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SOIL STABILIZATION USING PLASTIC WASTE

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Abstract Soil stabilization is a process which modifies the properties of the soil like shear capacity, bearing strength, etc. by using suitable form of admixtures like cement, lime, ash and therefore the other waste. The value of introducing these additives is increasing this has opened the door widely to use other quite soil additives like plastic, bamboo, etc. This new technique of soil stabilization is effectively accustomed meet the challenges faced by society to scale back the quantities of waste, producing useful material from non-useful waste materials. Use of plastic products like polythene bags, bottles etc. is increasing day by day resulting in various environmental concerns. Therefore, the disposal of the plastic wastes without causing any ecological hazards has become a true challenge. Thus, using plastic bottles as a soil stabiliser is a cost-effective utilization since there's scarcity of fine quality soil for embankments. Indian terrain is usually occupied by black cotton soil. It's highly expansive soil which shows more swelling, shrinkage and settlement problems. Thus, Construction of buildings and other engineering structures on this soil is risky. This project involves a detail study of possible use of waste plastic bottles on soil stabilization. Modified Proctor Test is suggested than Standard Proctor Test because the soil which is tested are used for construction which needs high compaction. The optimum moisture content of the soil was revealed by Modified Proctor Compaction Test. The optimum percentage of plastic strips in soil was revealed by California Bearing Ratio Test. The dimensions and content of strips of waste plastic bottles have significant effect on the enhancement of strength of the soil. Sieve analysis was allotted to see the grade of soil which revealed to be well graded soil. It's observed from the study that improvement in engineering properties of black cotton soil is achieved at 0.4% plastic content with strip size of 2 cm×1 cm.

Keywords: Plastic bottle strips, Shear strength, California Bearing Ratio (CBR) test, Compaction test.

1. INTRODUCTION

Soil stabilisation means the improvement of stability or bearing power of the soil by the use of controlled compaction, proportioning and/or the addition of suitable admixture or stabilisers. The basic principles of soil stabilisation are:

- Evaluating the properties of given soil.
- Deciding the lacking property of soil and choose effective and economical method of soil stabilisation.
- Designing the stabilised soil mix for intended stability and durability values.

Stabilisation are often wont to treat a good range of sub-grade materials from expansive clays to granular materials. In wet weather, stabilisation can also be wont to provide a working platform for construction operations. These sorts of soil quality improvement are mentioned as soil modification. The determining factors related to soil stabilisation could also be the prevailing moisture content, the top use of the soil structure and ultimately the value benefit provided. Nearly as good soil becomes scarcer and their location becomes harder and expensive, the necessity to enhance quality of soil using soil stabilisation is becoming more important. Soil stabilisation using raw plastic bottles is an alternate method for the development of subgrade soil of pavement. It can significantly enhance the properties of the soil utilized in the development of road infrastructure.

2. OBJECTIVES OF STUDY

The objectives of the present study are to,

- i. To evaluate the effect of percentage of plastic strips on geotechnical properties of BC soil such as California Bearing Capacity ratio.
- ii. To determine the optimum percentage of plastic strips for soil stabilisation.

3. SCOPE OF WORK

The scope of the work includes addition of plastic bottle strips to the locally available black cotton soil to enhance the engineering properties. The work presented in this paper aims to investigate the improvement of soil properties such as shear strength, maximum dry density (MDD) and CBR values by adding strips cut from plastic bottles. A series of laboratory test were conducted on both plain as well as plastic reinforced soil to compare the improvement of soil properties.

4. MATERIAL USED

4.1 Black Cotton Soil

Soil used in this study is taken from Arjun Nagar which is about 1.0 km away from Government College of Engineering (GCOE) Amravati. The soil is collected at certain depth of 2m from the ground level. The distributed soil sample is then transported to the Geotechnical Laboratory of GCOE Amravati.

4.2 Waste Plastic Strips

Cold drink bottles are collected and cut into strips of aspect ratio two. The dimensions of waste plastic bottle strips used in this study is $2\text{cm} \times 1\text{cm}$. These strips are added in the soil in different proportion by weight. In this study strips used are 0%, 0.2%, 0.4% and 0.6% of dry weight of soil.

4.3 Plastic Bottle Cutter

To cut the plastic bottles into strips a plastic bottle cutter is made at home with the help of carpenter. It is made by cutting a wood of length 17.5 cm and width of 3.5cm and base cross section of $3.5\text{cm} \times 2\text{cm}$. Two cuts are made in this wood piece, one along length up to depth of 4.5cm and one across length which is 1cm deep. A blade is fitted in this cuts which converts plastic bottles into desired strips.

5. METHODOLOGY

Plastic strips are mixed at different percentage i.e., 0%, 0.2%, 0.4% and 0.6% of dry weight of soil. Sieve analysis was carried out to find out the suitability of soil. First to find out the optimum moisture content and maximum dry density Modified Proctor Compaction test was performed. On basis of OMC and MDD further California Bearing Ratio (CBR) test was performed to find out the bearing capacity of the soil. Mixing of plastic strips in soil have been done carefully such that these strips are distributed uniformly in the soil. The mixing is done manually and proper care is taken to prepare a homogeneous mixture.

Sieve Analysis

Before sieving, the soil was oven dried in order to avoid lumps of fine particles and also to prevent clogging of the finer sieves. Sieves were properly cleaned before use. The sieving was done with the help of sieve shaker in the laboratory. Grading curves with the ordinates representing cumulative percentage passing and the abscissa the sieve opening to logarithmic scale was drawn to study the results of sieve analysis of soil. By using these curves, it became possible to see whether the grading of a given sample conforms to that specified or is too coarse or too fine, or deficient in a particular size.

