ENHANCEMENT OF SOIL BEARING CAPACITY BY USING POLYMER EMULSION

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ENHANCEMENT OF SOIL BEARING CAPACITY BY USING POLYMER EMULSION

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Abstract : *In the last decades, using of nontraditional chemical materials like polymer in soil stabilization field has been widely increased to treat the weak in available local soils. To discuss the effect of polymer emulsion on physical and chemical characteristics of soil material, a laboratory experiments are performed for California Bearing Ratio (CBR) test in present paper. CBR test considers a good parameter to recognize the weak and problematic soils which have indeed low value of CBR test, therefore it is need to more thickness of pavement and structural foundation. The grain size and modified proctor tests are included in the performing laboratory tests to classify the subbase material that utilized in experiments according to ASTM. A different amounts of polymer are taken as a percent of weight of subbase and mixed together in laboratory conditions. From the results, it is found that the strength of subbase material significantly improved and showed the suitable percent to achieve the goal. The prime objective of this study is to improve strength of natural soil for increasing California Bearing Ratio of in-situ soils by 2 to 4 times.*

Keywords: California Bearing Ratio Test, Nontraditional Stabilizers, Polymer, Soil Stabilization, Subbase Material.

1 INTRODUCTION

Numerous methods of enhancing available local soils have been adopted to ameliorate one or more of its properties to match an engineering tendency. Those methods, (biological physical, chemical, or combined) are currently known as soil stabilization[1]. Most effort focus on increasing bearing capacities of natural soil, subsoils, sands, and other decay materials so as to boost under structure. Other objectives of soil stabilization are permeability and soil resistance improvement to weathering erosion and traffic usage [2].

Table 1: Engineering properties of natural soils (subbase Type C)

Property		Test value	Specification value
sieve analysis %	2-in. (50-mm)	...	...
	1-in. (25.0-mm)	100	100
	3⁄8-in. (9.5-mm)	74	50 to 85
	No. 4 (4.75-mm)	61	35 to 65
	No. 10 (2.00-mm)	43	25 to 50
	No. 40 (425-µm)	26	15 to 30
	No. 200 (75-µm)	5	5 to 15
Proctor parameters	Optimum Moisture Content, (%)	7	--
	Maximum dry unit weight,(g/cm3)	2.02	---
CBR %		32	30 minimum

Cement, lime, fly ash, cement kiln dust, reinforcement, and asphalt emulsion are in expensive and usually easy to apply on different types of soil. These materials give rise to increase strength and durability. Polymer, acids, enzymes, and others, may be in liquid or solid form are unconventional additives available from commercial sector and can be usable for most soils[3,4,5,6,7]. Conventional techniques of soil stabilization use widely accepted types of products like bitumen emulsion which is apply in road base as a fasten tool, but it becomes brittle when dries out, therefore it can be consider as non environmentally friendly. Some of a new additives prevent road failure because of water permeation or dense frosts depending on making a hydrophobic surfaces technique that prohibiting the access of water into the processed stratum.

Another method of soil stabilization called deep injection method is non destructive and effective in improving the ability to withstand deficiency or incoherent soils especially for re-compaction and consolidation strata[8]. Generally, increasing bearing capability and improving the strength and the treating of sinkhole troubles under structures are ultimate purpose for researchers.

2. MATERIALS:

2.1 Subbase type (C): is used in this experimental study. Gradation or grain size distribution is used to help depict and sort a subbase material. Gradation (SEIVE ANALYSIS) of the soils is achieved criteria which are presented in Table (1) according to ASTM D1241-14[9].

Compaction requirements are measured in terms of dry density of subbase materials. The maximum dry density and optimum moisture content (OMC) for compactive stress are basic properties to construct subbase layers. These properties are determined by compaction curve, i.e., a moisture density curve or a proctor curve[10].
Optimum moisture content to satisfy maximum dry density of the subbase material was determined by using the modified Proctor method (ASTM D1557). The moisture-density compaction curve for the sample is presented in Figure 1.

California Bearing Ratio test is prevalent method of estimating strength of materials for construction Requirements [11]. If the California bearing ratio (CBR) of the material has very low value, it needs more thickness of pavement or foundation. Thus CBR is Considered as standard method used to predict bearing capacity which is done according to (ASTM D1883).

