

Soil Stabilization Using Plastics and Bottle Strips

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ABSTRACT: Construction of buildings and other civil engineering structures on expansive soil is risky due to its high compressibility, low shear strength and high permeability. The foundation is very important for any structure and it has to be strong enough to support the entire structure. For foundation to be strong the soil around it plays a very important role. Expansive soils like black cotton soil always create problems in foundation. The problems are swelling, shrinkage and unequal settlement. Plastic wastes have become one of the major problems of the world. Use of plastic bags, bottles and other plastic products is exponentially increasing year by year. Due to which we are facing various environmental problems. A review paper is presented here to focus on soil stabilization by using waste plastic products. The tests such as liquid limit, plastic limit, standard proctor compaction test, California bearing ratio (CBR) test and unconfined compressive strength (UCS) have been conducted to check the improvement in the properties of black cotton soil. This paper reviews the work of various researchers on stabilization of soil and use of plastic and bottle strips materials in improving its strength.

KEYWORDS: BC SOIL, Plastic strips Particle size Distribution, Hydrometer Analysis, Triaxial test, admixtures, shear strength, California bearing ratio, Compressibility.

I. INTRODUCTION

1.1. General:

Every man made structure resting on the ground needs safe and stable soil. To attain this safety and stability requirements the engineering properties of the soil beneath the structure or on the structure must be identified. However, obtaining these engineering properties of soils requires relatively more time and money. On the other hand investigating the index properties of a soil is much easier than other engineering properties; in terms of time, money and efforts. Moreover, most of the engineering properties of soils depend upon their index properties. Therefore, by obtaining the index property of soil that involves simpler and quicker method of testing, the engineering properties can be predicted satisfactory. Soil compaction, California bearing ratio and direct shear test are the most commonly used techniques in engineering projects such as highways, sub-grades, railways, pavements and foundations. The main of these tests are to improve engineering properties of soils such as increase in dry density, reduction in compressibility leading to reduction in settlement, reduction in permeability, increase in shear strength and its load bearing capacity. Atterberg's limits and specific gravity tests are also considered to find out the moisture content of the soil.

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II. MATERIALS

2.1. SOIL

The soil type in study is black cotton soil. BC soil is clayey soil seen grayish and black in color. It Contains montmorillonite clay mineral which contains very high expansive characteristics .BC soil possesses low shrinkage limit and high optimum moisture content. BC soil is such a soil which has tendency to swell or shrink when it comes in contact to water. This property of swelling or shrinking leads to gigantic loose to the structure. BC soil is connected directly to engineering structure.

Fig.1 Lateritic soil sample



2.1. Plastic Material

A word plastic is a material of consists huge range of synthetic organic. It's a very huge issue to whole world as it degrades very slowly to earth. Plastic pollution is gathering of plastic a product that is dangerous to human habitats, animal, plants, etc. Manufactured of plastic is increasing due to low range, easy to produced, imperviousness to water, etc. Since 60-65 years its production is increasing to first stage in pollution. Utilization of plastic waste bottle in geotechnical construction may reduce the problems faced for its disposal as their properties are mostly related to natural material. In this chapter we had mention about how we are using plastic waste bottles. By the use of this bottle stabilization of soil of obtained. We had cut bottles of plain surface whose dimension is almost length 20mm and width 4mm.

Raw Plastic Bottle Strips

Plastic is a non-renewable source and bio-degradable. The disposal of waste plastic bottles causes environmental pollution, it's a sustainable waste. Plastic can be recycled or reused i.e. reprocessing these plastic wastes makes the useful products. Such wastes of plastics can be used as additives for stabilized soil.

2.2. Random fiber reinforcement:

This arrangement has discrete fibers distributed randomly in the soil mass. The mixing is done until the soil and the reinforcement form a more or less homogeneous mixture. Materials used in this type of reinforcements are generally derived from paper, nylon, metals or other materials having varied physical properties. Randomly distributed fibers have some advantages over the systematically distributed fibers.

Somehow this way of reinforcement is similar to addition of admixtures such as cement, lime etc. Besides being easy to add and mix, this method also offers strength isotropy, decreases chance of potential weak planes which occur in the other case and provides ductility to the soil.

III. METHODOLOGY

The compaction tests were done to assess the amount of compaction and the water content required. The water content at which the maximum dry density is attained is obtained from the relationships provided by the tests. The California Bearing Ratio test is conducted for the soil by adding plastic strips with varying percentage of 0.2 i.e. 0.2%, 0.4%, 0.6% etc. and determines 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 2.5mm penetration and 5mm penetration and value of 2.5mm penetration and 5mm penetration is recorded. Then finally plot a graph of

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Percentage of Plastic content and CBR value and obtained the maximum CBR value corresponds to percentage of plastic content.

