

## Effect of Adding Polypropylene Fiber on The Behavior of Saline Soil under Washing and soaking

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### Abstract

Saline soil is a soil rich with salt resulting from evaporation of irrigation water. This soil has good engineering properties when dry, but once is wetted it loses its entire structure (collapse) and undergoes very large instantaneous settlement. The soil is brought from Al-Dalmaj district. A square footing 50mm×50mm made of steel is used. The stress is applied from a fixed loading system designed especially for model tests. In this study effect of adding Polypropylene fiber as percentage 1%,3% by weight on behavior of saline soil at the same loading level was investigated and shows improving in results in collapsibility of soil by percent 62% in percent adding 1%.

Keywords: Saline soil, Polypropylene, Collapsibility.

### تأثير اضافة مادة بولي بروبيلين على التربة السبخة وسلوكها اثناء غمرها وغسلها بالماء

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### الخلاصة

التربة المالحة هي التربة الغنية بالملح التي تنتج عن تبخر مياه الري. هذه التربة لها خصائص هندسية جيدة عندما تجف، ولكن بمجرد تعرضها للبلل فإنها تفقد هيكلها (انهيار) ويحصل فيها هبوط فوري كبير جداً. تم جلب التربة من منطقة الدلمج وأستخدم أساس مربع بأبعاد 50×50 مم وضعت بقلب من الصلب. حيث يتم تطبيق الضغط من نظام تحميل ثابت صمم خصيصاً لاختبارات نموذجية. في هذه الدراسة، قمنا بدراسة تأثير إضافة الألياف مادة البولي بروبيلين كنسبة مئوية 1%، 3% وزناً على سلوك التربة المالحة على نفس مستوى التحميل وتظهر في نتائج تحسين انهيارية التربة من 62% إلى 1%.

كلمات البحث: التربة المالحة، انهيارية، مادة البولي بروبيلين

### Introduction

Saline soils are associated with many geotechnical problems, due to presence of digenetic salts of different contents, shapes and compositions, and shallow saline ground waters. Therefore; Saline soil is considered to be an inferior construction



material. Because of their characteristics, some of pavements located on a saline flats have exhibited various types of deterioration in form of reveling, cracking, rutting and formation of landslides in recently built roads. The susceptibility of these soils to strength loss and collapse upon wetting makes their use in construction very risky. Saline soils present high rigidity and high shear strength when dry, but they change radically upon wetting which triggers huge localized settlement in civil works. Many studies were performed about geotechnical behavior of saline soil under civil projects for different countries. Saline soil possess a high collapse potential attributable primarily to dissolution of sodium chlorides, leaching of calcium ions and soil grain re-adjustment (Al-Rawas et al., 2005; Al-Shamrani, M.A. 1998).

## Polypropylene

A plastic polymer of the chemical designation  $C_3H_6$  has been used widely in many different settings, both in industry and in consumer goods. It can be used both as a structural plastic and as a fiber. It is a thermoplastic polymer, rugged and unusually resistant to many chemical solvents, bases and acids.

## Experimental Work

The soil used in this study is brought from Al-Dalmaj district from 2m depth of handmade borehole. Natural moisture content for soil is 10%, grain size analysis is conducted on soil after washing on sieve No.200 as shown in figure (2). Classification test is made for the soil include liquid limit and plastic limit which values are 38%, 30% respectively; therefore; the soil is well graded type. A cylinder made of thick steel with 27cm diameter and 30cm height is used. The soil was oven dried, pulverized and sieved through sieve No.4. The soil was placed in the cylindrical container with unit weight  $17.5 \text{ KN/m}^3$ . The addition of polypropylene to the soil is made in two cases before and after compaction. The soil density was controlled by dividing it into three layers in to each individual layer was compacted to recorded level until reaching the last layer; the soil surface was leveled with aid of sharp instrument. A square footing  $50\text{mm} \times 50\text{mm}$  made of steel, was placed at the center of the model, on the soil surface. The system of loading frame chosen for all laboratory model tests is of fixed loading type, to ensure continuous and long term loading application and easy stress controlling and loading additions during test. The model consists of vertical steel shaft of square section (1.2m length,  $1 \times 1\text{cm}$  cross section) area connected as shown in figure (1). The settlement is measured using 0.01mm sensitivity dial gauge, fixed out of the model with the aid of magnetic holder. The loading frame and settlement control were designed especially for these type of test on model footing to investigate settlement during soaking and leaching of saline soil with water. The settlement is record with time for model tests at dry state; this state takes about 20 minutes which represents the immediate settlement. At soaking stage (takes two days), the water was let to flow soak the soil in the model from top to bottom. The leaching process takes 3 days in which the small openings at bottom of container permit drainage of water. The loading frame is placed on steel footing with weights attached on it as to support a pressure on soil of 50 KPa and 75 KPa . This pressure is chosen as it is believed that most domestic houses and small engineering projects may apply a similar pressure on soil.