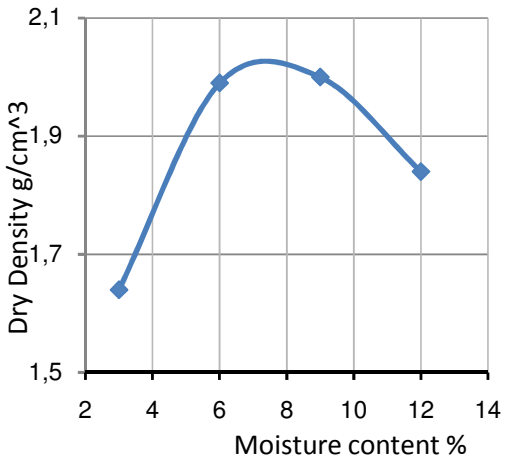

Figure 1. Moisture-Density Curve

Therefore the properties of the tested natural soil in term of sieve analysis, compaction parameters and CBR value are given in Table 1.

2.2 Polymer emulsion consists from two products(Poly Ole and Poly vinyl Acetate) mixed together in specific percentages by Polymer Research Center in Basra University to produce the Polymer emulsion in final form which mix in turn, with the specified percent of optimum moisture content, to prepare samples of CBR test. Poly Ole(P.O) is used as a hardener and inflator which is a commercial cruciferous material and is used by 1:3 as a bond material. Poly vinyl acetate(P.V.A) material is used as adhesives for porous materials mostly for wood and paper.

3. SAMPELS PREPARATION:

CBR specimens were prepared and tested according to ASTM D1883-14. A sample of the materials(polymer emulsion and subbase material) was mixed to dough by using mechanical kneader, where the polymer emulsion is added gradually to subbase through mixing operation as shown in Figure 2. The samples, uniformly mixed dough, were well compacted with 25 blows by a moving hammer for each layer where the mold was filled with material by 5 layers to meet the requirements of the modified proctor compaction (ASTM D1557-14). Figure 3 shows a mechanical press with made to compute CBR values of performed samples. An applied force and vertical deflection into the sample have been measured by digital load cell and linear variable differential transformer respectively.

CBR samples were conducted at a strain rate of 0.05 inches per minute. Stress measurements are recorded at a total depth of 0.5 inches every 0.025 inches of penetration. CBR values are recorded at each 0.1 inch interval by taking the stress at each interval and dividing it by the stress of a standard gravel material. The CBR design is taken as the higher value at either 0.1 or 0.2 inches of penetration into the top and bottom of the sample. As provided in the ASTM D 1883, the prepared samples were immediately soaked for 96 hours in a soaking tank.

Figure 2. Mechanical kneader

Figure 3. Mechanical CBR test Device

4. TEST RESULTS:

the influence of polymer emulsion addition on The California Bearing Ratio of subbase material has been investigated by perform experimental work

4.1 The desired quantities of polymer as a percentage of sample's dry weight were mixed and thereafter added to dry soils with 50% of O.M.C. The amounts of polymer emulsion were selected as 1, 2, 3, 4, 5, 6 and 7% by Total sample's weight.

The mixed sample was placed in the mould and submerged in the water basin. The specimens were taken out of the basi n after 4 days later and

it tested. The results have been recorded as shown in Fig 4.1

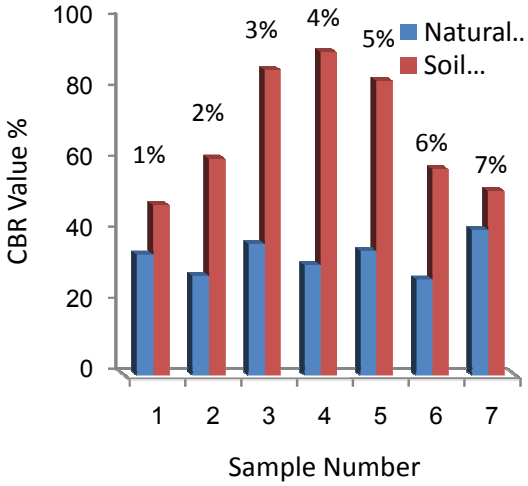

Fig 4.1 CBR values for 7 samples of soil with and without additive

Where the sample number represents percentage value of the additive (polymer emulsion). From this results it is noted that the percent value 4% gives more suitable result than other additive percentages and the CBR value is increased by three times of the sample without additive. And it can be seen that CBR values will be reduced after 4% additive because increase moisture content significantly in the samples.

