Characteristics of Clayey Soil Mixing With Randomly Distribute Plastic Waste Bags

Arindam Saha, Joyanta Maity, Bikash Chandra Chattopadhyay

***Abstract*— Due to large-scale constructional activities of roads in India, requirement of fill material is enormous and available soils near construction sites may be weak in strength and of high compressibility, even after proper compaction. Such soils need addition of some strengthening elements to increase the strength and to reduce the compressibility of weak soil. On the other hand, the uses of plastic waste bags are increasing in everywhere in an unprecedented rate. Huge stockpiles of scrap or waste plastic bags constitute environmental and health hazards by producing air pollution from waste plastic stockpile fires and breeding grounds for potential disease. Also scrap waste plastic does not decompose easily. In such conditions, clayey soil mixed with randomly distributed waste plastic bags can be used if suitable, to increase strength and decrease deformability in road construction in a cost- effective manner. This paper presents the stabilization of cohesive soil using randomly distributed waste plastic bags at varying lengths and percentages by weight of cohesive soil. Compaction tests were conducted to investigate the behavior of clayey soil mixed with waste plastic bags. From the test results, it was observed that with the increase in percentage of waste plastic bags in clayey soil, maximum dry density decreases whereas optimum moisture content increases. But, the strength values of the composite at OMC, increased with increase in percentage of waste milk plastic bags up to a certain limit.**

***Index Terms*— Waste plastic bags, Compaction tests, strength values, clayey soil**

I. INTRODUCTION

The uses of plastic waste bags are increasing in everywhere in an unprecedented rate. Huge stockpiles of scrap or waste plastic bags constitute environmental and health hazards by producing air pollution from waste plastic stockpile fires and breeding grounds for potential disease carrying mosquitoes and vermin. Also scrap waste plastic does not decompose easily. Scrap waste plastics are being environmental and drainage problem at many places. In this situation a safe disposal system for these is essential. If the application of scrap waste plastic in clayey soil results increase in strength and decrease of deformability, such application will then reduce the cost by providing lesser thickness of pavement and thus lesser quantity of materials.

Plastic bags are generally made of non-porous materials mainly polyethylene produced from non-renewable petroleum and natural gas resources. Recently, plastic has taken the centre stage among materials by being extremely cheap, highly durable and versatile material highly benefitting the economy of a society. Plastics have also helped reduce energy consumption and green house gas emissions compared to its alternatives. The amount of plastics disposed is increasing day-by-day. The world's annual consumption of plastic materials has increased from around 5 million tonnes in the 1950s to nearly 100 million tonnes today. Plastic waste has been used as a reinforcing element to minimize settlement and to increase the rate of consolidation of soil. The experimental results of several studies indicated that the waste plastic, when added to hot aggregate will form a fine coat of plastic over the aggregate and such aggregate, when mixed with the binder is found to give higher strength, higher resistance to water and better performance over a period of time. Waste plastic such as carry bags, disposable cups and laminated pouches like chips, pan masala, aluminium foil and packaging material used for biscuits, chocolates, milk and grocery items can be used for surfacing roads. The linear consumption patterns of plastic bags involving single usage and then disposal has led to environmental challenges such as diminishing landfill space, marine and urban pollution.

Application of waste plastic bags from polyethylene for reinforcing soil in different geotechnical engineering applications such as, road bases, embankments and slope stabilization have already been made. The randomly mixing of plastic waste with soil results increase in the bearing capacity of weak soil, reduce settlement of soil, provide lateral stability, and increase resistance against liquefaction.

II. PROPOSED INVESTIGATION

MATERIAL USED:

SOIL: The soil was used in experimental program collected from the site of Kayasthapara, Kasba, Kolkata. The soil is classified as "MI" as per IS classification. The physical properties of this used soil are given in Table 1.

WASTE PLASTIC BAGS: Waste plastics (Metro diary milk packets) were collected from local market for using in experimental program and processed by cutting into small pieces of length 1cm x 1cm, 1cm x 2cm and 1cm x 4cm (fig. 1). Waste plastic bags were randomly mixed with procured soil with various percentages of 0.5%, 1% and 1.5%. The mixture of soil and plastic was done thoroughly with requisite moisture content.

Fig 1: Plastics bag cut into different sizes

Fig2: Plastic milk packets mixed soil

TABLE 1: Physical properties of soil

PROPERTIES	SOIL
IS Classification	MI
Specific Gravity	2.5
Liquid Limit (%)	41.3
Plastic Limit (%)	27.5
Plasticity Index (%)	13.8
Co-efficient of uniformity (Cu)	21.76
Co-efficient of curvature (Cc)	1.02
Maximum dry density (g/cc)	1.56
Optimum moisture content (%)	16.25
Unsoaked CBR at OMC (%)	3.3

TEST PROGRAMME:

In this study to investigate the effect of inclusion of waste plastic bags on compaction characteristics of locally available clayey soil, standard Proctor tests and CBR tests were conducted for clayey soil mixed with randomly distributed varying percentages and lengths of waste plastic bags (fig. 2). All the tests were conducted as per relevant I.S. codal provision.

III. RESULTS AND DISCUSSIONS

Standard proctor test have been conducted in the laboratory as per I.S codal provision, for different series of clayey soil-waste plastic bags composite. The results of these tests are given in table 2.