**Fig. (1-A): Laboratory model test and equipment.**



**Fig. (1-B): Soil with polypropylene**

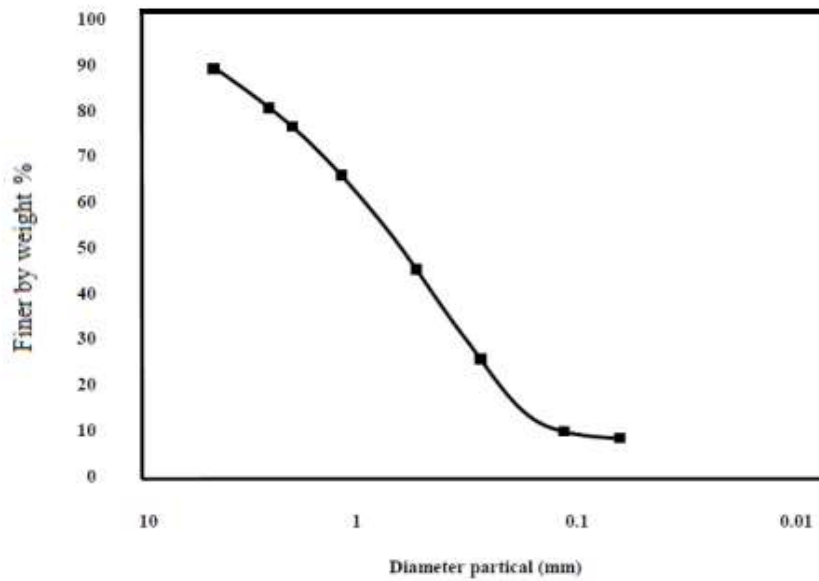


Fig. (2): Partical size distribution curve of saline soil.

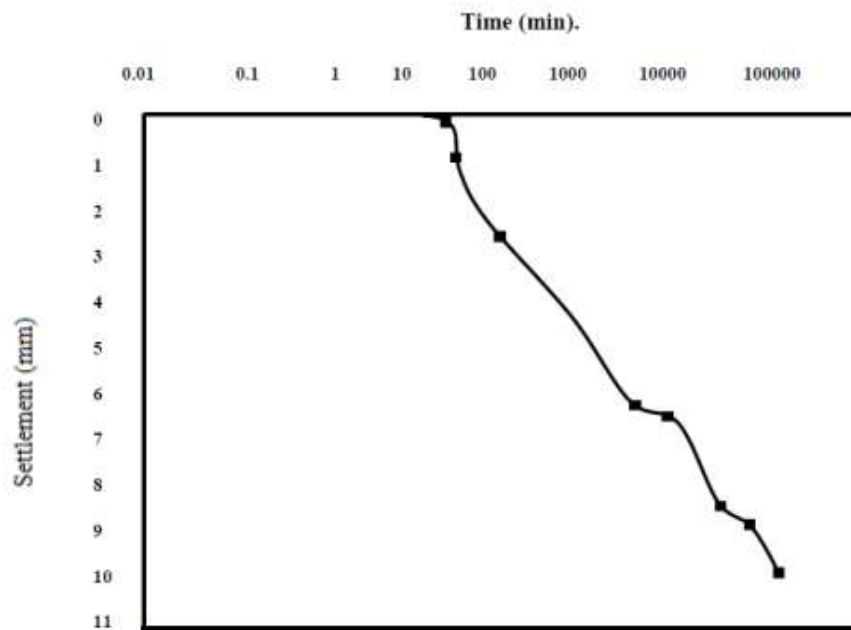


Fig.(3): Time-settlement curve for saline soil without treatment (stress=50kpa).