4.2. A desired percentage of polymer is adopted to form samples which are submerged in water basin after releasing it a 24 hours to be stiffing as mentioned in the criteria of ASTM D1883 where the specimen contains self-cementing materials(which gain more strength with time) and comparing results with natural case(submerged immediately) as shown in Fig 4.2. From this figure it is clearly that the samples which left to dry 24 hours have better CBR values than soaking immediately.

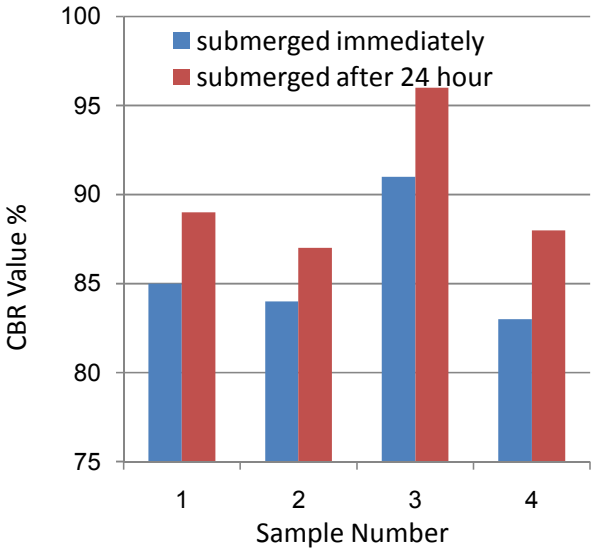

Fig 4.2 CBR values for 4 samples of soil with 4% polymer.

To study the behavior of the polymer emulsion with another stabilizer material its added a 1% cement of dry weight of subbase to the mixture and modeling some samples to test then the results were plotted as shown in Fig. 4.3.

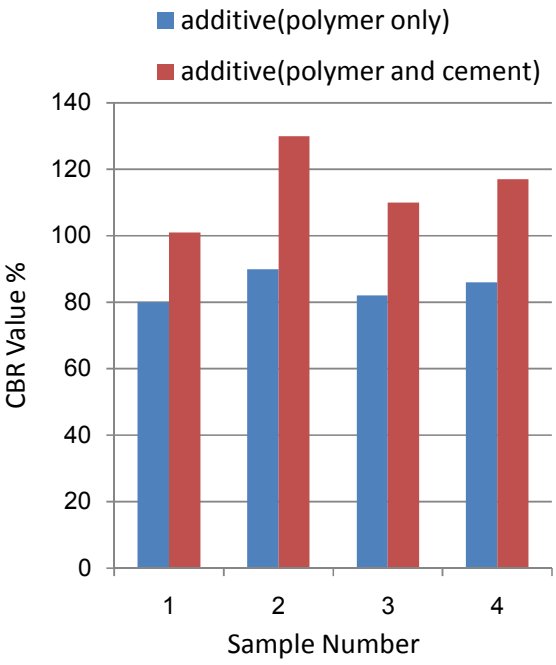

Fig 4.3 CBR values for 4 samples of soil with two type of additive(polymer and cement)

5. CONCLUSIONS:

1- The CBR of a soil increases by 3 times when polymer emulsion is added. The amount of improvement depends upon the additive percentage. As shown, in case of sample No.4 ,without adding the CBR value, is 31% and with polymer additive the CBR value increases to 91%.
2- Its can see that CBR values will be reduced after 4% additive because increasing of moisture content significantly in the samples.
3- It is clear that there is a considerable amount of increase in CBR value of soil with additive when it is released 24 hour at least before soaking in water.

4-High results of CBR were recorded when its adding the cement to mixture reach to 134%.

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