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Improvement of Soil by Waste Tires Addition

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Abstract

Low able fill material is a self – leveling– compacting one; these types of material rapidly gain acceptance and application in construction utility earthworks. The use of scrap tires as a reinforcement element is an attractive solution that combines the advantage of improving soil mechanical behavior with environmental concerns.

The present work describes an experimental study on replacing sand aggregate grain size with wastes rubber and plastics at different mixing ratio (6, 18, 30) % wt. respectively to support technical feasibility of muddy soil by using wastes materials then compared with commercial additives (carbon fiber) afterward check their hydro-dynamical properties (E.L, P.L, hydrometer, compaction, and sp.gr) of prepared compacting improved soil mixtures. Experimental results indicate that crumb rubber have successfully used to produce a light weight flow able fill (1.2 to 1.6 g/ cm^3) than other additive waste plastic and carbon fiber based on the characteristic properties (E.L, P.L, hydrometer, compaction) as follows:

Have 65% for rubber samples than other additives of 45% and 55% molecules respectively for hydrometer test, 2 Gs for rubber than 1Gs for other additives; and 560 g/cm^3 compaction for rubber additive than 520 g/cm^3 for other additives carbon fiber and waste plastic.

Keywords: scrap tires, crumb rubber, light weight, aggregate, flow able fill, controlled characteristic properties.

تحسين التربة بأضافة الاطارات المستهلكة

الخلاصة

إن تطبيق المواد الخفيفة القابلة للرص لاقت قبولا سريعا مؤخرا وخصوصا في أعمال البناء وأعمال الترميم والاستصلاح التي تجري على الأراضي المتروكة وذلك باستخدام نفايات الإطارات المستهلكة والنفايات البلاستيكية كعناصر مدعمة وحل فعال يربط بين تحسين مواصفات التربة الميكانيكية وتخليص البيئة من ملوث خطر.

البحث الحالي يوضح دراسة تجريبية تعمل على استبدال نسبة من مكونات التربة الناعمة بأخرى مدعمة مثل المطاط والبلاستك المعاد وعند نسب استبدال مختلفة وهي على التوالي (6، 18، 30)% نسبة وزنيه لدعم وتحسين الخصائص التقنية للرص للتربة الطينية ومقارنتها مع مضافات تجارية (ألياف الكاربون) ، ثم دراسة تأثير هذه المضافات على الخصائص الهيدرميكانيكية للتربة المحسنه وهي (حد المرونة ، وحد اللدونة ، التأثير الهيدروليكي ، الرص ، والوزن النوعي) .

النتائج التجريبية وضحت نجاح واستبدال نسبة من التربة بجزء من المطاط المعاد المجروش والبلاستك المعاد المطحون وألياف الكاربون وحسنت التربة وخصوصا قابلية الرص والخصائص الميكانيكية، وكانت المواصفات والخصائص المقاسة (حد المرونة واللدونه والارتفاع الهيدروليكي)

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65% لنموذج التربة المحسن بمضاف المطاط و45 و 55 % جزيئه للخاصية الهيدروليكية للتــرب ذات المضافات الاخرى (البلاستك المعاد والياف الكاربون)، وGs2 للترب المحسنة بالمطاط

المعاد و Gs1 للمضافات الأخرى ، إضافة إلى 560 غم/ سم^3 لمضاف المطاط المحســن للتــرب لخاصية الرص اكبر من 520 غم /سم^3 للمضافات الأخرى على التوالي.

Introduction

The technique of soil reinforcement consists of introducing metal strips or geotextile sheets in to a soil mass. The improvement of shear stress at the soil – reinforcement interface reduces the horizontal thrust on retaining structure, and improving their stability conditions.

Scrap tires are a solid waste, which are produced in increasing rates every year in particular at Iraq. They have been usually disposed in landfills or tire piles with serious environmental risks. This problem may assume a larger importance in areas of tropical climate with precarious sanitation conditions moreover scrap tires piles consist a serious fire hazard [1-5].

