BEARING CAPACITY IMPROVEMENT OF BLACK COTTON SOIL USING LDPE, POLYSTER AND PLASTIC STRAWS

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Abstract —Due to rapid urbanization and globalization there is a huge amount of generation of waste plastic all around the world. This cause huge amount of environmental problems. Soil is the key element of the nature and all the basic needs of the life such as food, house and cloth are fulfilled by the soil. Black cotton soils with high potential for swelling and shrinking as a result of change in moisture content are one of the major soil deposits of India. Soil stabilization is the process which improves the physical properties of soil, such as shear strength bearing capacity which can be done by use of controlled compaction or addition of suitable admixtures likes cement, lime, sand, fly ash are by providing geo textiles, geo synthetic, etc., Black cotton soil is the weakest soil compared to other soils so we have selected black cotton soil for stabilization. This project involves the details study on the possible use of waste plastic straws(polypropylene) and waste plastic fiber materials(LDPE, polyester) for soil improvement. The addition of these waste plastics and fiber in the soil by different percentage and conducted tests such as liquid limit, plastic limit, CBR, etc., The results obtained are compared between normal soil samples and soil with waste plastic and waste fiber materials.

Keywords— Black cotton soil, waste plastic straws, waste fiber materials(LDPE, polyester) CBR test, direct shear test.

I. INTRODUCTION

For any land-based structure, the foundation is very important and has to be strong to support the entire structure. In order for the foundation to be strong, the soil around it plays a very critical role. Soil is highly homogeneous and unpredictable material which has been subjected to vagaries of nature, without any control. So, to work with soils, we need to have proper knowledge about their properties and factors which affect their behaviour. The process of soil Stabilization helps to achieve the required properties in a soil needed for the construction work. Due to rapid urbanization and globalization there is a huge amount of generation of waste plastic all around the world. Plastics are durable and degrade very slowly. This cause huge amount of environmental problems. Thus presently 20 times more plastic is produced as compared to 50 years ago. The main objective of our project is to investigate the use of waste plastic and fibre materials in geotechnical engineering applications. The utilization of waste plastic material into useful material for the stabilization of soil.Experiments where done by taking an available weak soil as sample. The weak soil we have chosen is black cotton soil. As black cotton soil has low bearing capacity, poor strength and deformation characteristics. As it as more disadvantages it is not suitable for buildings. Black cotton soil is the weakest soil as compared to the other soils. To make black cotton soils suitable as a good substratum for construction usage improvement in existing properties are necessary. So we have increased the bearing capacity, shear strength of black cotton soil and we have stabilized it by using waste plastic and fibres. Plastic used is poly propylene collected from waste of plastic straws and fibre used is low density polyethylene and polyester collected from waste of plastic packing covers.

II. SCOPE AND OBJECTIVE

Increased use of plastics in day to day consumer applications has resulted in the municipal solid waste, an ever growing fraction of plastic materials which were used for a short time and then discarded. There is, therefore a growing need to find alternative uses of reclaimed plastic bag waste to lengthen the usage time of the plastic material and thereby save the degrading environment. The concept of reinforcing soil masses with strips of plastic cover may be relatively, a new development. In contrast, the use of random-materials as

reinforcement for soil is probably not older than written history, but only sparsely represented.
The objective of this project is to analyse the effect of inclusion of plastic fibres in soil on the stability of soil in a cost effective manner. The four different replacement percentages of plastic fibres (4%, 6%, 8%,) will be tested.

III. MATERIALS AND ITS PROPERTIES

BLACK COTTON SOIL

Black cotton soil is made up of extremely fine clayey materials. It is usually known as expansive soil but the mass that expand under wetting will shrink after drying. Black cotton has consistent chemical properties which are not influenced by their formation. Expansive soils, which are also called as swell-shrink soil, have the tendency to shrink and swell with variation in moisture content. During periods of greater moisture, like monsoons, these soils imbibe the water, and swell; subsequently, they become soft and their water holding capacity diminishes. As opposed to this, in drier seasons, like summers, these soils lose the moisture held in them due to evaporation, resulting in their becoming harder. Generally found in semi-arid and arid regions of the globe, these type of soils are regarded as potential natural hazard – if not treated, these can cause extensive damage to the structures built upon them, as well causing loss in human life. Soils whose composition includes presence of montmorillonite, in general, display these kinds of properties. For our experiments we have collected black cotton soil from udumelpet taluk.

