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Effect of Reclaim on California Bearing Ratio of Sandy Soil

Mohammed K. Fakhraldin[1], Tawfek Sheer Ali[2], Rasha A. Al-Fatlawy[3]

Dr., Civil Eng. Dept., Faculty of Engineering, Kufa University, Najaf, Iraq[1]

Dr., Structures and Water Resources Dept., Faculty of Engineering, Kufa University, Najaf, Iraq[2]

Assistant Lecturer, Civil Eng. Dept., Faculty of Engineering, Kufa University, Najaf, Iraq[3]

Abstract: Recently, a fast evolution of structures in urban centres attended by a dearth of beneficial areas has pushed the specialists to recover soil properties in order to carry the applied loadings of structures. One of the technology of soil advancement is use of admixtures. In Iraq, the tires Reclaim are produced by Ministry of Industry and Metals with low costs because it is considered as a by-product of tires manufacturing. This paper concerned with investigates the use of Reclaim as additive to soil. The effect of Reclaim on California Bearing Ratio (CBR) of sandy soil is studied. Many of laboratory tests was carried out on the original soil (0% Reclaim) and using 0.5%, 2%, 4% Reclaim by the weight of soil. A CBR laboratory tests on soil samples without and with Reclaim under 4 days soaking condition to simulate the long-term soaking case. The results show that the dry unit weight of sandy soil increase when the Percent of Reclaim increase. Also, for all cases (0%, 0.5%, 2% and 4%) Reclaim, CBR increase as the dry unit weight increase for each case. The main important conclusion conducted that CBR decrease when the percent of Reclaim increase, thus, use of Reclaim do not improve the soil to carry the applied loads, the increment in CBR varies from 7.6% to 68.8%.

Keywords: Improvement soil, CBR, Rclaim, Tires waste.

I. INTRODUCTION

Recently, a fast evolution of structures in urban centres attended by a dearth of beneficial areas, has pushed the specialists to recover soil properties in order to carry the applied loadings of structures. The technology of ground recovery might be removal and replacement, pre-compression, vertical drains, in-situ densification, grouting, stabilization using admixtures and reinforcement. The quantity of the old tires dump is increasing as the size of urbanization grows around the world. One of the available options to get rid of these waste products is to recycle them by using them as a stabilizing material. Recently many studies have been conducted to examine the tire waste in enhancing soil performance in terms of strength, bearing capacity and permeability.

[1] Investigated the subgrade pavement soil stabilized with sliced (10 × 20) mm unused tires chips. CBR tests were carried out on soil and soil-tire chips mixtures to investigate the CBR from which the adequacy of soil improved with sliced tires can be assessed. In addition to that the thickness of the pavement can also be determined from the CBR value. The founding is that the improvement in CBR of improved soil is twenty one percent in unsoaked condition and twenty two percent in soaked condition, importantly reduction in the total thickness of the pavement achieved by the increase in CBR because of that the total cost confused in the project.

[2] Study of improving shear strength of sand by mixing rubber material with fine and coarse sand in four percentages: 5, 10, 20, and 50%. Mixing of Leighton Buzzard and Ceyhan as coarse and fine sand, respectively, with various percentages of rubber content has shown that internal friction and shear strength are reduced as the rubber content increased in the direct shear test. However, sand which includes rubber content less than 10% has yielded a maximum shear strength reduction. As the rubber content more than 10%, the maximum shear strength for sand remains constant. For the angle of friction of Ceyhan sand, it is reduced up to adding 10% rubber content, while no further change occurred with the other percentages.

[3] Investigating the effect of using tire waste as an additive on bearing capacity and shear strength. To accomplish that, a many experiments have been carried out on samples of soil for different sand to tire content ratios, moisture content, and size of tire waste. Two configurations of tires waste have been applied: tire buffing and tire powder. Percentages of sand to tire mixtures of zero, Ten, Twenty and Thirty percents of waste tire content by weight were considered. Two apparatus: direct shear test device and CBR test device has been used to study the effect of tire waste material on the bearing capacity of the soil, both apparatus were calibrated and tested to meet respective standards. Results showed that adding of up to 20% of tire buffing to that sand will result in a very little effect on bearing capacity while a major effect is noticed in increasing (c and Ø).

II. MATERIALS AND TESTING

1. Soil Properties

A sieve analysis of used soil is carried out according to [4] is shown in Fig. 1. The used soil is indexed as SW (Well-graded sand with gravel) accordance to the Unified

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Classification. The physical and chemical properties are drawn in Table 1. Physical properties represented by water content, sieve analysis, specific gravity and maximum density. Chemical properties include SO_3 content, total soluble salt content (T.S.S), organic content and gypsum content.

