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STUDY THE EFFECT OF PLASTIC WASTE AND SOIL INTERACTION ON SOIL PROPERTIES

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Abstract: 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 like cement, lime, sand, fly ash, or by providing geo textiles, geo synthetics etc.
The new technique of soil stabilization can be effectively used to meet the challenges of society, to reduce the quantities of Plastic waste, producing useful material from non-useful waste materials.
Since the use of plastic in diversified forms such as chairs, bottles, polythene bags, etc., has been advancing speedily and its disposal has been a problem all the time regarding the environmental concern, using plastic waste as soil stabilizer would reduce the problem of disposing the plastic as well as increases the density and California Bearing Ratio (CBR) of soil in an economical way.
In the present study, an experimental program was conducted for stabilization of Black Cotton Soils. With the utilization of Plastic waste as soil stabilizer. Different contents of plastic waste (% by weight varying from 0% to 20%) are added to the Black Cotton Soil and the optimum percentage of plastic waste in soil was found out by conducting Standard Compaction test and California Bearing Ratio Test.

***Key words* – Plastic waste, Soil Stabilization, Soil Interaction**

I. INTRODUCTION

Black cotton soil Black Cotton Soils which are very fertile and suitable for agriculture but not good for construction of Civil Engineering Structures because of its low Bearing Capacity and intensive shrinkswell process which results in development of cracks. With the formation of new capital, rapid Industrialization, bursting population and decrease of available land, a greater number of buildings and other civil engineering constructions has to be carried out on available Black Cotton soils which are having poor shear strength. Hence, a great diversity of ground improvement techniques such as soil stabilization and reinforcement are needed to be employed to improve behavior of soil, thereby enhancing the reliability of construction.
Soil stabilization in the present situation, stabilizing of soils is of utmost importance, which makes them suitable for various construction activities. Various materials and methods may be used for stabilizing soils and are presented below. Soil stabilization is the process by which the engineering properties of the soil are improved and it is made more stable. It is used to decrease the soil's unqualified characteristics such as permeability and consolidation potential and increase the shear capacity. The method is mainly adopted for highway and airfield construction projects. Commonly, activities such as compaction and pre-consolidation are used to improve types of soils which are already in good form. But soil stabilization goes way up to encouraging usage of weak soil and reducing the uneconomical process of weak soil replacement. Other than working on the soil mass interaction, chemically altering the soil material itself is also the focus of this process. Sometimes, soil stabilization is used for city and suburban streets to make them more noise-absorbing.
Different methods have been developed previously to stabilize weak and unsuitable soils. Some of these methods include mechanical (granular) stabilization, cement stabilization, lime stabilization, bituminous stabilization, chemical stabilization, thermal stabilization, electrical stabilization, as well as grouting stabilization by geotextile and fabrics. Recently, researchers have introduced another way of soil stabilization by using waste materials. Plastics are one of the leading waste materials that are found to be suitable for this purpose. They reduce the cost of stabilization at a large rate.
Using plastics for this purpose simultaneously solves the challenges of improper plastic waste recycling that is currently a teething problem in most developing countries. Improper plastic waste disposal is becoming a pressing environmental issue in most African countries. They are currently covering landfills and water bodies, clogging sewerage systems, disrupting the ecological cycle and creating an aesthetically unpleasing environment. This in turn causes serious damage to animal, plant and human lives. Polyethylene Terephthalate (PET) bottles are conventional plastic bottles that currently are highly utilized. They are used to package water, soft drinks, liquid foods, and various other beverages. With their increasing demand, their disposal is becoming difficult. The degradation of waste PET bottles takes a very long time in nature (more than a hundred years).
Recycling and using these plastic bottles to stabilize expansive clay soil are moves in the right direction making the construction industry an appropriate candidate with its high consumption ability. This will be a decent alternative for R. B. Kassa et al. DOI:

10.4236/ojce.2020.101006 57 Open Journal of Civil Engineering clearing and protecting the environment from waste plastic bottles. This paper presents appropriate and easy to implement ways of recycling plastic water bottles as reinforcing material for the stabilization of expansive soil to improve and achieve the required properties for construction works. The experimental tests that were performed with the achieved results are presented.

II. OBJECTIVES

1. To determine the density, Optimum Moisture Content of soil with plastic waste as an admixture.
2. To Determine CBR value of soil with plastic waste.
3. To increase stability of soil.
4. To provide an alternative solution for the disposal of plastic waste.
5. To provide an economical solution for soil properties using plastic waste.
6. To determine the optimum plastic waste content to be used.

III. LITERATURE REVIEW

Tarun Kumar, Suryaketan "Behaviour of Soil By Mixing Of Plastic Strips", International Research Journal Of Engineering & Technology e-ISSN: 2395-0056, Vol. 5, Issue 05, May 2018 By increasing the amount of plastic contents, the value of the MDD decreases whereas the value of OMC increases. There is increase in CBR value for soil with increasing the percentage of plastic strips. The maximum CBR value is obtained when the percentage of the plastic strips is 0.8% of dry weight of soil. Hence 0.8% of strips having length of 2cm is considered as required amount.

