading to permit of cement components to get on enough time for hydration.

5. Results of Collapsibility Tests

Three groups of tested specimen are used to predict the behavior of collapsibility of soil at its natural state and after addition the pre-used (oil of cars) and cement-oil of cars mixture in different percentages.

First group contained specimens of soil in its natural state without any treatment, the collapse test shows that the collapse potential is reached to (10.1) as shown in **Fig.(3)**.the collapsibility is classified as sever trouble according to **Table (1)**.

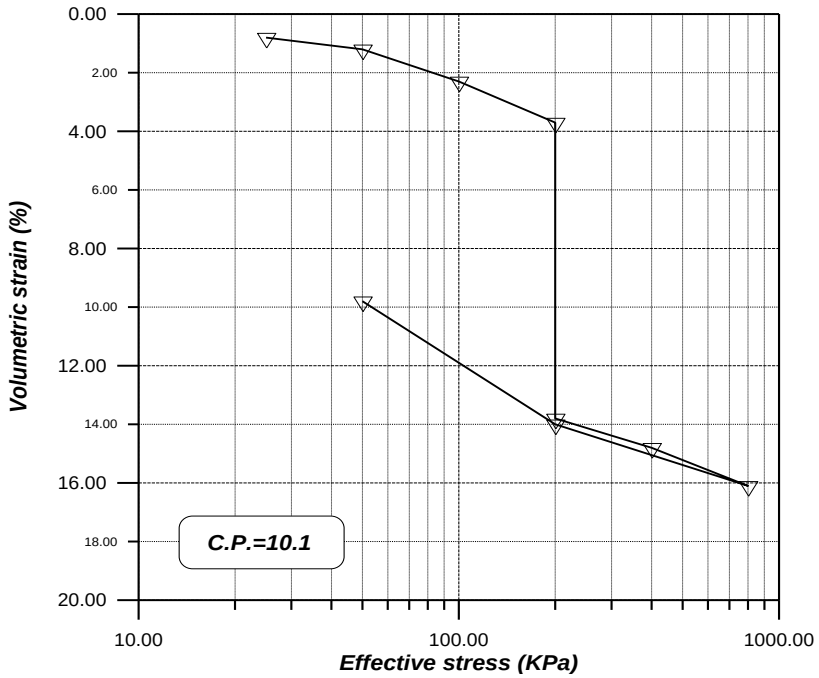

Figure (3) Single collapse test for untreated specimen

Summary of the data for collapse tests are given in **Table (3)**.

Table (3) Results of collapse test

Type of binder	**Results of specimens treated by Pre-used car's oil**			**Results of specimens treated by Pre-used car's oil-salt resistance cement mixture**			
% of binder	0	3	5	3+ 2 % cement	3+4% cement	5+2% cement	5+4% cement
C.P.	10.1	3.9	2.6	2.5	1.7	1.2	1.4

From **Fig.(3)**, it can be noticed that instantaneous and significant settlement take place upon flooding in water.

The change in volume upon flooding in water pointed out that the soil is collapsible. When water is added to the soil sample under constant stress destruction of the particles binder due to dissolution of gypsum particles and anew reorientation of particles will take place resulting in an instantaneous settlement. According to the value of collapse potential in **Table (1)**, the soil may be classified as "sever trouble" [7].

The second group of specimens included specimens treated by pre-used car's oil in two percentages, 3% and 5% respectively.

For the first percentage, the collapse potential is reduced to (3.9%), while in the second , the collapse potential is reduced to (2.6%), as shown in **Fig.(4)** and **Fig.(5)**.