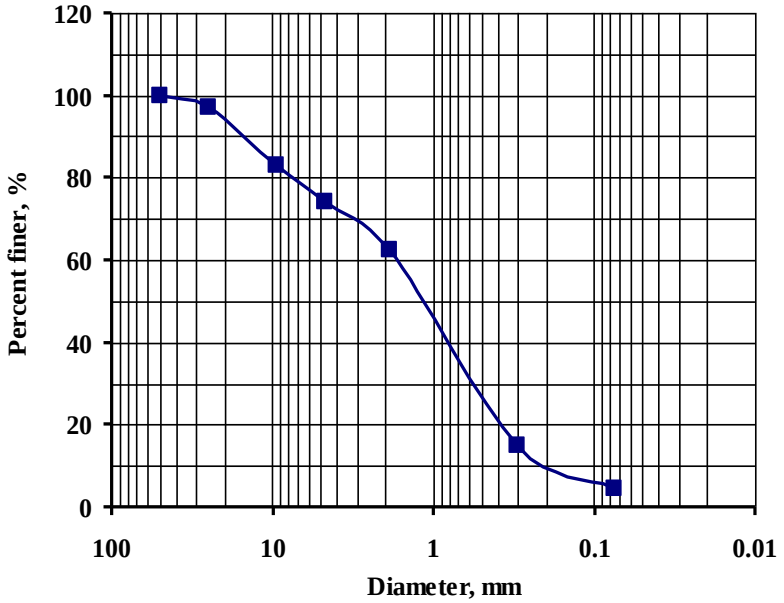

Fig.1. Grain size distribution of used soil

2. Tires Reclaim

Remade the loss rubber is a very considerable problem. In theory as well as economically and actually. From the various origins of scrap rubber, those gotten from tires are the much useful. Thus, over the past few years, important care has been given to the rubber application's problem of disposing of this scrap. Reclaimed Rubber is cured rubber that has passed through a Thermo-Chemical process. This case softens and inflation the rubber. The viscosity of the rubber is reduced by reducing the polymer chain by mechanical shear and chemical action.

Reclaimed rubber factory is one of the factories of State Company for Tire Industry in Iraq. The reclaimed rubber produced by this factory, part of it used by Babylon tires factory and the rest marketed to sister companies and the private sector, this Reclaim is used in this study.

Table 1 Chemical and Physical Properties of Used Soil

The chemical Properties	So_3	T.S.S	Organic Content	Gypsum	-	-	-	-
	0.1%	0.3%	0.01%	0.5%	-	-	-	-
The physical properties	G_s	$\gamma_{d\ max}$	O.M.C	LL	PL	PI	C_u	C_c
	2.62	20.5	8.2%	28%	16%	12%	9.25	1

III.CBR TEST

California Bearing Ratio (CBR) test is a laboratory test used to estimate of base, sub-base and subgrade layer strength of roads. The CBR was developed by the California Department of Transportation, and since then it has been used for pavement design purposes. It was intended to describe granular aggregates with sizes ranging between 4.75 mm and 20 mm. More recently it has been used for soil materials. To simulate the effect of long – term soaking field condition, the soaked CBR is determined on a representative sample of the soil. First, compaction of each specimen and other sample of the remaining material after compaction of each specimen, the water content is determined then according to [5]. The optimum water content and maximum dry density according to the compaction method specified [6] are determined. The water content-unit weight relation for the 10-blow and 30-blow per layer compactions is made and each test specimen compacted is penetrated. water content-unit weight relation for the 65- blows is developed also to specified unit weight at or near hundred percent $\gamma_{d\ max}$ so it will be very important to give an offort of compaction greater than fifty six blows for each layer, [7].

All compaction is performed in the CBR mold. The relationship between load and penetration for the 4 days soaking soil can be drawn and choose corrected stress values taken from the relationship for 2.54 mm and 5.08 mm displacements, evaluate the bearing ratios of each by division the corrected stresses by the standard pressures 6900 kPa and 10300 kPa respectively, [7], the higher value is adopted as a CBR. The equipment of CBR test is shown in Fig. 2.

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IV. RESULTS AND ANALYSIS

Many CBR laboratory experiments on the soil samples without and with 0.5%, 2% and 4% Reclaim. The tests are performed under 4 days soaking condition to simulate the long-term soaking case. CBR results are recorded and the comparisons are drawn as follows:

1. CBR Test Calculation

According to (ASTM D854-05, 2007), the relationship between load and penetration is drawn to determine stress value corresponding to 2.54 mm and 5.08 mm penetration and estimate the bearing ratios for each by division the corrected pressures by the standard stresses of 6900 kPa and 10300 kPa respectively.