The use of scrap tires filled with soil as reinforcement element is an alternative solution that combines the advantage of improving mechanical behavior of the reinforced soil with low construction costs. Besides, it contributes to environmental policies of reducing undesirable solid wastes [6].

Two mechanisms are responsible for increasing the stability of reinforced retaining structure:

1. The shearing resistance of the soil – interface.
2. The passive resistance mobilized by the soil in front of the reinforcing element. By bonding the rubber chips with soil with create a much smaller over-bugrden pressure than earth material. This characteristic makes rubber- soil very suitable for use in earth structure construction on soft ground [7].

Recent studies on leachate from crumb rubber showed no deleterious effects to the environment. In fact, research has shown that scrap tire rubber can absorb and retain volatile organic compounds (VOCs). Also park et al conducted laboratory – scale column tests on a slurry cut off wall back fill material that contained15% ground tires by weight, the authors reported a 10 fold increase in break through time for the VOCs in the slurry blended with ground tires when compared to that standard soil – betonies slurry [7-12].

Aim of present work

This work aimed

1. Improved the absorption properties of muddy soil.
2. Improved the homogeny of muddy soil by the use of fibers additives.
3. Improved the hydrodynamical properties of erosion soil and optimization of their characteristic properties.

Experiment

Material:

1. Muddy soil from karakoush baladrous that site in north of Iraq.
2. Waste tires (crumb rubber) available locally mixed of (0.5) s.pg.
3. Waste plastic (80% poly propylene, 20% poly ethylene) available locally.

4. Carbon fiber (short cut or crumbed) for comparison available commercially..
5. Sodium phosphate of (99.9) % for testing by BDH.CO.
6. Distilled water for testing.

Procedure

In this study different reinforcement additive materials (waste tires (crumb waste rubber (No. 50 mesh) (W.R))), waste plastic (W.P), and carbon fiber (C.F)) are used. A known amount of standard muddy soil according to characteristic tests (3000g, 50 g, and 10 g) is prepared then mixing continuously with additive reinforcement materials as (6,18, and 30 % w/w) additive ratios respectively until reach homogeneity mixture in order to develop three low-fillable mixtures afterward checked their hydrodynamic properties as (E and P-L, Sp.gr ,hydrated property and compaction) respectively and their suitability for different applications to give strength fillable properties for muddy soil [13].

Characteristic properties

According to interaction ASTM (D698-70 and D1557-70) for geotechnical testing for light weight, high-way construction, laying material in high-way and land-fill construction applications [13], and the use of testing apparatus available in soil lab of civil engineering department. Specified weight of soil and additives placement were mixed together (10, 50, and 300 g) with (6, 18, and 30) % wt. respectively by the use of locoed lend special fund Enesco equipment E and P.L tester hydrometer to check hydration properties, and use of G.N.T roles model 33-T00 70 equipment for compaction of prepared samples and two types of digital 0.00, 0.0000 micro-balance respectively are used with the following equations below:

$sp.gr. = (w_s/ w_s - w_b w_s) * GT$ ------1

w_s= weight of soil (g).

w_b, w_s= weight of pykcnometer filled of soil and water at temperature T.

G.T= Sp.gr of water.

Moisture content= $((w_2-w_3)/ (w_3-w_1)) *100$ -------2

Where:

w_2= weight of tin with moisture soil.

w_3= weight of tin with dry soil.

w_1= weight of tin only.

$R_{corr.} = R_{act.} - R_w + C_r$ -------3

$N \% = [(R_{corr.}) x (a) / W_s] x 100$ ---4

Where

$R_{corr.}$ = corrected reading for hydrometer.

$R_{act.}$ = reading of hydrometer.

R_w = reading of hydrometer with water only.

a = correction factor= 0.99.

W_s = weight of soil (g).

N = number of tracks.

$\gamma_t = w/vol.$ ----------5

$\gamma_d = \gamma_t / (1+w_c)$--------6

$w_c (\%) = [(w_{wet} - w_{dry})] / w_{dry} \times 100$-7

Where:

γ_t= total density of moisture soil (g/cm^3).