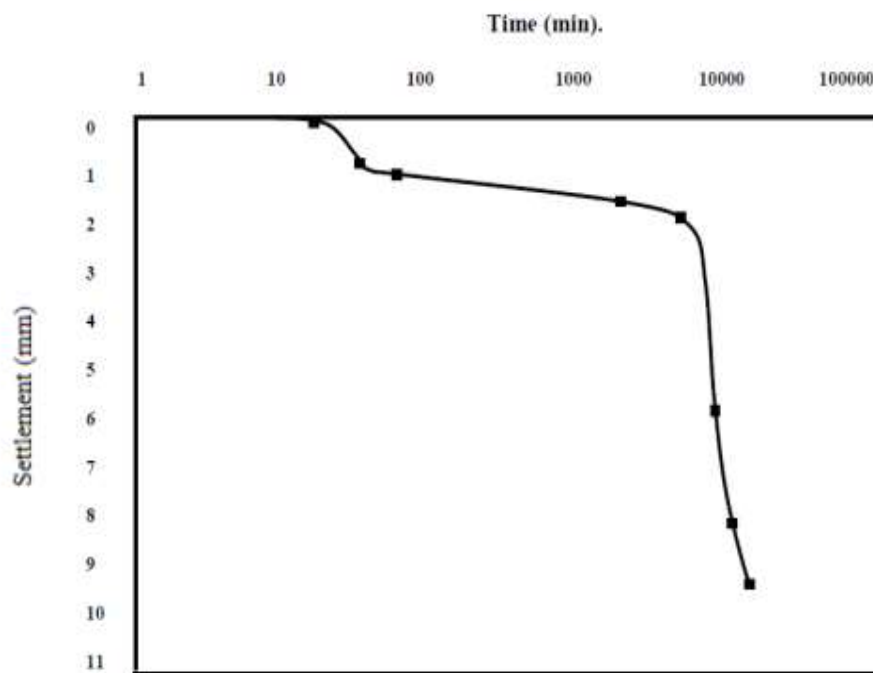


Fig.(4): Time-settlement curve for saline soil with addition polypropylene 3%, after compaction soil (stress= 50 kpa).

