

BEHAVIOUR OF SOIL BY MIXING OF PLASTIC STRIPS

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Abstract – Infrastructure is a major sector that propels overall development of Indian economy. The development of roadways is very important and it is to be strong enough to support different loads. For roads to be strong the soil around it plays a very important role. On the other hand, 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. Therefore the correct way of disposing plastic waste without causing any ecological hazard has become a real challenge today. So, Plastic wastes are to be utilized so that its consequences should be minimized. In this paper plastic wastes are to be mixed in soil in the form of strips of various sizes. A series of standard Proctor test and unsoaked California Bearing Ratio (CBR) tests are done for locally available clayey soil mixed with various length and proportion of plastic strips with the aim of identifying the percentages (by dry weight of soil) and length of the plastic causing optimum improvisation of soil-plastic mix composite used.

Key Words: Roadways¹, Sub-grade², Plastic Strips³, California Bearing Ratio⁴, Standard proctor test⁵.

1. INTRODUCTION

Roadways are now becoming an integral part of development of country. But because of unsuitability of soil, this cannot meet the cost effective road construction. So, proper treatment of soil is required to optimise the strength of soil sub-grade. A treated or stronger sub-grade soil shall require relatively thinner section of a flexible pavement as compared to that of an untreated and weaker sub-grade resulting in significant cost advantage. The use of plastic as reinforcement has increased drastically in geotechnical engineering. Plastic waste is non- biodegradable waste has become ecologically burdensome. So reinforcing soil with Low Density Polyethylene (LDPE) strips obtained from waste plastic may provide an easy and sometimes an economical means to improve the engineering performance of sub-grade soils. On the other hand, they are otherwise considered unsuitable and if found effective can also reduce the problem of disposal of this non- biodegradable waste causing environmental hazards. Prediction of pavement performance becomes difficult if unconventional materials are used as a part of pavement structure. Therefore, in the present investigation an attempt has been made to demonstrate the potential of reclaimed LDPE strips as soil reinforcement for improving the sub-grade soils. The paper describes a series of CBR test carried out with varying percentage of LDPE strips of different sizes mixed uniformly with the soil. The results obtained from the test were presented and discussed.

2. REVIEW OF PAST WORKS

Use of plastic products is increasing day by day. The disposal of plastic wastes without any ecological hazards has become a challenge to our society. So, the use of plastic waste as soil stabilizing material is economical. Several studies have been made with waste plastic strips to observe the behavior of soil-plastic waste strip mixed composite. After reviewing the performance of waste plastic mixed soil, Dhatrak et.al (2015), observed that for construction of flexible pavement to improve the sub grade soil of pavement using waste plastic bottles chips is an alternative method. Malhotra et.al. (2014) studied the effect of High Density Polyethylene (HDPE) plastic waste on the Unconfined Compression Strength (UCS) of soil. In a proportion of 1.5%, 3%, 4.5% and 6% of the weight of dry soil. They concluded that the UCS value of black cotton soil increased on addition of plastic waste. Choudhary et.al. (2010) demonstrated the potential of HDPE to convert as soil reinforcement by improving engineering properties of sub grade soil. Nagle et.al. (2014) performed CBR studied for improving engineering performance of sub grade soil. They mixed polyethylene, bottles, food packaging and shopping bags etc as reinforcement within black cotton soil, yellow soil and sandy soil. Their study showed that Maximum Dry Density (MDD) and CBR value increases with increase in plastic waste. Load bearing capacity and settlement characteristics of selected soil materials are also improved. Poweth et.al. (2013) investigated on safe and productive disposal of quarry dust, type waste and waste plastic by using them in the pavements sub grade. In their paper a series of CBR and SPT test were carried out for finding the optimum percentages of waste plastics, quarry dust in soil sample. The results shows only quarry dust should be mixed with the soil plastic mix, to increase its maximum dry density and is suitable for pavement sub grade. Types alone are not suitable for sub grade. They concluded that soil plastic mixed with quarry dust maintains the CBR value within the required limit. Soil mixed with quarry dust gives lesser CBR value than soil plastic quarry dust mix but it can be used for pavement sub grade. Fauzi et.al.(2016) calculated the engineering properties by mixing waste plastic (HDPE) and waste crushed glass as reinforcement for sub grade improvement. The chemical element was investigated by Integrated Electron Microscope and Energy-Dispersive X-Ray Spectroscopy (SEM-EDS). The engineering properties angle of internal friction (ϕ), MDD, CBR values were increased when content of waste HDPE and Glass were increased. Chebet et.al. (2014) did laboratory investigations to determine the increase in shear strength and bearing capacity of locally available sand due to random mixing of strips of HDPE material from plastic shopping bags. A visual