γ_d= dry density of soil (g/cm^3).

vol. = volume of molar used (cm^3).

w = weight of compacted soil in molar (g).

w_c = weight content of soil (g).

$w_{dry,wet}$ = dry and wet weight of soil (g).

Results and Discussion

Results and discussion:

From the experimental work manually you could notice and be careful to the following details below:

1. eotextile fabric should be placed between the chips, crumb and wrapped and above them.
2. he geotextile must completely enclose to tires chips in order to provide the necessary containment.
3. omogenous grain size for both additive and muddy soil in order to have homogenous improvement for characteristic properties.
4. heck every test 3 times in order to insure a correct result.

Characterization tests

Total wet and dry density (total density) and specific gravity (Gs): Figures (1, 2) show the effect of moisture on the prepared standard and improved soil mixtures with waste rubber , plastic and commercial carbon fiber. The values of total density were improved at increasing additives and reduce the amount of moisture required from 15% of standard sample to 25% for improved mixture and decreasing these values for waste rubber additive especially for optimum additive of 18 % w/w (WR) at 15% moisture required and 560 g/cm^3 total density than 600 g/cm^3 for waste plastic optimum sample and low density for standard and commercial additives of 520 g/cm^3 according to the high absorption waste rubber to moisture then improve the absorption property for the improved muddy soil[9,10]and less absorption properties for waste plastic and inhommgenity properties for commercial one respectively[7].

Figures (3, 4) show the effect of moisture and additive content on dry density. The values of dry density wereG decreased with increasing both moisture and weight percent of additives especially for optimum one of 18% wt for both additive waste rubber and plastic of 27 and 20 g/cm^{3}T according to improvement in chemical properties between additives and soil molecules than standard and commercial sample of segregation and inhomegiety structure [9,11]. H

Figures (5, 6) shows the effect of additive weight percent of (WR, WP, SS, and CS) on Gs values of improved soil, these values were fixed approximately with weight percent additive with less values for plasticC waste than rubber on under hot and cold ambient conditions applied this lead to high compaction for WR additive than WP one according the similarity in physical properties between waste rubber and plastics [10].

Figure (7) show an optimum weight of additive waste mixed that give best compaction after drying at 18% additive weight percent for both waste plastic and wastes rubber at 1.95 for WP than 2.05 for WR respectively.

Figures (8, 9) indicate the effect of additive weight percent on the hydration properties of improved soil. The values of participated molecules were increased with increasing additive weight percent of waste used than standard one with preference 18% wt for plastic and 30% wt for rubber at increasing time of 55 and 40 molecules participant according to different relation between additive molecules and water molecules with high absorption properties for waste rubber than plastic one respectively [7,10].

Figures (10,11) show the effect of required moisture that made failure mix (truck no.) .The values of moisture have reverse relationship to no. of trucks that cause failure where less amount of moisture required for 18% wt of waste plastic sample and 60% for waste crumb rubber sample according to the absorption characteristic properties for crumb rubber than plastic [11].

And Figure (12) shows the effect of additive weight percent of plastic limit for all standard and improved mix. The plasticity limit was decreased with increasing of weight percent content until reach optimum weight content for both at 18% wt and 25% plastic limit for ISR and 15% plastic limit of ISR one according to absorption properties of crumb rubber than plastic one [11].

Conclusions

Based on the experimental results described in this research, the following conclusions are put forward:

1. The crumb rubber optimized to satisfy both requirement maximum speed of absorption and mixing time to control bleeding at 18% wt.WR.
2. The crumb rubber have low moisture content and high compaction (strength) properties at 18% wt of 555 g/cm^3 T.D than plastic one of 545 g/cm^3 and 540 for commercial carbon fiber one .
3. Low density for optimum crumb rubber mix and high GS result get it at 22 g/cm^3 at 18% wt and 2GS rather than 23 g/cm^3 and 1 GS for plastic on that are required to design light weight material mix.
4. Best hydrated properties of less hydration of optimum mix of crumb rubber 40% of participated molecules rather than 55% for waste plastic sample for 3 day period.
5. Low moisture contact and both high strength and compaction properties for optimum mix of 18% wt for crumb rubber than waste plastic applied.