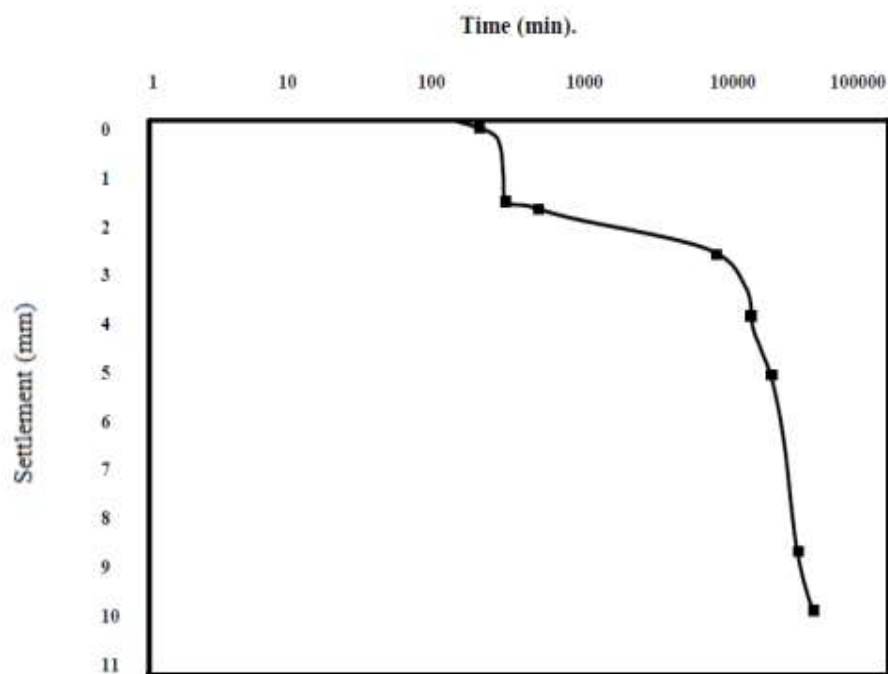
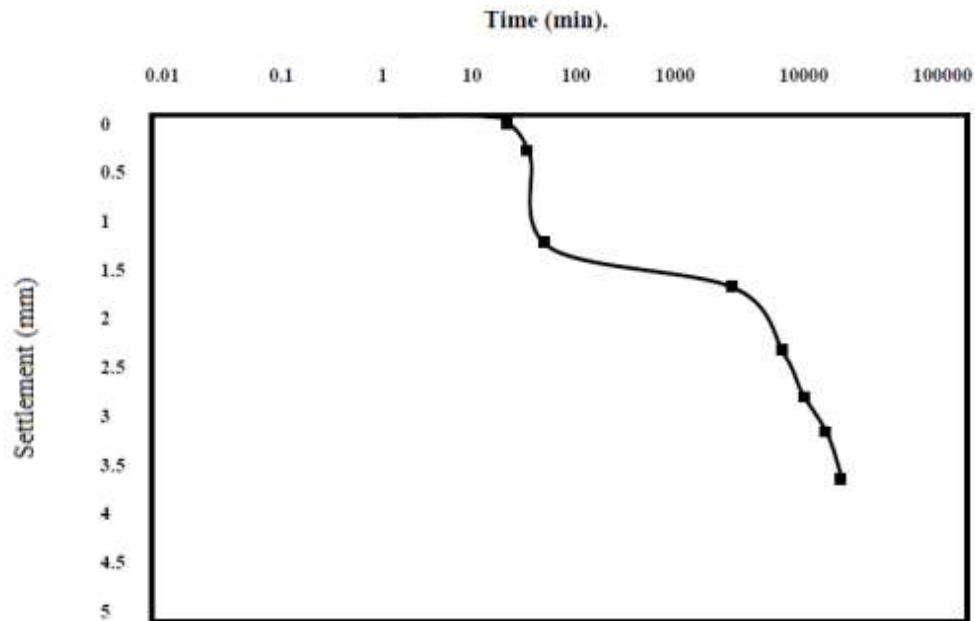
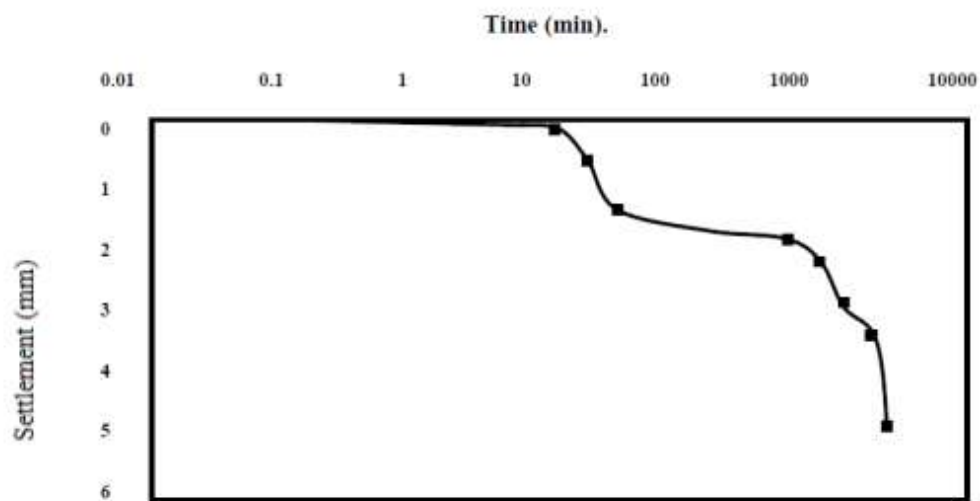


Fig.(5): Time-settlement curve for saline soil with addition polypropylene percent 3%, after compaction soil (stress= 50 kpa).