Figure 3 show the relationship between penetration and stress for 10, 30 and 65 blows for original soil (0% Reclaim), the value of CBR for this case is 10.8, 15.7 and 21.5 for 10, 30 and 65 blows respectively. Figures 4, 5 and 6 shows the same relationship for 0.5%, 2% and 4% Reclaim of the weight of soil, the same procedure adopted to calculate CBR.

Fig 2 CBR equipment

2. Percent of Reclaim and Dry Unit Weight Relationship

The water content-unit weight relation for the 10 blows, 30 blows and 65 blows per layer compactions is made and each test specimen compacted is penetrated. The relationship between the percent of Reclaim and maximum dry density for each No. of blows can be drawn as shown in Fig. 7. From this figure it can be seen that the maximum dry density increase significantly when the percent of Reclaim increase up to 1% and the increment vanishes gradually reaching to 4% Reclaim.

3. Dry Unit Weight and CBR Relationship

Design CBR for one water content only using the data obtained from the 3 specimens by plotting the CBR-dry density as molded relation for 4 days as a periods of soaking as shown in Fig. 8.

4. Effect of Reclaim on CBR

One of the main aims of this study is investigating the effect of add the Reclaim to the sandy soil. Fig. 9 show clearly this effect by drawing the relationship between the percent of Reclaim and CBR value. From this figure it can be seen that the CBR decrease by add the Reclaim to the sandy soil. To make the decrement in CBR resulting from add the Reclaim to the soil more clear, the relationship between the percent of Reclaim and CBR ratio is drawn as shown in Fig. 10.

CBR ratio can be expressed by the following equation as:

$$CBR\ \% = [(CBR_w - CBR_R)/(CBR_w)] \times 100\%$$

Where,

CBR % = CBR ratio
CBR_w = CBR without Reclaim
CBR_R = CBR with Reclaim

This ratio show the increment in CBR as a percentage, for example, in Fig. 10 at the percent of Reclaim 2% the increment in CBR is 21.7%

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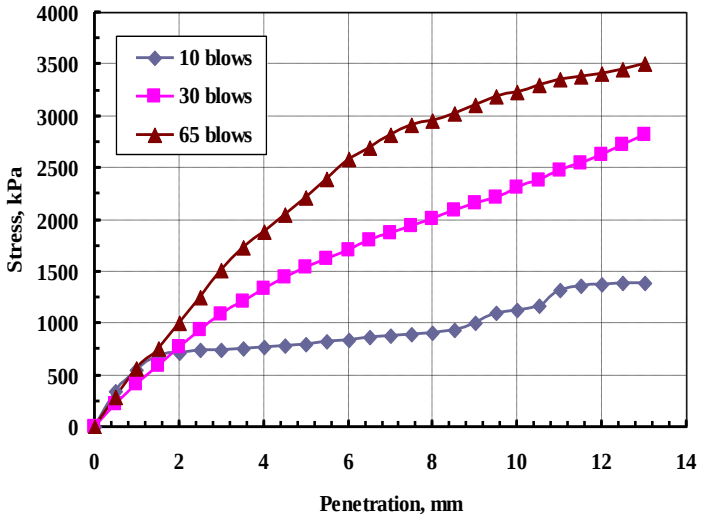

Fig. 3. Load - Penetration curves of CBR test for original soil (0% Reclaim) case