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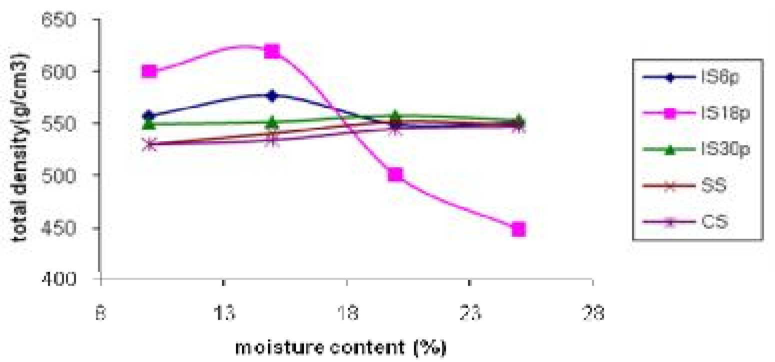

Figure (1) Effect of moisture content on the total density of standard, improved and commercial sample of soil.

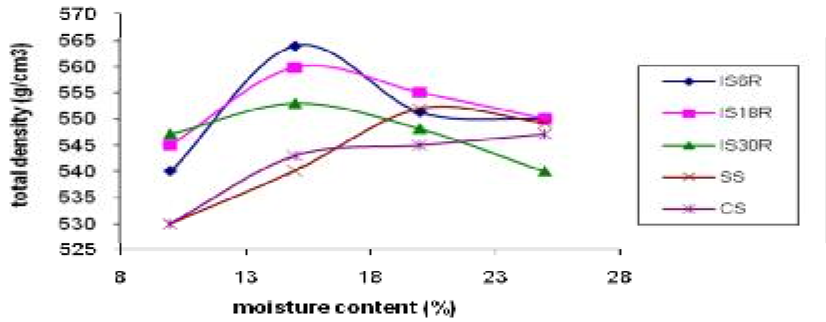

Figure (2) Effect of moisture content on total density of improved, standard and commercial soil.

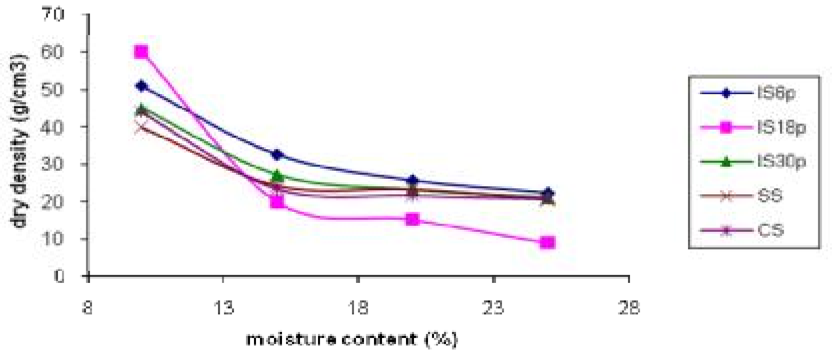

Figure (3) Effect of moisture content on dry density of improved, standard and commercial soil.