inspection of the plastic material after tests and analysis indicates that the increased strength for the reinforced soil is due to tensile stresses mobilized in the reinforcements. The factors identified to have an influence on the efficiency of reinforcement material were the plastic properties (concentration, length, width of the strips) and the soil properties (gradation, particle size, shape).

3. MATERIALS AND METHODOLOGY

3.1 MATERIALS USED:

(a) **SOIL:** Soil available locally from Nazirabad near Kolkata, West Bengal is used for experimental study. As per I.S. Classification (IS 1498, 1970), the soil is classified as Low Compressibility Silt (ML). The properties of soil as determined in the laboratory are given in Table 1.

Table -1: Properties of Soil

Properties	Values
Specific Gravity (%)	2.37
IS Classification	ML
Liquid Limit (%)	34.62
Plastic limit (%)	27.01
Plasticity Index	7.61
Maximum Dry Density(gm/cc)	1.69
Optimum moisture content (%)	15.1
Unsoaked CBR (%) at OMC	2.82

(b) **PLASTIC:** The waste plastic strips used in the study is collected locally from Nazirabad, Kolkata. They are made of LDPE. It has density between 0.910 to 0.940 g/cc and thickness of 0.14 mm. These are cut into 1 cm, 2 cm and 3 cm length. The plastic strips to be added in soil were considered a part of the solid fraction in the void solid matrix of the soil. The tests were conducted at various strip contents of 0%, 0.2%, 0.5%, 0.8% and 1.0% of the dry weight of soil.

3.2 METHODOLOGY:

In this study the effect of inclusion of plastic strips on compaction and strength characteristic of soil have been investigated with varying size and varying percentages. The plastic strips are cut into 1 cm, 2 cm and 3 cm length and mixed randomly with clayey soil in different proportion of 0%, 0.2%, 0.5%, 0.8% and 1.0% of the dry weight of soil. Standard Proctor and unsoaked CBR tests have been conducted as per relevant I.S. code provision.

4. RESULT AND DISCUSSION

To study the reinforcing effects of mixed plastic strips on soil, a series of standard Proctor and unsoaked CBR tests have been conducted. The experimental test results of these tests are summarized in table 2.

Table -2: Experimental Test Results

PLASTIC LENGTH (cm)	PERCENTAGE OF PLASTIC (%)	SOIL		
		MDD (g/cc)	OMC (%)	CBR (%)
NO PLASTIC	0	1.69	15.1	2.82
1	0.2	1.681	15.6	4.55
	0.5	1.674	15.7	5.91
	0.8	1.67	15.9	6.59
	1	1.665	16.1	6.47
2	0.2	1.676	15.4	4.68
	0.5	1.668	15.8	6.15
	0.8	1.66	15.9	7.11
	1	1.654	16.2	6.97
3	0.2	1.665	15.6	4.63
	0.5	1.661	15.7	5.98
	0.8	1.655	15.8	6.72
	1	1.65	16.1	6.54

4.1 Standard Proctor Test:

The Standard Proctor test has been conducted as per IS 2720 (Part-VII) on cohesive soil - plastic mix composites to determine optimum moisture content (OMC) and maximum dry density (MDD). The soil is mixed with randomly distributed plastic strips of varying percentages of 0.2%, 0.5%, 0.8% and 1.0 % of the dry weight of soil and varying lengths of 1cm , 2 cm and 3 cm. Standard proctor test has been conducted on soil – plastic strips mixture. The OMC and MDD values obtained from the standard Proctor test are given in table 2 and variation of MDD and OMC with percentage of natural fibers are shown in figure 1 and 2 respectively.

