Improvement of Engineering Properties of Subgrade Soil of Eastern Peripheral Expressway

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Abstract— Pavement design is based on the premise that minimum specified structural quality will be achieved for each layer of material in the pavement system. The engineering properties of soil subgrades are needed to be strong enough to sustain load by stabilization methods. Subgrade of a soils are stabilized by using cement and lime. This work is done to enhance its engineering properties and improve its subgrade strength also it reduces the cost by using some stabilizers. With the variation of stabilizers content, samples were made at their maximum dry density and optimum moisture content. The CBR value is changed with increase in cement content and slightly increase with addition of lime. It is found that construction of pavement with stabilized sub-grade is economical than untreated subgrade.
Key words: Soil Subgrade, Cement, CBR, Stabilization

I. Introduction

Soil stabilization refers to the process of changing **soil** properties to improve strength and durability. A soil exhibiting a marked and sustained resistance to deformation under repeated or continuing load application, whether in dry or wet state, is said to be a stable soil. When a less stable soil is treated to improve its strength and its resistance to change in volume and moisture content, it is said to be stabilized. Thus, stabilization infers improvement in both strength and durability. In its earlier usage, the, term stabilization used to signify improvement in a qualitative sense only. These quantitative values are expressed in terms of compressive strength, shearing strength or some measure of load bearing value. These in turn indicate the load bearing quality of the stabilized construction. Again, the durability indicates its resistance to freezing and thawing and wetting and drying. Stabilization as used in road construction is a method of processing available materials for the production of low-cost roads. In this type of design and construction, emphasis is usually placed upon the effective utilization of local materials with a view to decreasing the construction cost.

II. Literature view

I have reviewed many research works related to my research. In which some of most important and similar to my project are as under:

Manar Gaafer et. al, is described that Soil at a construction site may not always be totally suitable for supporting structures in its natural state. In such a case, the soil needs to be improved to increase its bearing capacity and decrease the expected settlement. This paper gives an overview of techniques that are commonly used to improve the performance of saturated clayey soil in situ, its functions, methods of installation, the applicable soil types and cost of those techniques. Then, this study concluded that there is an urgent need to study the technique of removal and replacement for improving soil behavior taking into consideration geotechnical requirements (i.e. bearing capacity and settlement) and cost to achieve the optimum thickness of replacement layers and the most suitable material corresponding to minimum total cost of foundation works.

A. Air Slaked Lime

According to the ASTM-C-51-47, lime is defined as a general term which includes the various chemical and physical forms of quick lime, hydrated lime, and hydraulic lime. It may be high-calcium, magnesium or dolomitic. The quick lime is a calcined lime stone, the major part of which is calcium oxide or calcium oxide in association with magnesium oxide, capable of slaking with water. Air slaked lime is the product containing various properties of the oxides, hydroxides, and carbonates of calcium and magnesium which results from the exposure of quick lime to the air in sufficient quantity to show physical signs of hydration (difficult to determine visually in pulverized quick lime).

The calcined lime-stones contain the oxides of calcium and magnesium in varying proportions. These oxides show a great affinity for water. The chemical reaction is

$$CaO + H_20 = Ca(OH)_2$$

Kulkarni (1977) showed that for every 56 parts of calcium oxide, 18 parts of water by weight combine to form 74 parts of calcium hydroxide. He also pointed out that for the hydration of lime, 47 percent of water by weight of lime was required.

III. Objective

The objectives of the research therefore as follows:

a) To find out the effect of stabilizer such as cement in order to obtain an improved sub-grade.
b) To develop a quick evaluation technique of compacted sub-grade.
c) To have economically analysis of pavement of treated and untreated sub-grade soils.

IV. Methodology

For efficient and economic application of stabilization technique it is essential to understand the basic mechanism of the process. The broad objective of this research is to experimentally review various aspects of soil-cement and soil-lime stabilization of two selected sub-grade soils.

A. The Test Programme

The whole research was divided into the following phases:

1) In first phase, index properties of the soil samples were determined in order to classify them.
2) In the 2nd phase, the moisture density relationship of the soils was established. Then durability and strength of stabilized soil were evaluated by wetting drying test,

unconfined compressive strength test and California Bearing Ratio Test.
3) In the final phase, dynamic cone penetrometer test was conducted on stabilized soil to have a relationship between DCP and CBR.

B. Moisture-Density Relationship

Moisture-density relationships for the soils were determined according to AASHTO method T99. For compaction of the soils, cylindrical mould of 4-inch diameter and 4.6-inch height was used.

The weight of the hammer was 5.5 lbs and the height of the drop was 12 inches. The mould was then filled with soil in three approximately equal layers. Each layer was compacted by 25 blows of the hammer. Air-dried samples passing through NO.4 sieve was used for compaction.