**Fig.(6): Time-settlement curve for saline soil with addition polypropylene percent 1%, before compaction soil (stress= 50 kpa).**



**Fig.(7): Time-settlement curve for saline soil with addition polypropylene percent 3%, before compaction soil (stress= 50 kpa).**

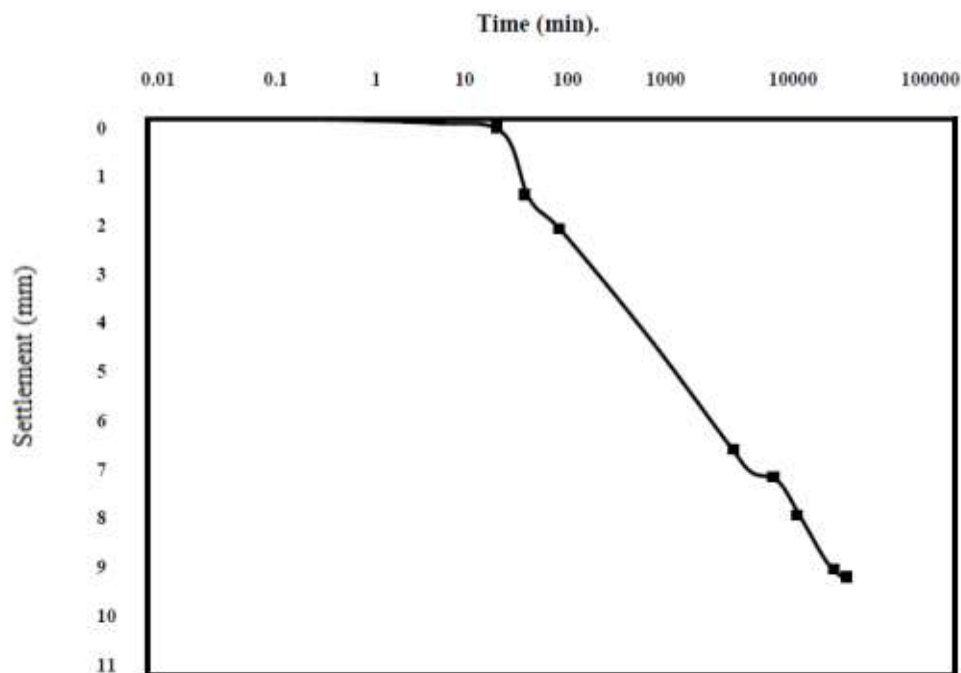


Fig.(8): Time-settlement curve for saline soil (stress=75kpa).

