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Soil Stabilization using Crumb Rubber Powder and Lime

Insha Kouser[1], and Er. Rabinder Singh[2]

[1] M.tech Scholar, Department of Civil Engineering, RIMT University, Mandi Gobindgarh, Punjab, India
[2] Principal, RIMT University Polytechnic School/College, Mandi Gobindgarh, Punjab, India

Correspondence should be addressed to Insha Kouser; inshakouser13@gmail.com

ABSTRACT- Karewa soils are widely spread in the stateof Jammu and Kashmir and they have been used assubgrade of pavement layers. Karewa soils are usuallyclayey soils and are characterized as low bearing capacity materials for flexible pavement layers.When such soils cannot be replaced, its performance should be increased by several modification techniques. The purpose of this research is to evaluate the use of low contents of lime and crumb rubber powder in the modification of Karewa soil properties. In this study an effort is made to obtain the optimum dosage of lime and crumb rubber powder for stabilization of locally available Karewa soil. Crumb rubber powder addition was made in the soil in the proportion of 5% initially to 10%, and then 15% by weight and unconfined Compressive Strength Tests and California bearing ratio tests are conducted for cohesive soil with 3%, 4% and 5% lime with the varying rubber percentage 0%, 5%, 10% and 15% and the results were noted and compared. The experimental investigations reveal that there is a tremendous increase in the CBR value of the soil treated with lime, thus leading to decreased thickness requirements of the sub-base and base courses. With addition of crumb rubber powder in soil, there is specific increase in the shear parameters of soil as well as will increase the permeability of soil.

KEYWORDS- Karewa soil, CBR, OMC, MDD, Crumb rubber Powder

I. INTRODUCTION

Soil Stabilization, a general term for any physical, chemical, biological, and combined method to modify the existing soil. Modifications includes improvising the strength void ratio and other geotechnical properties. Stabilization can increase the shear strength of soil and/or control the shrink-swell properties of a soil, thus improving the load bearing capacity of a subgrade to support pavements and foundation. However, recent technology has increased the number of traditional additives used for soil stabilzation purpose.

The main purpose of soil stabilization is to improve natural soil bearing capacity by its actual bearing capacity limit. Stabilizing a soil implies the properties of a soil-water-air system in order to obtain lasting properties, which are compatible with a particular application. But now in modern day using different kinds of materials like fly ash, ballast furnish slag, bagasse ash, stone dust, jute, steel slag. In India, the new stage of soil stabilization started in 1970, with a scarcity of petroleum and aggregates, it became essential for the geotechnical engineers to look at other ways of stabilising poor soil at building site. In past, Soil stabilization lost favordue to the absence of proper technique, soil stabilization lost favor. In recent times, with the rise within the demand for infrastructure, raw materials and fuel, soil stabilization has began to take a modified form. Soil Stabilization using waste materials is economical and environmental friendly.

II. OBJECTIVES

The purpose of this study is to determine the optimum moisture content, maximum dry density, shear strength for the original sample that is without additives and for the modified soil sample that is after the addition of additives. Secondly to check the improvement in soil performance for various building construction. Further to observe a right concentration mixture of the additional component like crumb rubber powder and lime content.

III. LITERATURE REVIEW

The soil improvement or modification through additives has been around for several thousands of years. At least 500 years ago, soils were stabilized with lime or pozzolonas. This technique is generally cost effective. For this reason, many engineers, researchers and professionals have developed various algorithms and techniques for improve the geotechnical properties of a soil. A review of the key related technologies and research is presented below:

Foose (1996) perfomed permeability test i.e falling head permeability test as clay is used that is fine done on rubber mixed soil samples and results were when water was allowed through samples noticeable increase in permeability was observed[1]. Lee et al. (1999) also determined the shear strength and stress-strain relationship of tire chip and a mixture of sand and tire chips. They noted the stiffness and strength parameters for chips shreds and rubber sand mixture[2]. Rao and Dutta (2001) used rubber chips in his analysis and mixed that with sand. Compressibility tests and triaxial tests were conducted. Various strength parameters were evaluated. From the results the internal friction value and effective cohesion value of sand showed a increasing trend with increase in percentage of rubber upto 15%[3]. Venkatappa and Dutta, (2006), performed a study with objective of determining compressibility and strength characteristics of sand and tire mixtures for suitability of sand tire chip mixture for embankment. The conclusion was made that up to 20%, the compressibility of sand tire mixture was 1% i.e. in tolerance limit for 10 m height of embankment and produced cohesion between 7-17.5 KPa and also internal frictional angle increased from 38 to 40 degree[4].

IV. METHODOLOGY

A. Sieve Analysis

The results after performing sieve analysis of the soil are plotted on a semi-log graph where the sieve size is written on abscissa and the percentage passing on the ordinate. D10 and D_{60} are obtained from this semi-log graph. This D_{10} is the diameter of the soil below which 10% of the soil particles lie[5].

B. Specific Gravity

The specific gravity of the soil is that the magnitude relation of weight of the soil solids and the exact weight of an equal volume of water. It can be determined using density bottle method fitted with a stopper having a hole[6].

C. Index Properties

1) Liquid Limit

It is the minimum water content at that the soil has tendency to flow. A groove of 2 mm size groove is made and number of blows needed to close the groove are noted. Graph is drawn on which number of blows are written logarithmic scale on the abscissa and water content on the ordinate.[7]

2) Apparatus Required

CASAGRANDE'S LIQUID LIMIT DEVICE

- Grooving device
- oven
- Evaporating dish
- Spatula

IS Sieve of size 425µm

- Weighing balance, with 0.01g accuracy
- Wash bottle

3) Plastic Limit

Plastic limit is outlined because the water content at that soil would simply begin to crumble when once rolled into a thread of roughly 3 mm diameter [7].