Modified proctor compaction test

The modified proctor test was conducted to determine the optimum moisture content (OMC) and maximum dry density (MDD) of BC soil. The water content at which the maximum dry density is attained is obtained from the relationships provided by the tests.

California bearing ratio test

The California Bearing Ratio test was conducted to determine the optimum amount of plastic strips in soil. This is done by mixing soil with varying percentages (0.0%, 0.2%, 0.4% etc.) of plastic strips in soil and the CBR value was obtained. Here we had performed unsoaked CBR test specimen. Determine the strength of soil until the strength reaches the highest level and stop at the interval when strength decreasing from the highest. Plot the graph and calculate the bearing value for 2.5 mm penetration and 5 mm penetration and value of 2.5 mm penetration and 5 mm penetration is recorded. Then finally plot a graph of Percentage of Plastic content and CBR value and obtained the maximum CBR value corresponds to percentage of plastic content.

6. RESULTS AND DISCUSSION

Sieve analysis

The grain size distribution was conducted on black cotton soil and the results of the test were plotted as IS sieve versus percentage finer curve

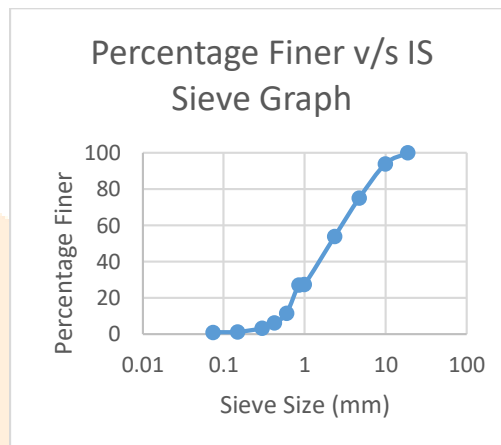


Fig 1 Sieve analysis curve

Modified Proctor compaction test

From the compaction curve, the maximum dry density and optimum moisture content were obtained as 1.69 KN/m^3 and 15% respectively. The California Bearing Ratio test was also carried out by mixing the soil with optimum moisture content.

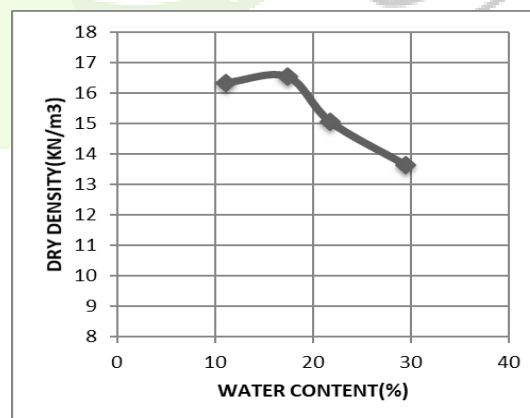


Fig 2 Compaction curve

California bearing ratio test

The specimens are prepared by mixing different percentage of plastic waste strips and then they are kept under CBR testing machine to determine CBR values

Table 1 CBR Values for soil with varying percentages of plastic strips

% of plastic content	CBR value
0.2%	1.44
0.4%	2.55
0.6%	1.99

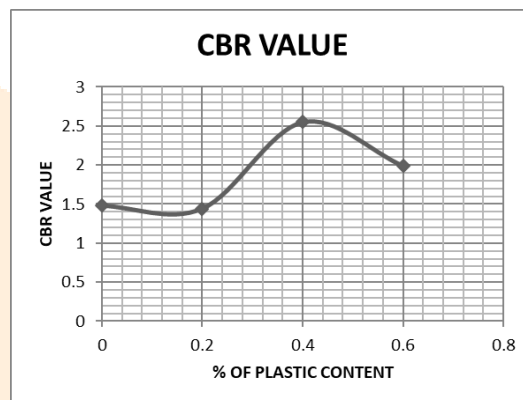


Fig3 Relation between CBR Value and percentage of plastic content

0.4% of plastic content of soil are found out to be most beneficial from the point of view of improvement of soil properties.

7. CONCLUSIONS

From the various experimental tests like Compaction Test (Proctor Test), California Bearing Ratio Test, and Sieve Analysis, following conclusions are drawn.

- From the grain size distribution graph, the value of coefficient of uniformity (C_u) is greater than 4 and value of coefficient of curvature (C_c) is less than 6. Thus, the soil is said to be well graded.
- California Bearing Ratio (CBR) test gives the reliable result at 0.4% i.e. 2.55 CBR value which is greater than CBR value at 0.6% and 0.2% plastic. Thus, it is concluded that using plastic strips as soil stabilizing agent is effective to improve the bearing capacity of soil.

8. FUTURE SCOPE

In future a number of variations can be done and iterated to find the different set of results. The same tests can be carried out with varying proportions and varying sizes. The orientation of the strips provided can also be altered (longitudinally or laterally or both or random distribution) plastics may also be used in combination with other geo textiles (jute) or sand or with different types of cement and other soil stabilizing agents like fly ash and rice husk. The test may also be iterated with waste or crushed plastic bottles filled with sand as a replacement of stone columns for stabilization. Here we have conducted only a lab test but later on we can also create a model of an embankment and check for its altered properties using the Universal Testing Machine (UTM). Then we can also account for the changes in improvement on field and in laboratory testing. Further studies can be done for improvement under different conditions of orientations and for different types of soil with plastics of different thickness. This technique can be effectively applied in construction of embankments proving it to be multipurpose because it not only strengthens but also preserves the environment.

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