3.1 Tri-Axial Test:

Today Tri-axial test is the most commonly used Strength Test in research laboratory. In this test the solid specimen, Cylindrical in shape, is subjected to direct stresses acting in 3 mutually perpendicular directions. This test gives shear Strength parameters of soil.

3.2 Direct Shear Test:

This is the simple and commonly used test on soil. This test is used to determine the shear parameters of soil by using shear box apparatus.

IV. EXPERIMENTAL INVESTIGATIONS

4.1 Scope of work:

The experimental work consists of the following steps:

1. Specific gravity of soil
2. Determination of soil index properties (Atterberg's Limits)
 - a. Liquid limit by Casagrande's apparatus
 - b. plastic limit
3. Particle size distribution by sieve analysis
4. Determination of the maximum dry density (MDD) and the corresponding optimum moisture content (OMC) of the soil by Proctor compaction test
5. Preparation of reinforced soil samples.
6. Determination of the shear strength by:
 - i) UU Triaxial test
7. California Bearing Ratio

A. Geotechnical Properties of untreated Laterite soil

| Property | Value/Description |
|---|-------------------|
| Specific Gravity | 2.68 |
| Liquid Limit | 25.55% |
| Plastic Limit | 13% |
| Plasticity Index | 12.55% |
| Unified Soil Classification System (USCS) | CL |
| Maximum Dry Density (MDD) | 1.7g/cc |
| Optimum Moisture Content (OMC) | 34.7% |
| Natural Moisture Content | 17.36% |

B. Atterberg's Limits

Liquid Limit = 25.55%

Plastic Limit = 13%

Plasticity index = 12.55%

Plasticity of Laterite soil was found---. So according to unified soil classification system (USCS) soil is classified as inorganic soils.

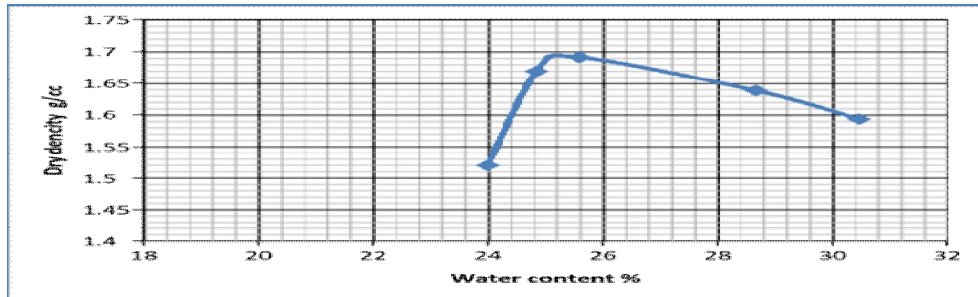


Fig.1. Shows Liquid Limit curve for Black Cotton Soil

Hydrometer analysis:

The particle size distribution curve for fine particles i.e., for particles $<75\mu$ is obtained through hydrometer analysis. Hydrometer analysis is based on the principle of sedimentation of soil grains in water. When a soil specimen is dispersed water, the particles settle at different velocities, depending upon shape, size, and weight, and the viscosity of the water.

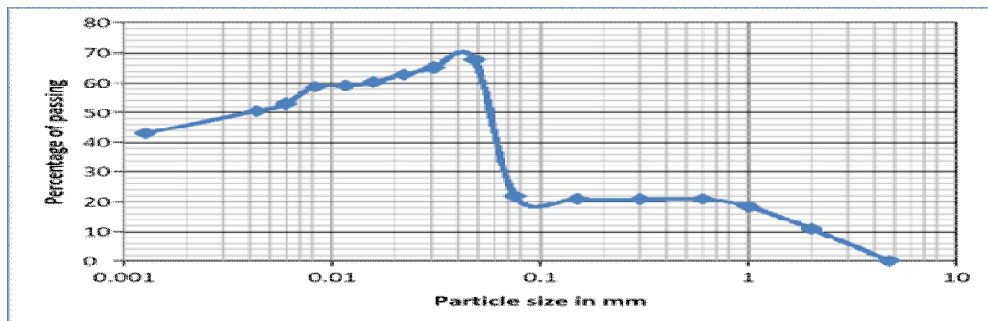


Fig.2. Shows Sieve Analysis

B. Compaction Test (Standard Proctor Test):

Given below figure shows the relation between water content and dry density. The optimum moisture content of black cotton soil has been found, $W_o = 37.4\%$ and max. dry density has been found (r_d) max = 1.76