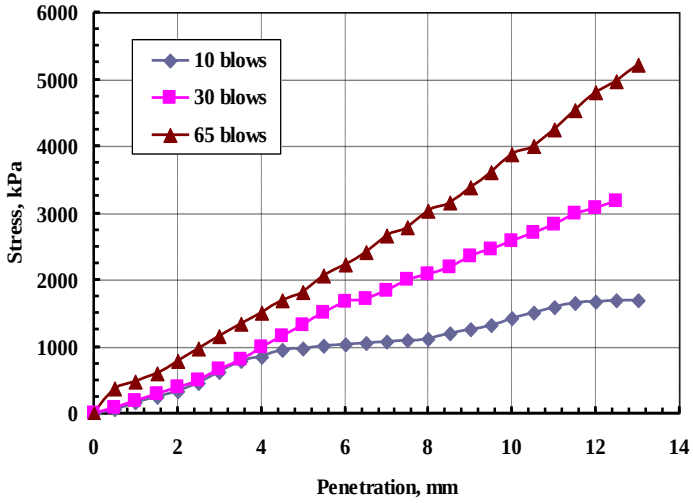

Fig. 4. Load - Penetration curves of CBR test for 0.5% Reclaim case

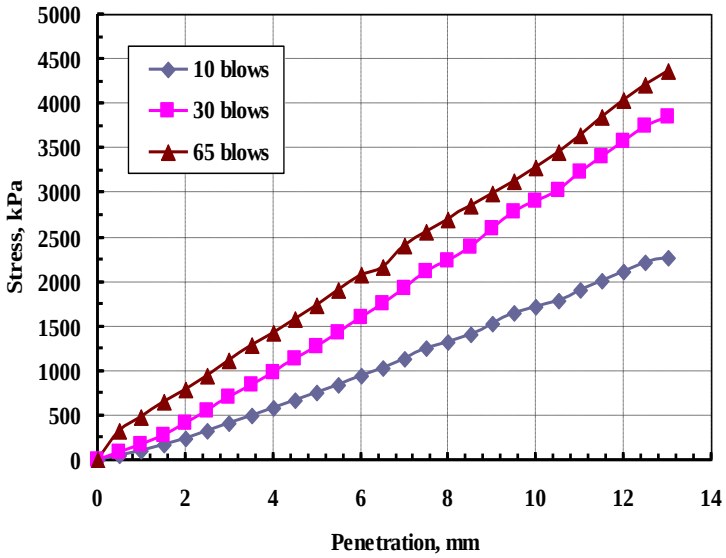

Fig. 5. Load - Penetration curves of CBR test for 2% Reclaim case

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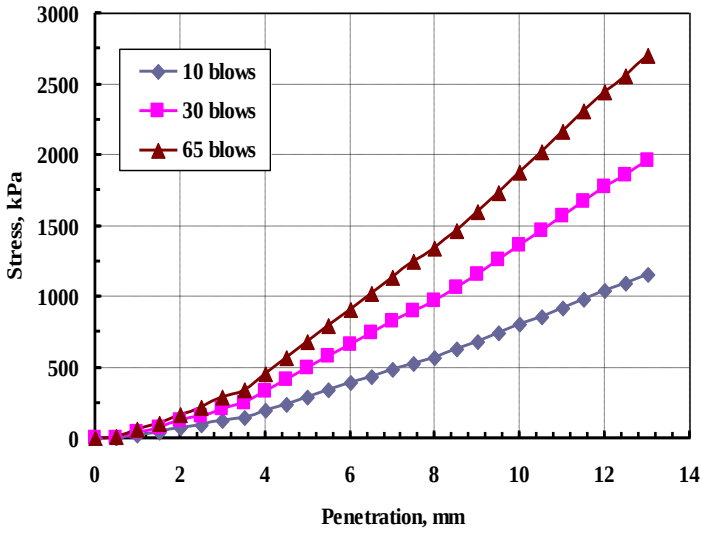