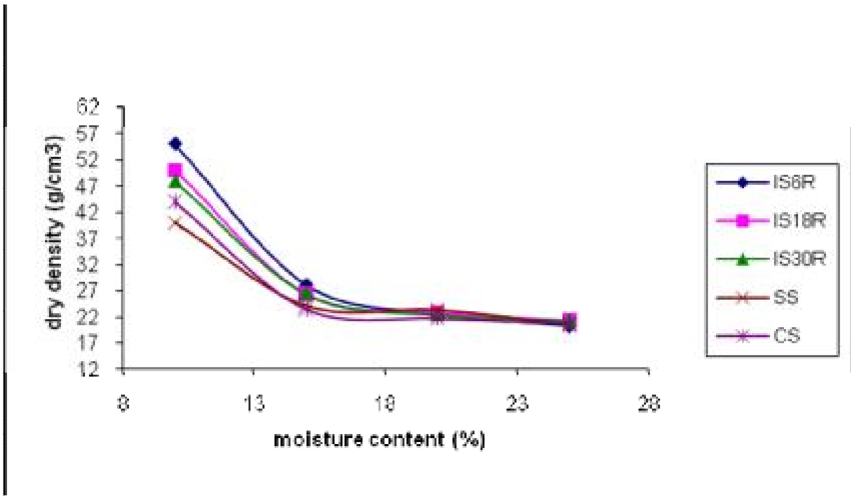

Figure (4) Effect of moisture content on dry density of improved, standard and commercial soil.

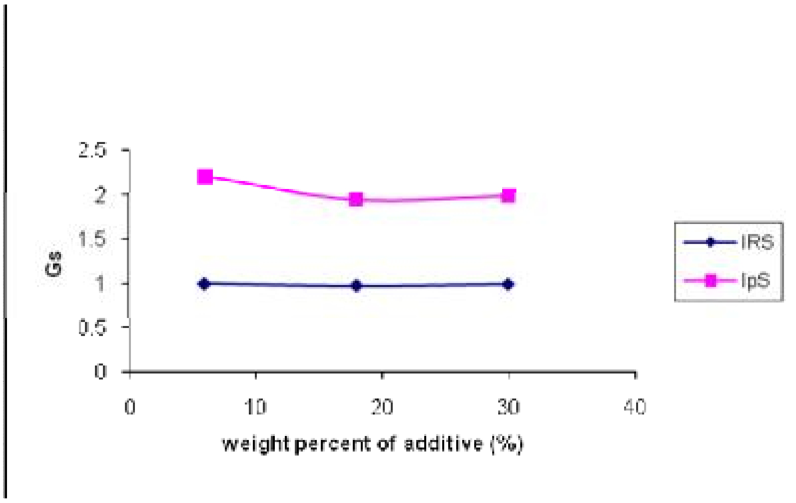

Figure (5) Effect of additive component on specific gravity Gs of soil under cold water.

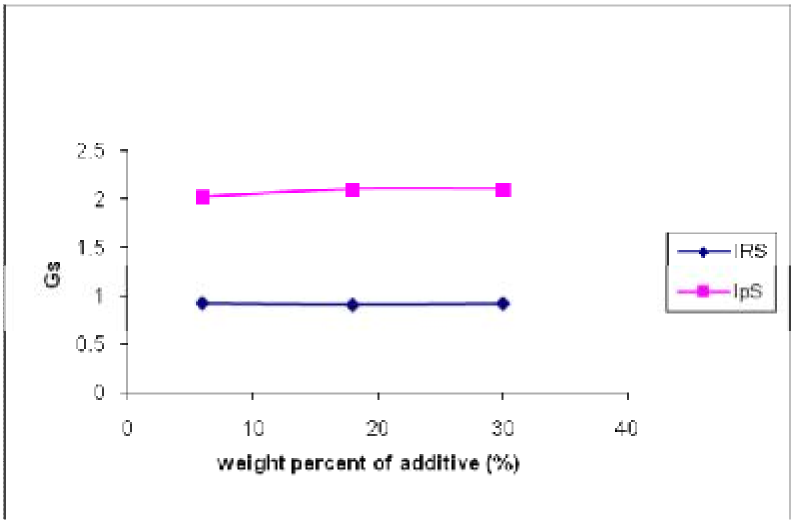

Figure (6) Effect of additive component on Gs of soil under hot water.

