Black cotton Soil stabilization using waste plastic bottle

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Abstract : Soil is the key component of this nature and all the fundamental needs of life is fulfil by this, for example house and fabrics are satisfied by the dirt. Expensive soils with high potential for swelling and contracting because of progress in dampness content are one of the real soil of India. The long-term performance of any structure depends on the strength of the underlying soils. Unstable soils like black cotton soils can create significant problems for pavements or structures by high swelling and shrinkage. Use of plastic products such as polythene bags, plastic bottles, containers and packing strips etc. is increasing day by day. The disposal of thrown away wastes such as plastic bottles create a serious challenge since these plastic bottles are non-biodegradable and unfit for incineration as they emit harmful gases. 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. This study involves the investigation of the effect of plastic bottles on black cotton soil with high compressibility for which a series of California Bearing Ratio (CBR) tests are conducted with varying aspect ratios of plastic bottles at different layers. The results reflect that there is significant increment CBR value with plastic bottles reinforcement in soil.

***Keywords*- Soil stabilization, Plastic, Black Cotton Soil.**

I. INTRODUCTION

Plastic industry expects to get a great thrust after a gloomy period in the last ten years consecutively. PET sector in India also expects a outstanding future. According to experts, polymer consumption by Indian plastic industry is expected to be double in next 6 years. It means that the magic figure of 20 Million metric tons can be expected by 2020. Immense potential of growth can be estimated by the fact that annual per capita plastic consumption is 8Kg in India as compared to 60Kg in developed nations.

The lack of awareness and absence of effective tools to collect back the discarded plastic products including the wrapping material has led to the indiscriminate littering and disposal of plastic waste. According to Central Pollution Control Board (CPCB), more than 15,000 tonnes of plastic waste are generated in India every day, of which 6,000 tonnes remain uncollected and littered. CPCB has estimated the generation of 15,342 tonnes of plastic waste in the country, out of which, 9,205 tonnes were reported to be recycled and leaving 6,137 tonnes uncollected and littered. Therefore the disposal of the plastic wastes without causing any ecological hazards has become a real challenge. Thus using plastic bottles as a soil stabilizer is an economical utilization since there is scarcity of good quality soil for embankments. This project involves the detailed study on the possible use of waste plastic bottles for soil stabilization.

II. WORK DONE TILL NOW ON SOIL STABILIZATION USING PLASTIC WASTE

Ashraf et al. (2011) studied about new technique of soil stabilization can be effectively used to meet the challenges of society, to reduce the quantities of waste, producing useful material from non-useful waste materials. Use of plastic products such as polythene bags, bottles etc. is increasing day by day leading to various environmental concerns. The analysis was done by conducting plate load tests on soil reinforced with layers of plastic bottles filled with sand and bottles cut to halves placed at middle and one third positions of tank. The comparison of test results showed that cut bottles placed at middle position were the most efficient in increasing strength of soil. The optimum percentage of plastic strips in soil was found out by California Bearing Ratio Test and using this percentage of plastic, plate load test was also performed. The size and content of strips of waste plastic bottles have significant effect on the enhancement of strength of the soil(Ashraf, Sunil et al. 2011).

S.W. Thakare and S. K. Sonule, (2013) carried out various laboratory tests to investigate the effect of reinforcement of sandy soil with model plastic water bottle through model plate load tests. The study showed that the ultimate bearing capacity of footing increases with increasing the layer of plastic bottles as reinforcement. The increase in bearing capacity may be due to the additional confinement to the soil in the vicinity of footing similar to that in case of Geocell. The bearing capacity increases with the increase in width of reinforcement and number of layers. Thus, the use of plastic bottles as reinforcement was recommended to reduce the quantity of plastic waste which creates the disposal problems(Peddaiah, Suresh et al.)

Mercy Joseph Poweth et al. (2014) investigated the effect of plastic granules on weak soil sample with plastic and without plastic granules in varying percentage. The percentage of waste plastic was taken as 0.25%, 0.5 %, 0.75%. Maximum dry density was obtained when 0.25 % plastic was added and OMC was less than the soil without plastic for this percentage of soil. Further CBR value decreases when 0.25 % plastic is added but it was found to be increased for 0.75 % of plastic. Authors also observed that for the same percentage of plastic, shear stress was maximum. Satyam Tiwari and Nisheet Tiwari (2016) investigated the

effect of waste polypropylene fiber on shear strength of unsaturated soil samples. Here, the percentage of specific gravity of the soil increases 0.3% by using 0.5% of fiber (PPF) (Poweth, George et al. 2013).

Jasmin Varghese Kalliyath et.al. (2016) studied the effect of plastic fibers. Various tests such as Standard Proctor, UCC were carried out with different samples of silty clay. Authors observed that the replacement of 0.5 % waste plastic fiber to the expansive clayey soil reduce its OMC and increased maximum dry density but UCS of the soil was found to be increased. The test results also showed that with 1% replacement, MDD and UCC were less than the 0.5 % replacement but greater than the untreated soil. Further increase in the plastic replacement showed decrease in the MDD and the UCS. The increase in the MDD of the soil with 1% replacement is due to the decrease in the number of voids with the addition of plastic which leads to effective compaction and also increase in the cohesion(Kalliyath, Joy et al. 2016).

Harish and Ashwini, H.M. (2016) studied the effect of plastic bottles strips as a stabilizer for two soil samples, red soil and black cotton soil. Red soil consists of 4 % gravel, 88% sand and 8% silt and clay and black cotton soil 2.6% gravel, 15.1 %sand and 82.3 % silt and 0.18 % of clay. They used plastic stripes in making the pavement and it was found that there was an increase in the strength of the soil. Authors conducted a CBR ratio test to find out MDD and OMC. They observed an increase in the strength of soil and bearing ratio of 2.9 for red soil and 3.3 for the black cotton soil by mixing 0.7 % of waste plastic strips to red soil and 0.5 % for the black cotton soil (Saikia and de Brito 2012).