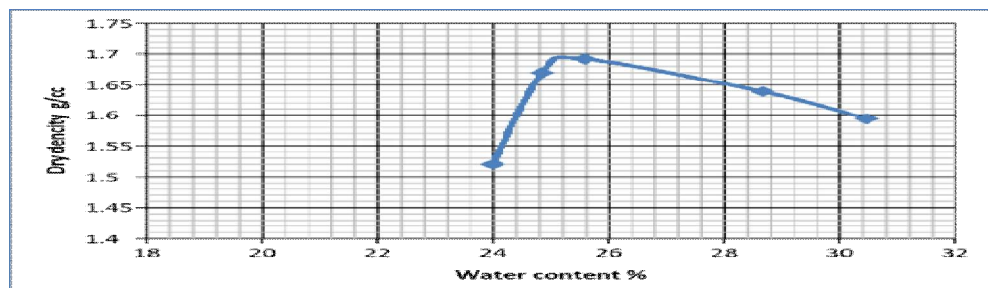


Fig.3. shows Compaction Test

Triaxial Test:

This is the test used to determine the shear strength of the soil. In this experiment the soil specimen of diameter 38mm and height 76mm is placed inside a triaxial cell and constant cell pressure is applied on the specimen through constant pressure system. This test is conducted for undrained unconsolidated conditions.

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| Sample No | Major principal stress $\sigma_1 = \sigma_3 + \sigma_d$ (Kg/cm ²) | Cell pressure σ_3 (Kg/cm ²) | Deviator stress σ_d (Kg/cm ²) |
|-----------|--|---|---|
| 1 | 0.76 | 0.5 | 0.26 |
| 2 | 1.67 | 1.0 | 0.67 |
| 3 | 2.65 | 1.5 | 1.15 |

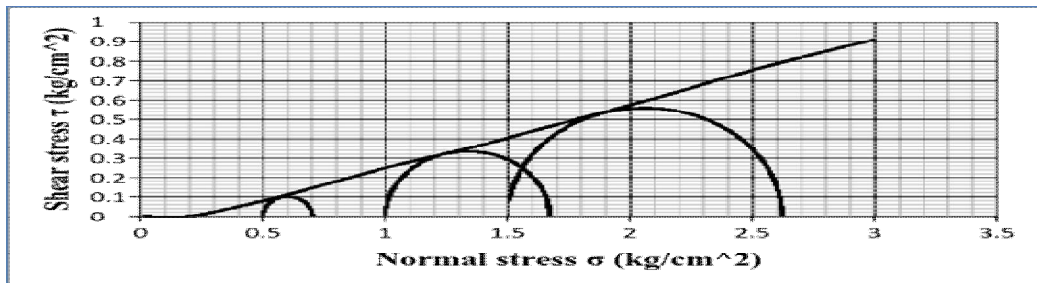


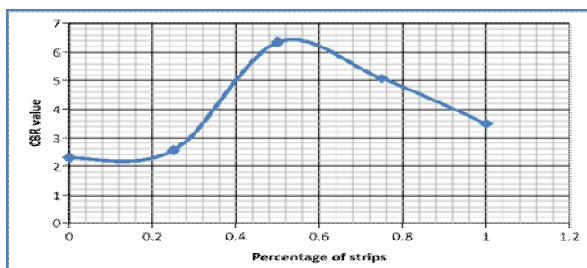
Fig.4. shows Triaxial Test
The above graph, cohesion $C=0$; Angle of internal friction $\phi = 20$

Compression test on the BC soil and with Geogrids.

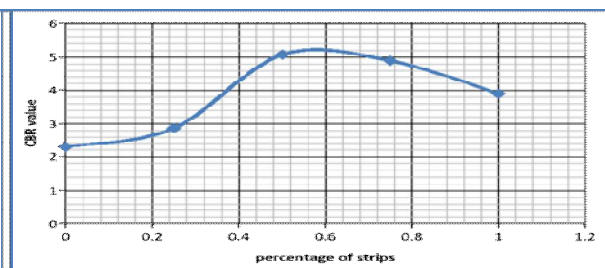
Figs shows variation of compressive strength of BC soil with Geogrids reinforcement for various materials. The graph is plotted against CS BC soil with Geogrids.

1. Based on CBR Test on soil (with strips of length 5cm), with strips reinforcement of 0.00%, 0.25%, 0.50%, 0.75%, and 1%, the increase in CBR Test values was found to be 3.34, 2.68, 6.20, 5.73, and 2.86 respectively explained above.

2. Based on CBR Test on soil (with strips of length 7.5cm), with strips reinforcement of 0.00%, 0.25%, 0.50%, 0.75%, and 1%, the increase in CBR Test values was found to be 3.34, 2.86, 5.24, 4.31, and 2.85 respectively explained above.