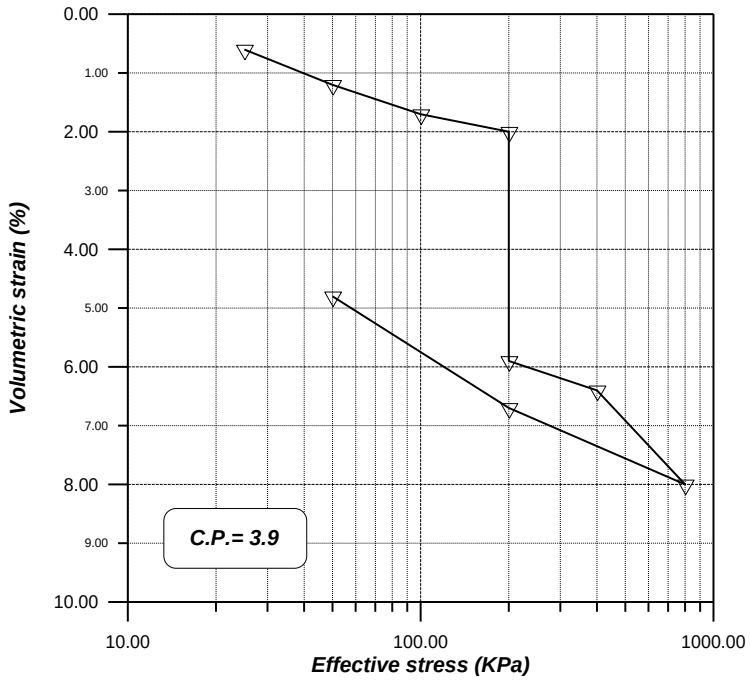

Figure (4) Single collapse test on specimen treated by 3% pre-used car's oil

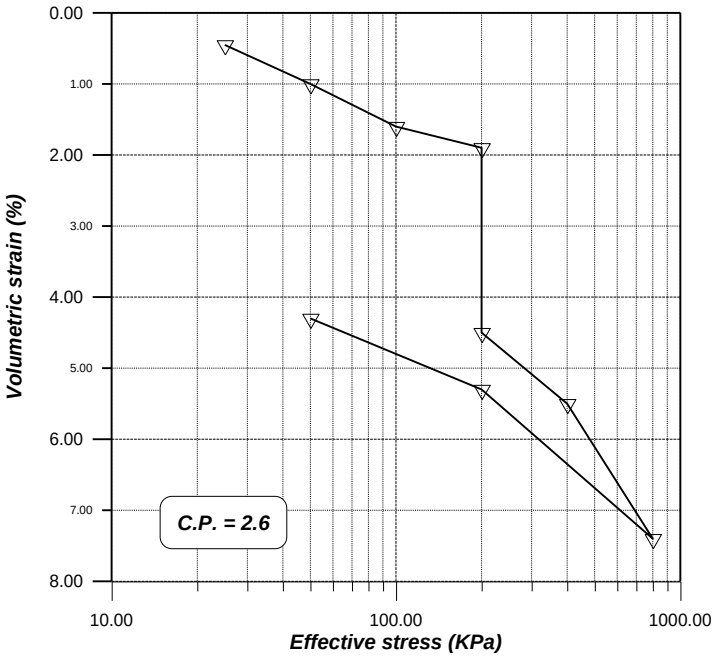

Figure (5) Single collapse test on specimen treated by 5% pre-used car's oil

In both test, this behavior can be attributed to cementation agent of pre-used car's oil plug the voids between soil particles.

In the third group four specimens are treated by mixture of cement (salt resistance) and pre-used car's oil in.

In the first specimens, treated carried out by adding (3%) from pre-used car's oil added to it (2%) of cement (salt resistance), the collapse potential is reduced to (2.5%) as shown in **Fig.(6)**.