III. OBJECTIVES OF THE STUDY

The main intention of the study is to use the notorious plant water hyacinth as an adsorbent to remove of Cr (VI) from synthetic aqueous solutions. Batch and continuous adsorption studies will be performed to check capability to adsorb Cr and Ni ions from aqueous solutions using dried water hyacinth in the concentration range 1–200 mg/L and also will be checked the effects of contact time, the initial concentration of metal ions, adsorbent dosage and temperature on adsorption capacity. The water hyacinth will be cost effective and has the good efficiency to remove these toxic metal ions from aqueous solution. For achieving the aim of the study aim is breakdown into small milestones which are given following:

1. To Brief study of electroplating industry.
2. To determine the following properties of soil:
    a. Specific gravity,
    b. Grain size analysis and
    c. index properties
3. To increase the density and California Bearing Ratio (CBR) of soil using plastic as an admixture.
4. To provide an alternative solution for the disposal of plastic waste.
5. To provide an economical solution for soil stabilization using plastic waste.
6. To determine the optimum plastic content for stabilization

IV. MATERIAL AND METHODOLOGY

4.1 Material

The experiments related to the project work are completed with help of some certain material which is mention below.

4.1.1 Soil

The clayey soil used for the study was collected from the subharti campus, Meerut Uttar Pradesh

4.1.2 Plastic waste bottles

4.1.3 Instruments/ Equipment

The instruments / Equipment which were used for the experiment and related to thesis work which are showing with the specification in the following Table *1*

Table 1 List of Instruments / Materials used in The Study

S.No.	Instruments/equipment	Function
1	Plastic bottles (cut & uncut)	Plastic is a non-renewable source and bio-degradable.
2	Black cotton soil	It Contains montmorillonite clay mineral which contains very high expensive characteristics. BC soil possesses low shrinkage limit and high optimum moisture content.
3	Knife	By using knife we cut the bottle at the top & bottom.
4	Scissor	We cut the bottles in strip in small sizes.
5	Scale	It is the measure by using it we measure the size of the strip of the bottles.

4.2 Methodology

There was need of method for preparing stabilizer and procedure to determine the index properties of soil.

4.2.1 Preparation of soil stabilizer

While preparation of adsorbent for experiments, following steps was followed-

1. Collection of water bottles
2. Cleaning of water bottles
3. Drying of water bottles
4. Striping of water bottles

4.2.1.1 Collection of Water bottles

Water bottles were collected from Subharti University, Meerut, Uttar Pradesh, India.

4.2.1.2 Cleaning of Water bottles

After collection of water bottles. It was washed thoroughly three to five times with the tap water for removing unwanted material like external dust particles, and finally it was washed with hot water.

4.2.1.2 Drying of Water bottles

Washed water bottles was put on the roof of the room under the sunlight to drying for 1 to 2 days. While drying of water bottles, one thing was always kept in mind that water bottles should above from the roof surface because lot of unwanted particles like paper, dust, broken glass, etc.

4.2.1.2 Grinding of Water bottles

Dried water hyacinth parts will be broken into small piece with help of hand beaten tools or another tool as per suitability. After this, it will be converted into powder form using the grinding machine. Obtained Water hyacinth powder will be sieved using Indian standard sieve and it was be stored in air tight container.

4.2.1.2 Cutting of Water Bottles Strip

Dried water bottles parts will be broken into small strips with help of knife and scissor tools or another tool as per suitability. Then we store the plastic strip in bag.

V. RESULTS AND DISCUSSION

5.1 Properties of Soil Sample

Test was conducted to find various characteristics of the soil sample. The results obtained are tabulated in **Table *2***

Table 2 Properties of Soil Sample

S. No	**Laboratory Test**		**Result**
1	Swelling Index		64.8%
2	Specific Gravity		2.66
3	**Sieve Analysis**		
	a.	Gravel	0%
	b.	Coarse Sand	0%
	c.	Medium Sand	0%
	d.	Fine Sand	0%
	e.	Silt and Clay	100%
4	**Atterberg Limits**		
	a.	Liquid Limit, LL	65.8%
	b.	Plastic Limit, PL	32.6%
	c.	Plasticity Index, PI	38.2%
5	Compressive Strength		89.5 kg/cm2
6	**Modified Proctor Test**		
	a.	Optimum Moisture Content, OMC	19.5%
	b.	Maximum Dry Density, MDD	1.68 gm/cc
7	California Bearing Ratio Test, CBR		1.0%

Table 3 Test Results of Soil Sample with percentage of Plastic Strips

Table 2:	MDD (gm/cc)	OMC (%)	CBR (%)
Soil	1.62	19.98	1.00
Soil with 2% plastic	1.68	18.95	2.02
Soil with 4% plastic	1.78	18.89	9.67
Soil with 6% plastic	1.71	17.96	4.80
Soil with 8% plastic	1.61	17.60	4.40

MDD: Maximum Dry Density; **OMC**: Optimum Moisture Content; **CBR**: California Bearing Ratio

VI. 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. The plastic stripes were made out of this plastic wastage and are used in making the payment 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 black cotton soil, adding the 4% of plastic stripes to black cotton soil it is found that the strength of the soil is increased resulting the bearing ratio of 9.67 for the black cotton soil. As it economic in nature and hazard free it is the one of the best solution for re-utilization of the plastic wastage.

Thus this project is to meets the challenge of society to reduce the quantities of plastic waste, the plastic stripes were made out of this plastic wastage and are used in making the payment and it is found that there is an increase in the strength of the soil.

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