COMPACTION CHARACTERISTICS:

The Standard Proctor tests were conducted as per IS 2720 (Part-VII) on clayey soil- waste plastic bags mix composites to determine the optimum moisture content (OMC) and maximum dry density (MDD). The local clayey soil is mixed with randomly distributed waste plastic bags of varying percentages (0.5%, 1%, 1.5%) and sizes (1cm x 1cm, 1cm x 2cm, and 1cm x 4cm) and standard proctor test were conducted on these mixtures. 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 waste plastic bags are shown in fig. 3 and 4 respectively.

From these figures, it can be observed that with the increase in percentage of waste plastic bags, the MDD value of clayey soil- waste plastic bags mix composites decreases whereas OMC value increases significantly.

TABLE 2: Summary of results of Compaction tests:

MIXING MATERIAL	% OF TYRE CHIPS	OMC (%)	MDD (gm/cc)	UNSOAKED CBR
Soil	0	16.25	1.56 1.572	3.33
Soil + plastic packet of Size 1cm x 1cm	0.5	18.5	1.543	5.58
	1	19	1.539	7
	1.5	20.3	1.531	6.5
Soil + plastic packet of Size 1cm x 2cm	0.5	20.2	1.539	5.63
	1	21.3	1.537	6.7
	1.5	22	1.529	6.6
Soil + plastic packet of Size 1cm x 4cm	0.5	20.96	1.535	5.64
	1	21.75	1.531	6.5
	1.5	22.5	1.527	6.3

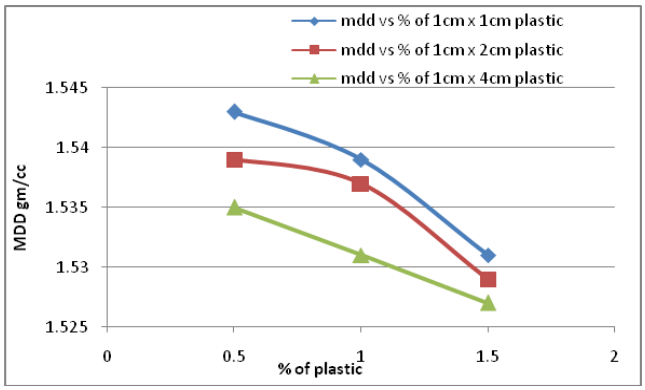

Fig 3.- Comparison between % of plastic mix vs MDD

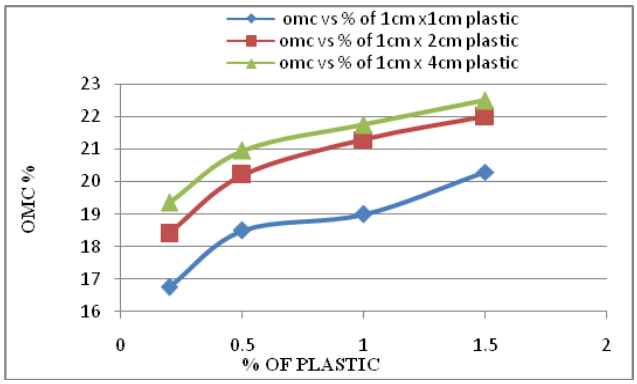

Fig 4.- Comparison between % of plastic mix vs OMC

STRENGTH CHARACTERISTICS:

Unsoaked CBR tests were conducted as per IS :2720 (Part-XVI) on clayey soil & waste milk plastic packets at respective OMC. Randomly distributed waste milk plastic packets of varying percentages of 0.5%, 1%, 1.5% and sizes of 1cm x 1cm, 1cm x 2cm, 1cm x 4cm, were mixed with clayey soil. The CBR values were obtained in the laboratory CBR tests are given in table 2 and the variation with percentage of waste plastic bags is shown in fig 5.

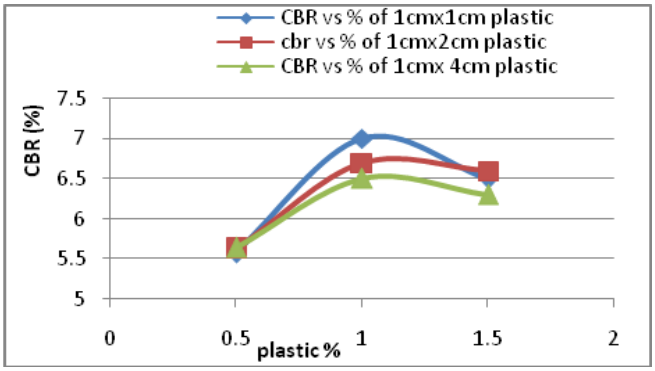

Fig 5.- Comparison between % of plastic mix vs CBR

From the figure, it is observed that the CBR values of the clayey Soil-waste milk plastic bags mix composite increases with increase of percentage of waste milk plastic bags and reaches maximum values and after that it decreases with further inclusion of waste milk plastic bags within the range of testing programme. The maximum unsoaked CBR value of clayey soil obtained from the laboratory test is 7%, for addition of 1% waste milk plastic bags of size 1cm x 1cm.

IV. Conclusion

On the basis of the results of experimental investigation made above, following conclusions may be drawn.

[1] Maximum dry density decreases with the increase in percentage of waste plastic bags.

[2] Optimum moisture content increased with the increase in percentage of waste plastic bag.

[3] CBR values of the clayey Soil-waste milk plastic bags mix composite increases with increase of percentage of waste milk plastic bags and reaches maximum values at 1% of 1cm x1cm size and after that it decreases with further inclusion of waste milk plastic bags within the range of testing programme.

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