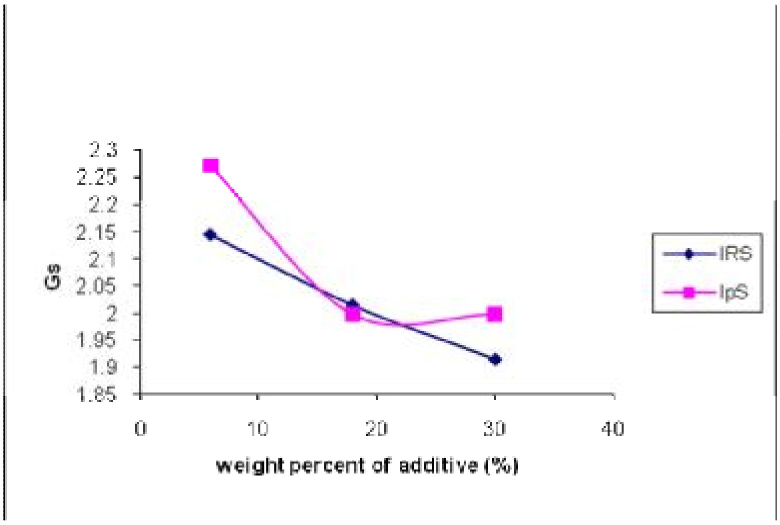

Figure (7) Effect of additive component on Gs of soil after drying.

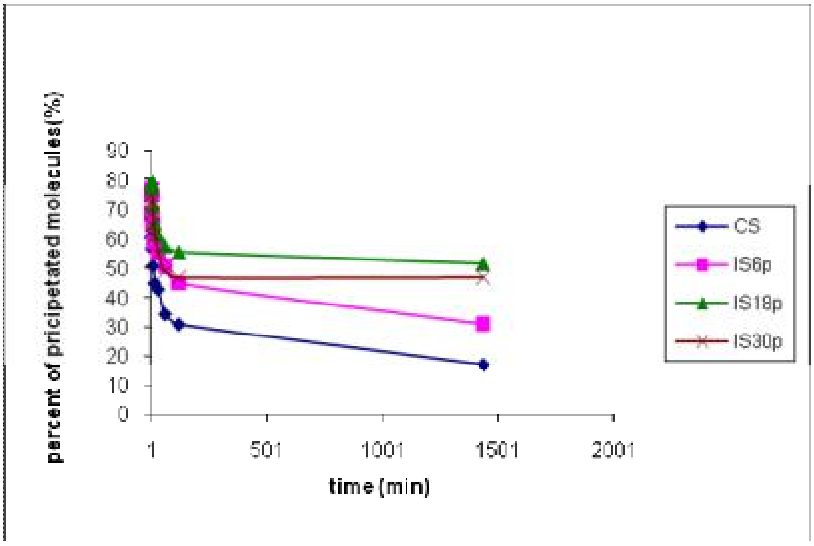

Figure (8) Effect of additive precipitated percent of molecules soil.

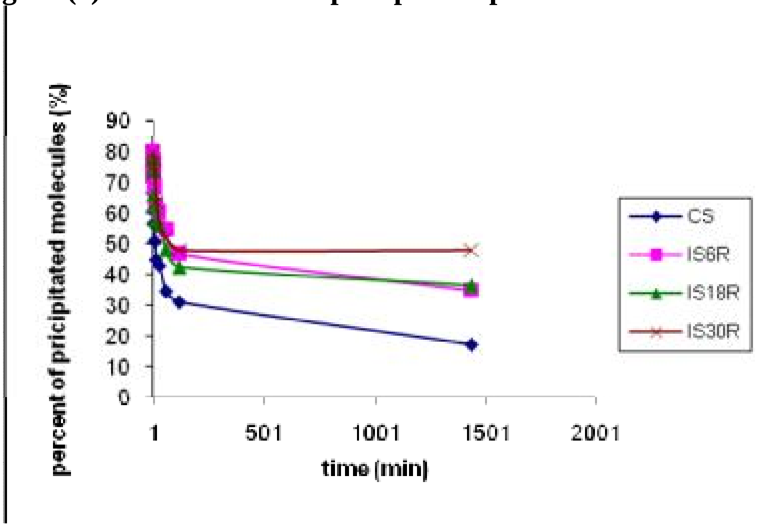

Figure (9) Effect of additive content on percent of precipitated molecules of soil.