Fig 1: Black cotton soil

PLASTIC STRAWS (POLYPROPYLENE)

Polypropylene fibers were formerly known as Stealthy; these are micro reinforcement fibers and are 100% virgin homopolymer polypropylene graded monofilament fibers. They contain no reprocessed Olefin materials. The raw material of polypropylene is derived from monomeric C_3H_6 which is purely a hydrocarbon. Poly propylene is a strong fiber.The monomer of poly propylene is propylene. Propylene is a buy product of petroleum. It is cheap in price. It has good resiliency and elasticity. It has excellent ability to protect friction. Acids does not effect on poly propylene. It has excellent protesting against acids. Organic solvent does not cause harm to poly propylene during action. In this we have collected waste plastic straws for our experiments.

Behaviour parameters	Values
Fibre type	Single fiber
Unit weight	0.91 g/cm3
Average diameter	0.034 mm
Average length	12 mm
Breaking tensile strength	350 MPa
Modulus of elasticity	3500 MPa
Fusion points	1650C
Burning point	5900C
Dispersibility	Excellent
Acid and alkali resistance	Very good

Table 1: Behavior and its values

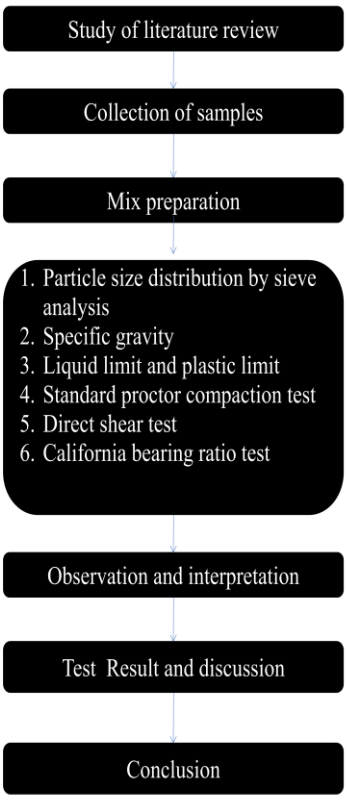
Fig 2: Plastic straws

FIBER (LDPE, POLYESTER)

This extruded maternal offers good corrosion resistance and low moisture permeability. It can be used in applications where corrosion resistance is important but stiffness, high temperature and structure strength are not.Semi-rigid, weatherproof, good chemical resistance. Translucent, easily processed by most methods Very tough and low cost. Tenacity is strong due to their crystalline nature elastic plastic nature. Hygroscopic nature resist the entry of water molecules. Thermal properties it is poor heat conductor and it has low resistance to heat. Elastic and plastic in nature. It is translucent to opaque strong, tough & enough to be virtually unbreakable and at the same time quite flexible.Chemically LDPE is uncreative at room temperature slowly attacked by strong oxidizing agents and some solvents will cause softening or swelling.Plastic fibers were obtained from waste plastic covers (snacks packets).

Fig 3: LDPE, polyester.

IV. METHODOLOGY



V.MIX PREPRATION

Following mix has been prepared by mixing black cotton soil with different percentage of polypropylene, LDPE, polyester.

- Soil Sample + 4% polypropylene+ 4% LDPE, polyester
- Soil Sample + 6% polypropylene+ 4% LDPE, polyester
- Soil Sample + 8% polypropylene+ 4% LDPE, polyester.

VI. RESULTS AND DISCUSSION

Tests	Trial 1	Trial 2	Trial 3	Trial 4
Plastic limit	35.167	32.574	30.54	-
Liquid limit	50.33	43.75	35.67	-
Specific gravity	2.26	2.496	2.61	2.761
OMC	9.820	11.542	11.357	12.462
Dry density	0.0008	0.0006	0.0007	0.0006
CBR	2.96	3.04	4.23	4.67
Direct shear	0.9775	0.9325	1.55	1.577

The test results shows with the increase of fibre and plastic content Liquid limit, plastic limit decreases, which makes the soil less plastic and hence plasticity index reduces. This results shows increase in bearing strength, cohesiveness and consistency of soil mass. Strength of the soil is directly proportional to specific gravity, more is the specific gravity more will be the strength of soil. OMC increases and dry density decreases decrease in MDD values is due to occupation of solids contributed less weight due to replacement of fibre and plastic. Shear strength increases it shows high stability of soil. CBR value increases it shows more resistance against compression.