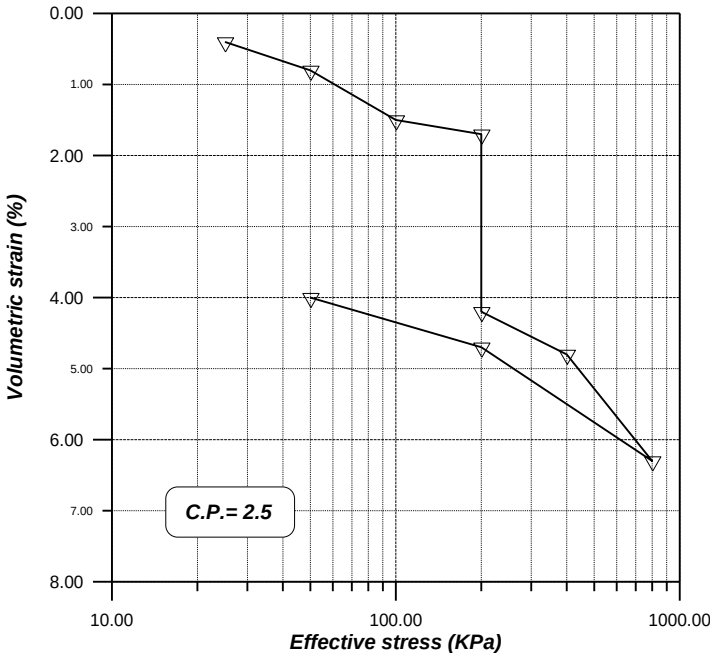

Figure (6) Single collapse test on specimen treated with 3% pre-used car's oil mixed with 2% salt resistance cement

The second specimen treated with (3%) of pre-used car's oil added to it (4%) cement (salt resistance) as shown in **Fig.(7)**.

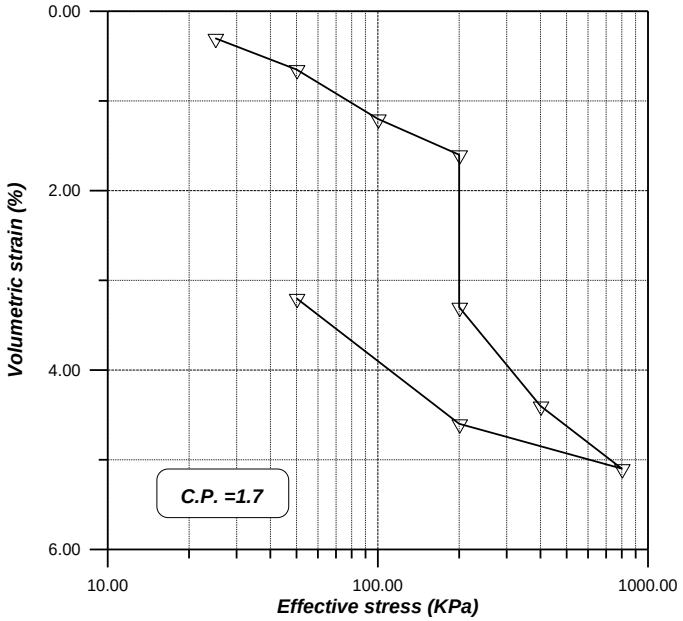

Figure (7) Single collapse test on specimen treated with 3% pre-used car's oil mixed with 4% salt resistance cement

The third specimen treated with (5%) of pre-used car's oil added to it (2%) of cement (salt resistance), in this specimen, the collapse potential is reduced to (1.2%) as shown in **Fig.(8)**.