Fig. 6. Load - Penetration curves of CBR test for 4% Reclaim case

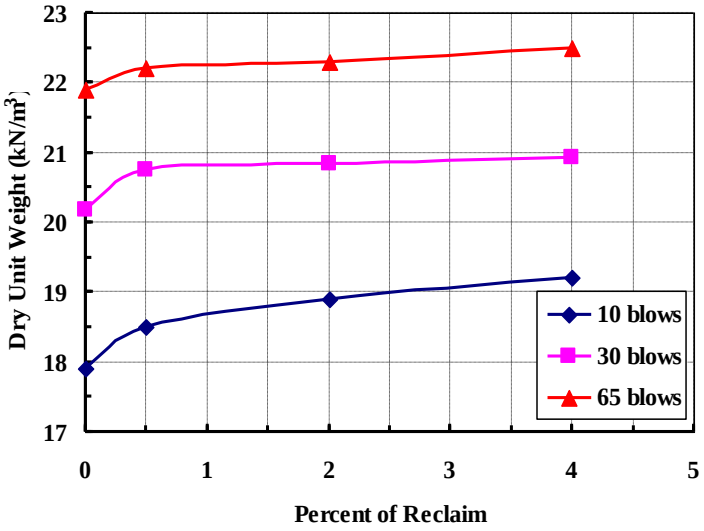

Fig.7. Percent of Reclaim and unit weight relationship

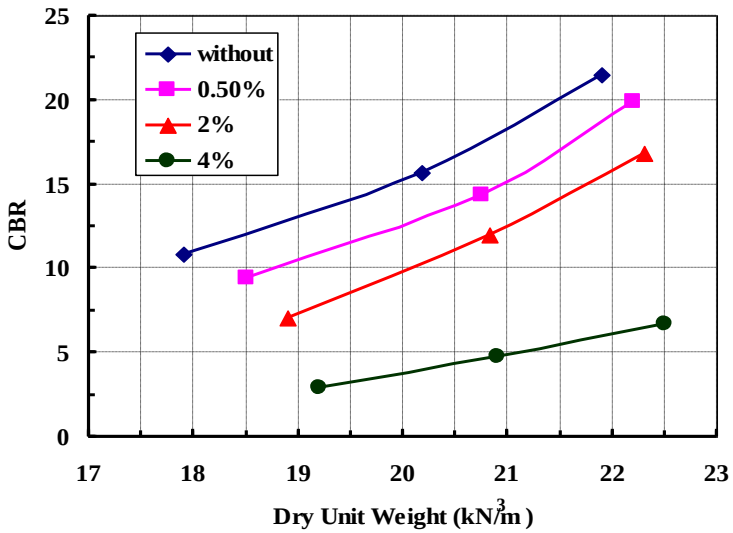

Fig. 8. Dry unit weight and CBR relationship

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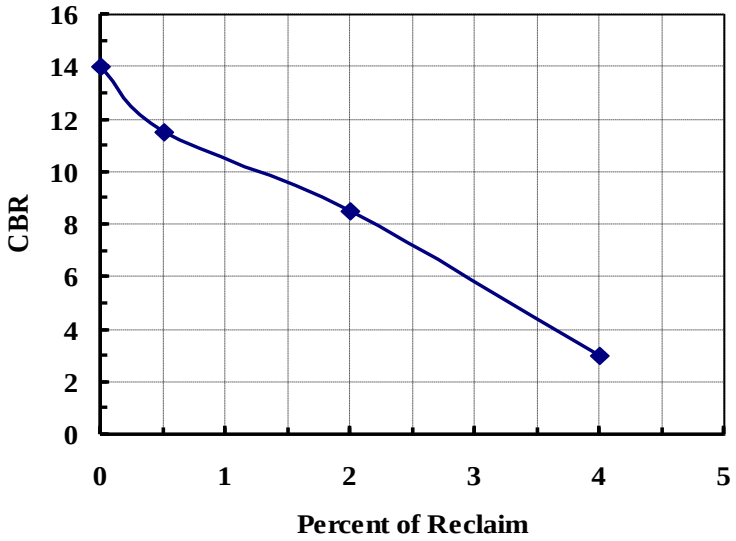

Fig. 9. Percent of Reclaim and CBR relationship

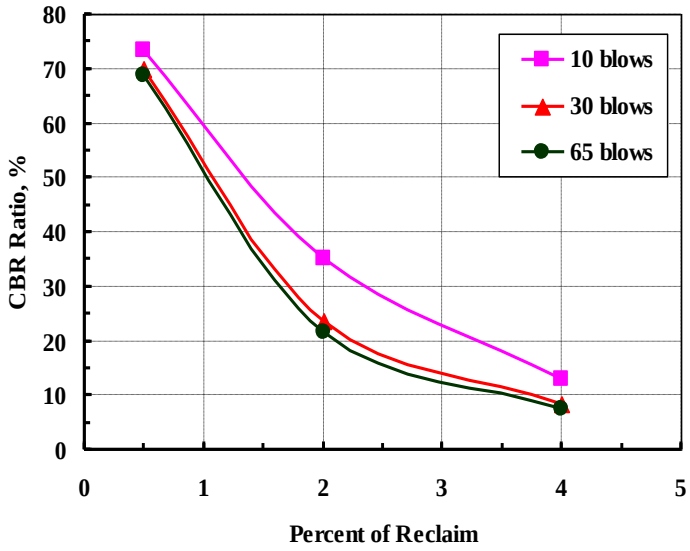

Fig. 10. Percent of Reclaim and CBR ratio relationship

V. CONCLUSIONS

Many laboratory tests on soil samples to find the value of CBR without and with Reclaim (0.5%, 2% and 4% Reclaim by the weight of soil). The tests are performed under 4 days soaking condition to simulate the long-term soaking case. Many conclusions can be drawn as:

1- The dry unit weight of sandy soil increase when the prcent of Reclaim increase, the increase is significant up to 2% Reclaim and the increment decrease gradually up to 4% Reclaim.
2- For all cases (0%, 0.5%, 2% and 4%) Reclaim, CBR increase as the dry unit weight increase for each case separately.
3- California Bearing Ratio (CBR) decrease when the percent of Reclaim increase, thus, use of Reclaim do not improve the soil to bear the applied loads.
4- The increment in CBR varies from 7.6% to 68.8% when the percentage of Reclaim varies from 0.5% to 4%.

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