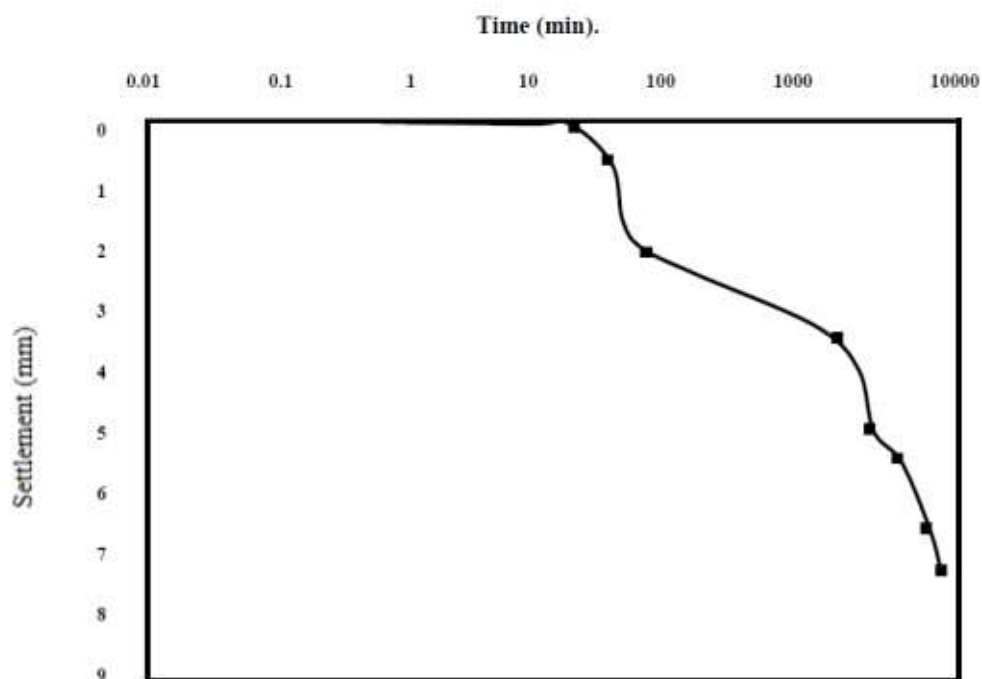


Fig.(9): Time-settlement curve for saline soil with addition polypropylene 1%, before compaction soil (stress= 75 kpa).



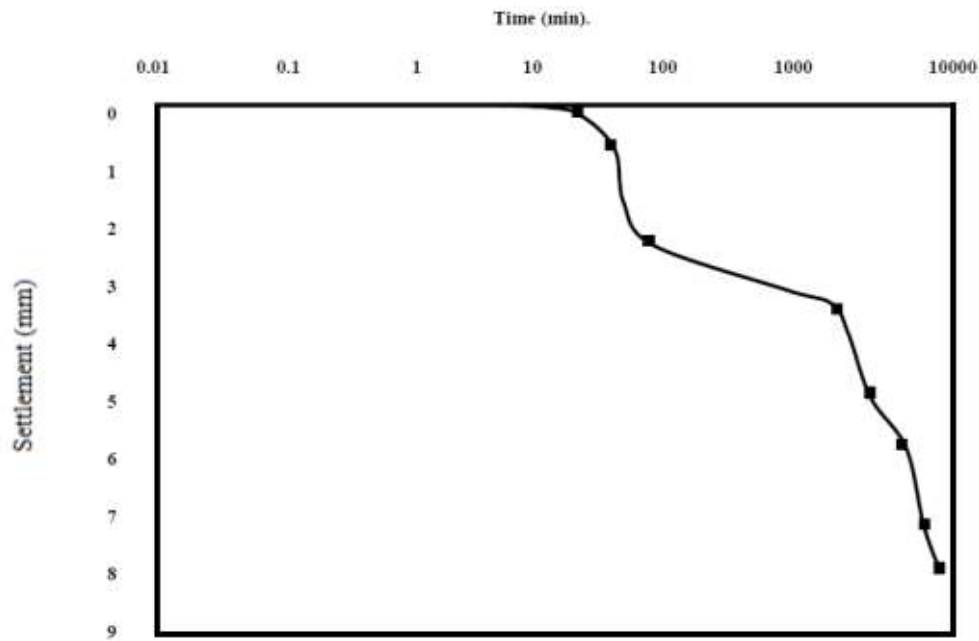


Fig.(10): Time-settlement curve for saline soil with addition polypropylene 3%, before compaction soil (stress= 75 kpa).