Test strip length 5cm and penetration 5mm



Test strip length 5cm and penetration 7mm

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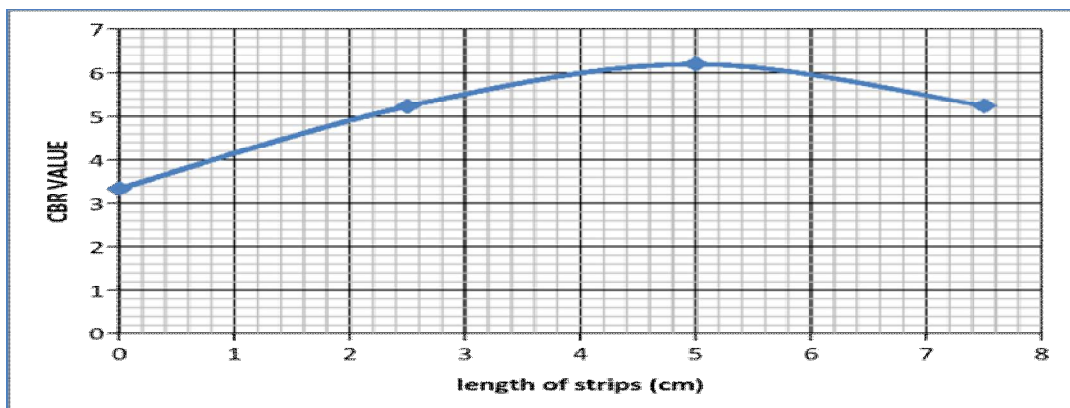
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| CBR value | Length of Strips (cm) |
|-----------|-----------------------|
| 3.34 | 0 |
| 5.23 | 2.5 |
| 6.20 | 5 |
| 5.24 | 7.5 |

Comparison on length of strips and CBR value



From the above graph we observed that according to the size of the strips also increases the CBR

Value with different lengths like 2.5cm, 5.00cm and 7.5cm in this 2.5cm to 5.00cm CBR value 5.23 to 6.20 respectively increases and 5.00cm to 7.50cm length CBR values decreases 6.20 to 5.24 respectively.

- So from the results shear strength of the soil increases up to 5.00cm length of strips and after decreases vice – versa.
- CBR value for 5.00cm is 6.20 it is optimum length of strips used for sub grade design.

Experimental study, the following conclusions are drawn.

Test Results

1. Based on CBR Test on soil(with strips of length 2.5cm), with strips reinforcement of 0 .00 %, 0.25%, 0.50%, 0.75%, and 1%, the increase in CBR Test values was found to be 3.34, 2.67, 5.23, 4.76, and 2.85 respectively explained above.
2. Based on CBR Test on soil(with strips of length 5cm), with strips reinforcement of 0 .00 %, 0.25%, 0.50%, 0.75%, and 1%, the increase in CBR Test values was found to be 3.34, 2.68, 6.20, 5.73, and 2.86 respectively explained above.
3. Based on CBR Test on soil(with strips of length 7.5cm), with strips reinforcement of 0 .00 %, 0.25%, 0.50%, 0.75%, and 1%, the increase in CBR Test values was found to be 3.34, 2.86, 5.24, 4.31, and 2.85 respectively explained above.
4. On comparing the results from CBR test conducted on lateritic soil with adding different percentage of plastic strips, it is found that the values of CBR Test CBR Values are increases up to certain percentage and decreases vice versa.
5. From above results using 5cm length of plastic strips with percentage of 0.50% is to be recommended for sub

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- grade design and embankment construction.
- Overall it can be concluded that plastic strips reinforced soil can be considered to be good for sub grade and embankment design.

V. CONCLUSION

Use of plastic products such as polythene bags, bottles, containers and packing strips etc. is increasing day by day. The disposal of the plastic wastes without causing any ecological hazards has become a real challenge to the present society. Thus using plastic bottles as a stabilizer is an economical and gainful utilization since there is scarcity of good quality soil for embankments and fills. Thus this project is to meet the challenge of society to reduce the quantities of plastic waste, the plastic strips were made out of this plastic wastage and are used in making the pavement and it is found that there is an increase in the strength of the soil. California Bearing Ratio test was carried out to find the maximum dry density and optimum moisture content. The CBR was conducted for soil mixed with plastic strips. The CBR test is conducted for the red soil and black cotton soil, adding the 0.7% of plastic strips to red soil and 0.5% for the black cotton soil it is found that the strength of the soil is increased resulting the bearing ratio of 2.9 for red soil and 3.3 for the black cotton soil. As it is economic in nature and hazard free it is the one of the best solutions for re-utilization of the plastic wastage. Producing useful materials from non-useful waste materials that lead to the foundation of a sustainable society.

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I am Dhara. Naveen Kumar student of final year belonging to Department of Civil Engineering have undertaken and completed a project on SOIL STABILIZATION USING PLASTICS AND BOTTLE STRIPS.

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