The various test results are shown in graph given below

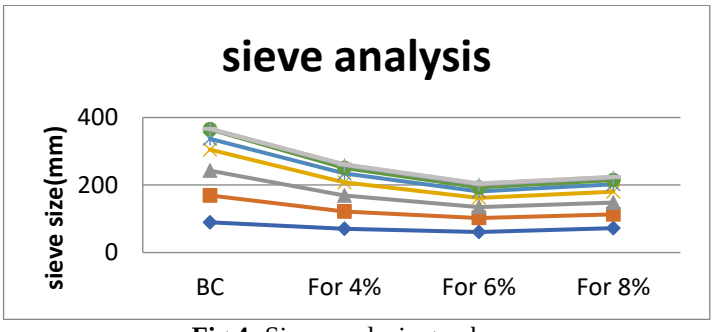


Fig 4: Sieve analysis graph

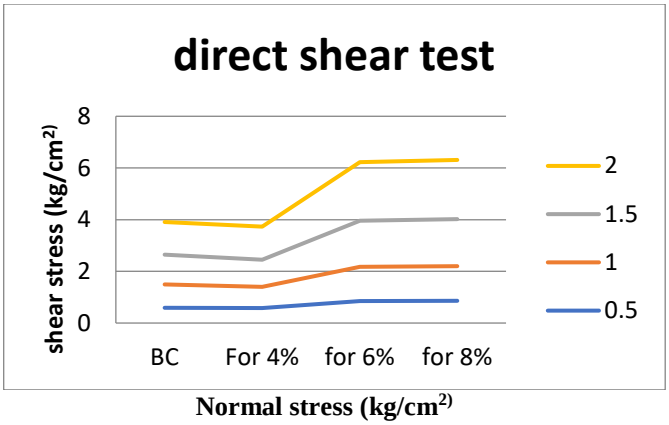


Fig 5: Direct shear graph

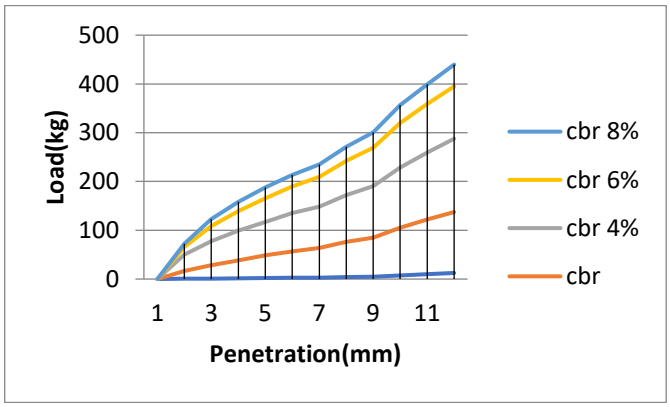


Fig 6: CBR

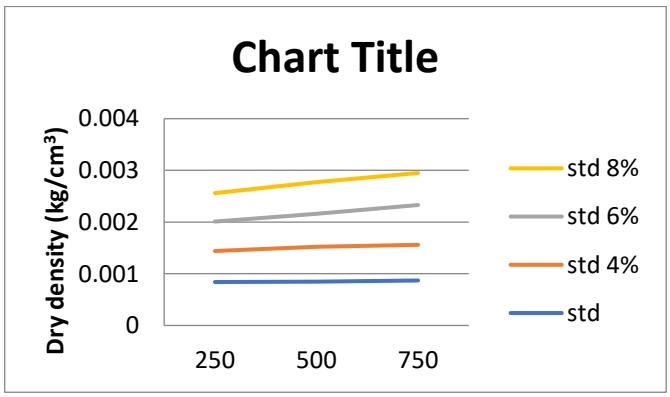


Fig 7: Standard proctor graph

VII. CONCLUSION

1. The plastics inclusions can improve the strength thus increasing the bearing capacity of soil.
2. Every year a lot of plastic waste is generated and occupied a lot space. It is necessary to find the solution for this problem. Based on literature, one of the solutions is use of waste plastics and fibres in soil reinforcement and stabilisation.
3. With the increase of fibre and plastic content Liquid limits, plastic limit and plasticity index decrease, which makes the soil less plastic and hence plasticity index reduces. This results shows increase in bearing strength, cohesiveness and consistency of soil mass.
4. CBR test data shows the increase in percentage of plastic and fibre increases the CBR values. It offers more resistance against compression. It can be used as sub base material and base coarse material.
5. Compaction test data shows that with increasing percentage of plastic and fibre OMC values are increasing and maximum dry density values are decreasing.
6. Based on Specific gravity of a soil with mixing of fibers and plastic specific gravity of the soil increases. Strength of the soil is directly proportional to specific gravity, more is the specific gravity more will be the strength of soil
7. The main advantage of using plastic fiber is proven to be economical as it is non useful waste and free of cost. It also eradicates the disposal problem of plastic waste. And it is used for stabilization of soil.

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