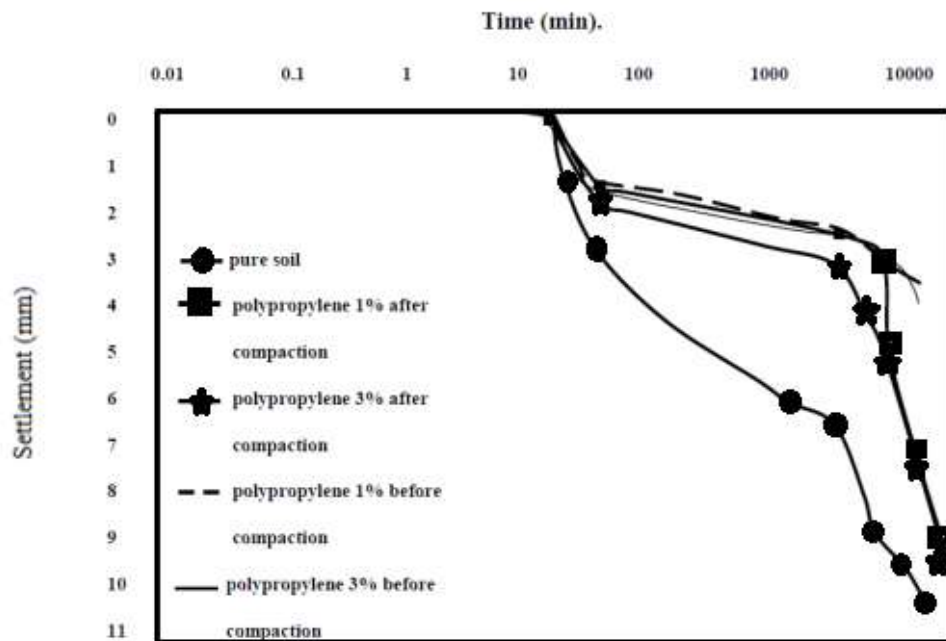
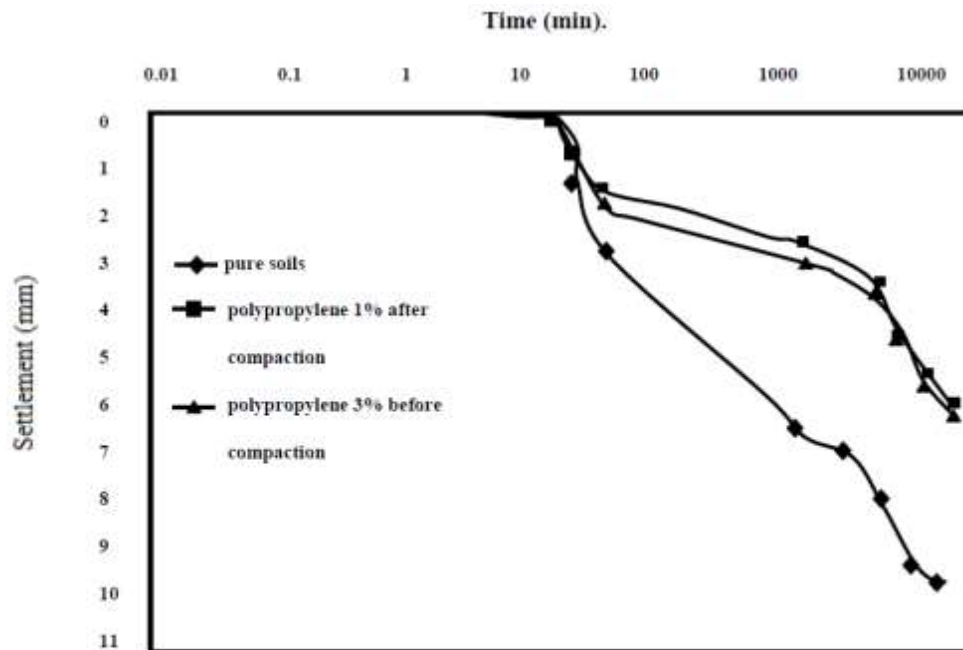


Fig.(11): Time-settlement curve for saline soil with addition polypropylene (stress= 50 kpa).





**Fig.(12): Time-settlement curve for saline soil with addition polypropylene (stress= 75 kPa).**

## Result and Discussion:

Two percentages 1% & 3% of polypropylene have been added to study the behaviour of saline soil main finely of the study is summarised below:

- The time-settlement relationship for saline soil, the soil tested as stress level 50 KPa and soil density  $17.5 \text{ KN/m}^2$  shown in figure 3.
- The percentage 1%, 3% by weight of polypropylene ratio shown in figure (4, 5, 6, 7).
- Figure (6 and 7) shown the settlement time curve for this case, it is noticed that the settlement is decreased to 62% and 52% respectively for both 1% and 3% of polypropylene percentage.
- Degree of decreasing settlement with increasing stress level as shown in figure (9, 10).

## Conclusion

The following points are noticed from this study:

1. The method of using polypropylene in saline soil as improvement material induced to a good improvement reduced the collapsibility to 62% for stress level of 50 KPa.



2. Degree of saline soil improvement changes with percent of 1% the best ratio, and the degree of improvement of saline soil decreases with increasing stress level.

Adding of polypropylene will decrease in liquid limit and plastic limit values, whereas the plastic limit increasing is constant.

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