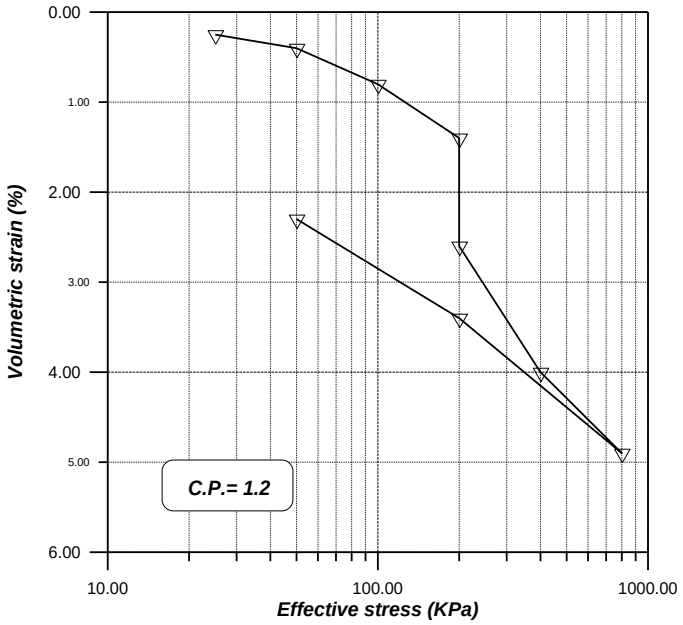

Figure (8) Single collapse test on specimen treated with 5% pre-used car's oil mixed with 2% salt resistance cement

For the last specimen, specimen treated with mixture of (5%) pre-used car's oil and (4%) cement (salt resistance), the collapse potential reached to (1.4%) as shown in **Fig.(9)**.

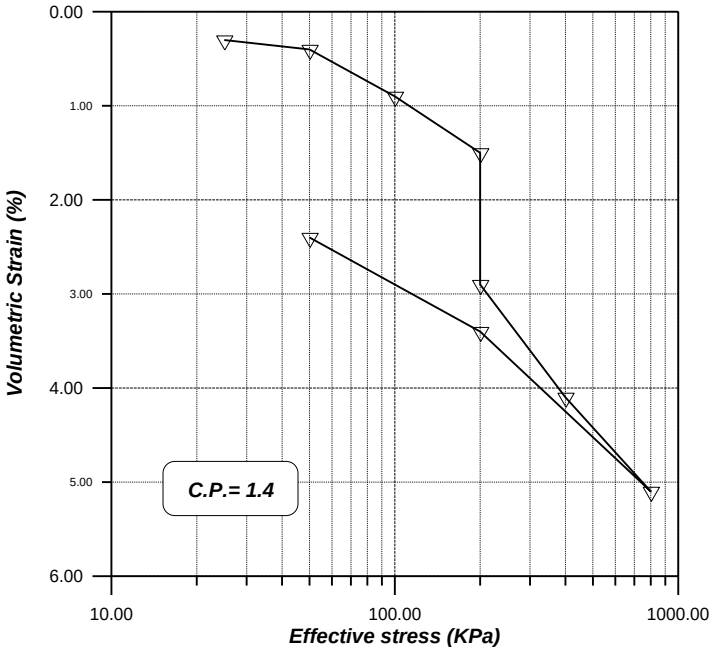

Figure (9) Single collapse test on specimen treated with 5% pre-used car's oil mixed with 4% salt resistance cement

The collapse potential is reduced from (10.1%) in natural case for the soil to (1.2%) in specimen treated by mixture of (5% pre-used car's oil + 2% salt resistance cement), the behavior can be attributed to cementation agent of pre-used car's oil as well as cement plug the voids between soil particles and worked as a water proofing.

6. Conclusions

As a result of the testing program conducted on soil samples taken from Samara City with gypsum content (69%), the following conclusions could be drawn.

1. For all ratios of pre-used car's oil large decreases in collapse potential when the sample treated by pre-used car's oil due to water proofing action for pre-used car's oil
2. Cementation agent for salt resistance cement and water proofing action for pre-used car's oil makes gypseous soil more resistance of water.
3. The increasing of the ratio of binder gives excellent results to a certain extent, and then gives negative results due to the sliding of particles on one another surrounded by the binder.
4. It is found that the value of collapse potential of the tested soil (untreated) locate between (10%-20%) indicates that the soil considered collapsible. In addition, the collapse potential as a very high is located between (1%-5%) after treating with different binders which means that the soil may be considered as a moderately collapsible.

7. References

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