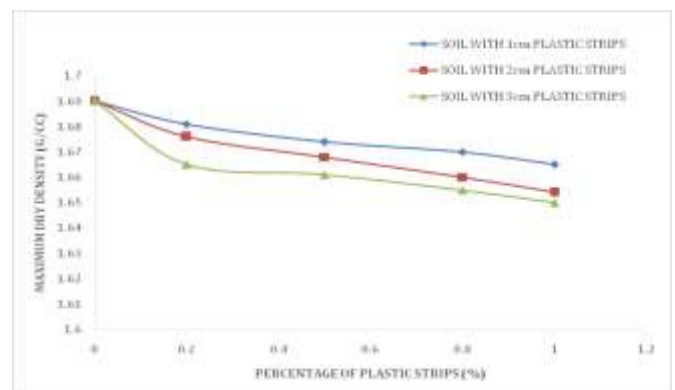


Figure -1: Variation of MDD with Percentage of Plastic Strips

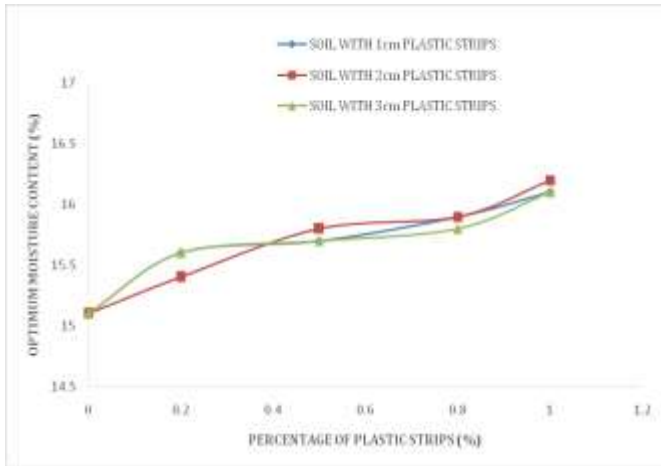


Figure -2: Variation of OMC with Percentage of Plastic Strips

From the figures, it has been observed that the maximum dry density of plastic mix soil decreases with increase of percentage of plastic strips, whereas, the Optimum Moisture Content of plastic mix soil decreases with increase in percentage of plastic strips in soil.

4.2 California Bearing Ratio (CBR) Test:

Unsoaked CBR test has been carried out on soil - plastic mix composites as per IS2720 (PART 16)-1979. The soil is mixed with plastic of varying percentages (0.2%, 0.5%, 0.8% and 1.0%) and lengths (1 cm, 2 cm and 3cm). The CBR values obtained from Laboratory unsoaked CBR test are given in table 2 and variation of CBR with percentage of natural fibers are shown in figure 3.

From the figure, it has been observed that the value California Bearing Ratio (CBR) increases with increase of percentage of plastic strips content up to a certain limit, after that it is decreases and it is maximum at 0.8% of the dry weight of soil. The optimum length of plastic strips inclusion is 2 cm.

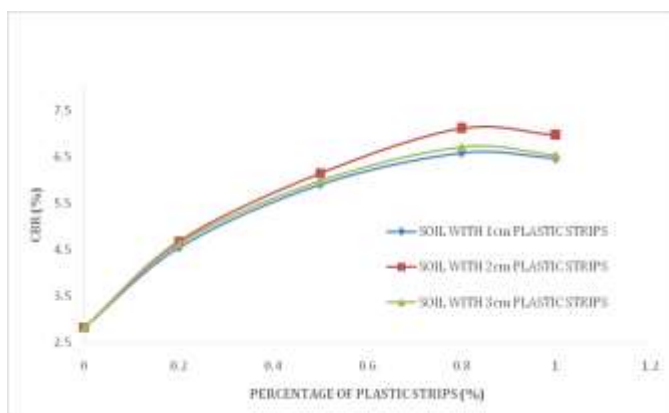


Figure -3: Variation of CBR with Percentage of Plastic Strips

5. CONCLUSIONS

On the basis of the results of experimental study made, following conclusion may be drawn:

- (i) With the increase of plastic contents, the value of MDD decreases whereas the value of OMC increases.
- (ii) There is an increase in the CBR value for soil with the increase in percentage of plastic strips.
- (iii) The maximum CBR value obtained when plastic strips is of 2 cm long, are added with 0.8% of the dry weight of soil. Hence, optimum percentage inclusion may be considered as 0.8% of the dry weight of soil and optimum length of plastic strip inclusion is 2 cm.

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