4) Apparatus Required

- Porcelain evaporating dishes about 120mm dia.spatula
- Container to determine moisture content
- Balance with an accuracy of 0.01g
- Oven
- Strength test[9]
- Standard Proctor Test (Light Compaction Test).
- Unconfined Compressive Strength Test.
- Standard Proctor Test

5) Sample Preparation

To get the optimum moisture content and the amount of compaction requirement, compaction tests are performed on the soil in consideration in the laboratory. The tests provide a relationship between the water content and dry density. About 3 kilograms of air-dried, pulverized soil passing 4.75 mm sieve is taken. Water is added to the soil to bring its water content to about 4% if the soil is coarse – grained and to about 8% if it is the soil is fine grained. The amount of water mixed at first trial may vary according to the soil sample composition. For the blended mixtures the quantity of soil depends upon the ratio at which it is desired to be mixed with other additives.

D. Unconfined Compressive Strength Test

The unconfined compression test is done to get the shearing resistance of cohesive soils either on undisturbed or remoulded clay specimens. An axial load is allowed to act by using any of the two i.e strain-control or stress-control condition. The maximum unit stress obtained within the first 20% strain defines unconfined compressive strength.[9]

1) Sample Preparation

A cylindrical sample of soil without lateral support is tested to failure in simple compression, at a constant rate of strain. The specimen is prepared with the help of a mould of 3.8 cm diameter and 7.6 cm height. To avoid the friction between soil sample and inner surface of mould, the inner surface is lubricated with oil. The sample is placed within the specimen mould in seven layers victimization spoon, and gently compacted. Pressure pad is inserted into the mould and then the whole assembly is compacted to the desired density. The sample is then kept under static load for atleast 10 minutes to allow for any subsequent increase in height of sample due to swelling. Failed soil specimen is as shown in Figure1.

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Figure1: Failed Specimen in UCS

V. RESULTS

Results of liquid limit and platic limit of soil mixed with definite proportion of crumb rubber powder are shown in table 1.

Table 1: Liquid limit& Plastic limit

Crumb rubber powder	Liquid limit %	Plastic limit%
0	44.34	33.33
5	45.02	31.29
10	42.01	29.74
15	34.67	24.31

Average Specific gravity came out to be 2.69, coefficient of uniformity as 11.2 and coefficient of curvature as 1.7.
The Compaction result are [8]

- For parent soil, the optimum moisture content and maximum dry density are 6 % and 1.4gm/cc respectively.
- For 5% Crumb rubber powder with parent soil, the optimum moisture content and maximum dry density are 14.73 and 1.637gm/cc respectively.
- For 10% Crumb rubber powder with parent soil, the optimum moisture content and maximum dry density are 10.2 and 1.723gm/cc respectively.
- For 15% Crumb rubber powder with parent soil, the optimum moisture content and maximum dry density are 9.40 and 1.83gm/cc respectively.
- For 5% Crumb rubber powder and 3% lime with parent soil,the optimum moisture content and maximum dry density are 9.12 and 1.718m/cc respectively.
- For 5% Crumb rubber powder and 5% lime with parent soil,the optimum moisture content and maximum dry density are 8.06 and 2.31m/cc respectively.
- For 10% Crumb rubber powder and 5% lime with parent soil,the optimum moisture content and maximum dry density are 9.81 and 2.315gm/cc respectively.
- For 15% Crumb rubber powder and 5% lime with parent soil,the optimum moisture content and maximum dry density are 10.218 and 1.689 gm/cc respectively.

VI. CONCLUSION

On the basis of present experimental study, the following conclusions are drawn:
The results of modified Proctor test conducted on the various mixtures .The inclusion of rubber in the clayey soil leads to lowering in the maximum dry density (MDD) of clay.The strength of used material is increases with decrease in water content for a particular composition. A study reveals that the peak axial stress of clay mixed with rubber increases marginally up to 5% inclusion of crumb rubber, thereafter it starts decreasing. Here maximum dry density 1.777 at minimum water content is 16.73.The unconfined compressive strength of the clay increases with the addition of cement. Both maximum dry density and optimum moisture content of the clay decreases with the addition of crumb rubber, whereas inclusion of lime in the rubberized clay leads to decrease in the density and increase the optimum moisture content of the mixtures. Rubber powder, crushed mechanically in ambient temperature, showed has a very low density of about 0.83, cohesion varied from 6.5 to 50 kPa. The presence of gap between the rubber and cemented clay is an indication of weak interfaces resulting into strength reduction in the composite. The use of crumb rubber as a stabilizer introduces a low cost method for stabilization and it significantly reduces the waste tyre disposal problem that currently exists.

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ABOUT THE AUTHORS

Insha Kouser is a B.Tech Scholarin in Department of Civil Engineering. PersuingM.Tech in Soil mechanics and foundation Engineering. Haven't published anything yet. This is the first publication on soil stabilization using crumb rubber powder and lime. Have done research on Application of municipal solid waste on flexible pavement.

Er. Rabinder Sing, Masters in Soil Mechanics and Foundation Engineering. Principle, RIMT University Polytechnic School/ College. Study area-On failure of hill slopes.