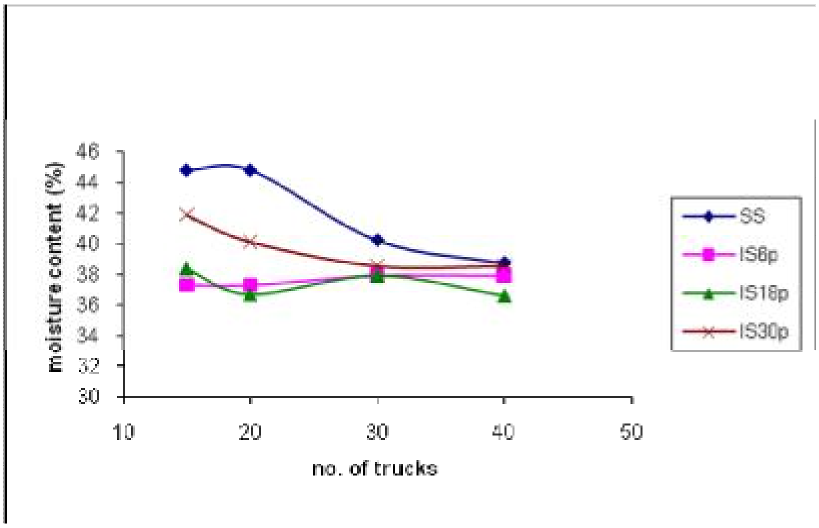

Figure (10) Effect of additive content on moisture and truck no. of standard and improved soil.

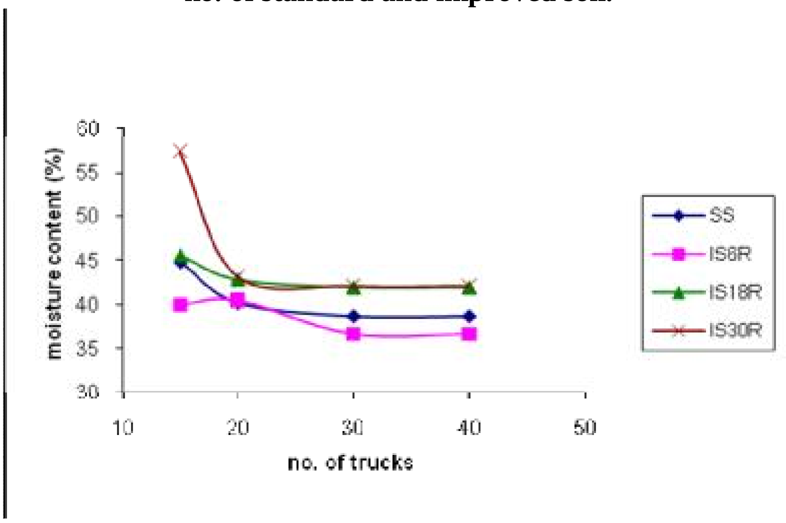

Figure (11) Effect of additive content on moisture and truck no. of standard and improved soil.

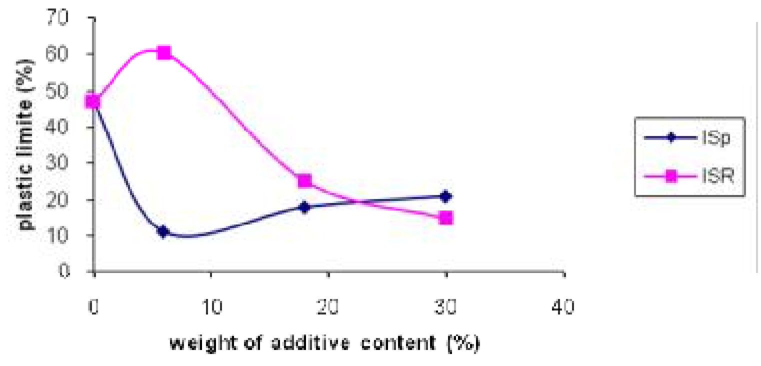

Figure (12) Effect of additive content on plastic limit of standard and improved soil.