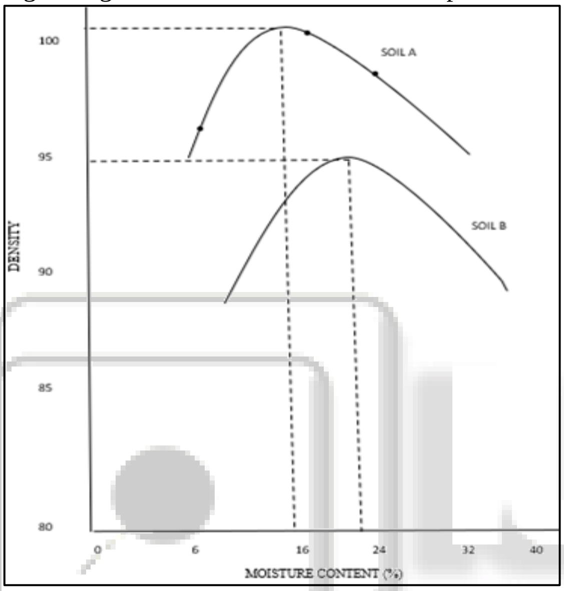

Fig. 1: Moisture Density Relation of Untreated Soil

The test results are shown in Fig. 4.1. From the moisture density curves of Fig. 4.1, optimum moisture contents and corresponding maximum dry densities for the soils were determined.

Soil Property	Soil A	Soil B
Sand, % (2 mm - 0.06 mm)	8	13
Silt, % (0.06 mm - 0.002 mm)	69.23	67
Clay, % (<.002 mm)	22.77	20
Percent passing # 200 sieve	95.4	89

Table 1: Properties of Untreated Soils

C. California Bearing Ratio Test

CBR test is a penetration test wherein, a standardized piston, having an end area of 3 sq. inch is caused to penetrate the sample at a standard rate of 0.05 inch per minute. The unit load required penetrating the sample at 0.1 inch and 0.2-inch penetration is then compared with a value of 1000 lb per sq. inch and 1500 lb per sq. inch respectively required to effect the same penetration in standard crushed rock. For design purpose the CBR value of the sub-grade, base or sub-base course at worst condition is required which can be obtained by testing the sample, after being saturated.

California Bearing Ratio (CBR) test was performed according to AASHO T193 and ASTM 01883 - 73. With the variation of cement and lime from 2 percent to 10 percent, samples were prepared at their optimum moisture contents. Moulds were compacted by 5.5 lbs hammer applying 65, 35 and 10 blows per layer. For each type of compactive effort three samples were taken for testing. The samples were cured in water for 4 days keeping a surcharge weight of 10 lbs on the top of, the mould. During soaking, the 'water level in the mould and the soaking tank was maintained approximately 1.0 inch above the top of the specimen. After being saturated, the penetration test was done. Due to swelling of the specimen, the top surface may be loose to some extent. Therefore, the stress strain curve obtained from the penetration test sometimes become upward which required correction by moving it to the right. By CBR value it means corrected value when this correction has been applied to the curve.

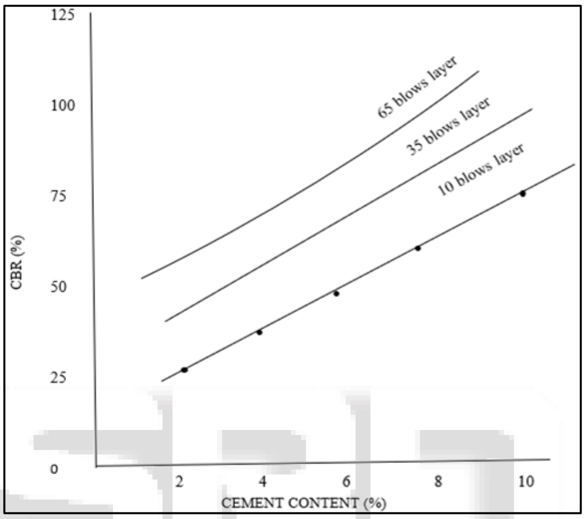

Fig. 2: Effect of Cement Treatment of CBR of Soil-B

V. CONCLUSION

The important findings and conclusions drawn on the various aspects of this research may be summarized with this limited study as follows:

- The two sub-grade soils satisfy the durability criteria recommended by the Portland Cement Association (PCA) at about 2 percent and 8 percent cement contents.
- The silty clay soils fail to satisfy the minimum unconfined compressive strength criteria of PCA for cement content at which the durability criteria are satisfied. For the type of soils used, higher cement content would be required' to satisfy the strength criteria. However, the soils showed appreciable strength gain over untreated soil with addition of only 2 percent cement by weight.
- The unconfined compressive strengths of cement treated soils increased due to the addition of cement.
- Curing period and proportion of cement significantly influence the strength characteristics of soil-cement mixtures.
- Due to the addition of cement, the sub-grade soils become non plastic. This treatment is suitable for highly plastic soils.
- There is a sharp increase of CBR value after addition of two percent cement over untreated soil. The value then increases at an increasing rate for higher cement content.

- We can say that construction of pavement on a stabilized sub-grade is economical than that of an untreated sub-grade.

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