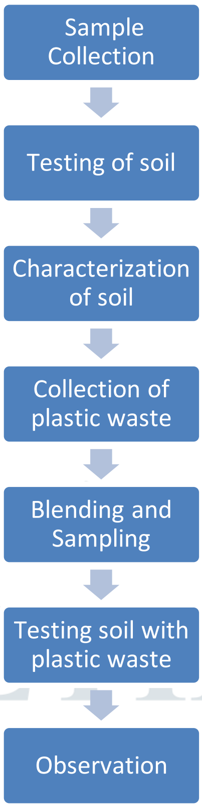
Kiran kumar Patil, Shruti Neeralagi "Soil Stabilization Using Plastic Waste", International Journal of Advanced Technology in Engineering & Science, ISSN 2348-7550, Vol. 5, Issue No. 07, July 2017 Stabilization of soils is an effective method for improving the properties of soil. The main objective of any stabilization technique used for increasing the strength and stiffness of soil, workability and constructability of the soil. Plastic such as shopping bags is used for reinforcing the soil for improving the various properties of soil.

Sayli D. Madavi, Divya Patel "Soil Stabilization Using Plastic Waste" International Journal of Research in Science & Engineering, Vol. 3, Issue 2, March-April 2017 Using plastic as a soil stabilizer is an economical and gainful usage because there is lack of good quality soil for various constructions. These techniques can be serves the purpose of reducing pollution and meet the challenges of Amravati, and also to the whole society, producing useful material from non-useful waste materials.

Sharan Veer Singh, Mahabir Dixit, "Stabilization of Soil by Using Waste Plastic Material: A Review", International Journal of Innovative Research in Science, Engineering & Technology, ISSN(Online) 2319-8753, Vol. 6, Issue 2, February 2017.

Infrastructure is a major sector that propels overall development of Indian economy. For any Structure foundation has the prime importance, the strong foundation plays very important role. Expansive soils such as black cotton soil creates problems in foundation and for this stabilization of soil is required. This paper focus on the soil stabilization by using plastic waste products. The plastic inclusion can improve the strength thus increasing the soil bearing capacity of the soil. Use of plastic waste as reinforcement which reduces the disposal problem of the waste materials.

III. RESEARCH METHODOLOGY



Specific gravity (Pycnometer test)

Weight of empty pycnometer (w1)	Wt of empty pycnometer + soil mass (w2)	Wt of pycnometer + soil mass + water (w3)	Wt of pycnomete r + water (w4)
623 gm	1005 gm	1735 gm	1505 gm
623 gm	1095 gm	1780 gm	1505 gm
623 gm	1030 gm	1750 gm	1505 gm

Table:01

Formula:
G1=(w2-w1)/(w2-w1) - (w3-w4)
G1= (1005-623)/(1005-623)-(1750-1505)
G1=2.513

G2= 2.395
G3= 2.513

Avg G = G1+G2+G3/3
Avg G = 2.513+2.395+2.513/3
Avg G = 2.47

WET SIEVE ANALYSIS As per IS: 2720 (part 4): 1985

SIEVE SIZE	MASS OF EMPTY SIEVE	MASS OF SIEVE + SOIL RETAINED	SOIL REATINED	% RETAINED	%PASSING
2MM	372	482	110	17.24	82.76
1.18MM	403	512	109	17.08	65.68
600MIC	384	481	97	15.20	50.48
425MIC	372	417	45	7.05	43.43
300MIC	372	429	57	8.93	34.5
250MIC	372	382	10	1.56	32.94
212MIC	337	369	32	5.01	27.93
150MIC	350	378	28	4.38	23.55

Table:02

Cu and Cc gives us idea about particle size distribution of soil
Cu=D60/D10
Cu=14.67 < 15
Hence, it is non-uniform soil

Cc=D302 /D60xD10
Cc=1.4 Hence,
It is well graded soil as Cc lies between 1-3

Calculations of standard proctor test on soil

Sr. No	Observations	5% water	10% water	15% water
1	Mass of empty mould (M1)	5390	5390	5390
2	Mass of mould + compacted soil (M2)	6884	7135	7210
3	Mass of compacted soil (M2-M1)	1494	1745	1820
4	Bulk density	1.494	1.745	1.820
5	Water content of soil (W%)	12	14.8	24.2
6	Dry density	1.33	1.53	1.46

Table: 03

Soil with 5% plastic waste with 5,10,15,20%of water:

Sr. No	Observations	5% water	10% water	15% water	20% water
1	Mass of empty mould (M1)	5390	5390	5390	5390
2	Mass of mould + compacted soil+plastic (5%) (M2)	6855	7142	7185	6992
3	Mass of compacted soil (M2-M1)	1465	1752	1795	1602
4	Bulk density	1.465	1.752	1.795	1.602
5	Water content of soil (W%)	5.5	17.64	19.64	21.04
6	Dry density	1.388	1.489	1.50	1.32

Table: 04

Soil with 10% plastic waste with 10,15,20,25% of water

Sr. NO.	Observations	5% water	10% water	10% water	20% water	25% water
1	Mass of empty mould (M1)	5390	5390	5390	5390	5390
2	Mass of mould + compacted soil+plastic(10%) (M2)	6875	6992	7062	7241	7285
3	Mass of compacted soil (M2-M1)	1485	1602	1672	1851	1895
4	Bulk density	1.485	1.602	1.672	1.851	1.895
5	Water content of soil (W%)	9.5	13.04	13.63	17.3	22.7
6	Dry density	1.35	1.417	1.471	1.58	1.55

Table: 05

Soil with 15% plastic waste with 5,10,15,20,25% of water

Sr. NO.	Observations	5% water	10% water	15% water	20% water	25% water
1	Mass of empty mould (M1)	5390	5390	5390	5390	5390
2	Mass of mould + compacted soil+ plastic (15%) (M2)	6787	6899	6990	6853	6650
3	Mass of compacted soil (M2-M1)	1393	1509	1600	1463	1260
4	Bulk density	1.397	1.509	1.6	1.46	1.26
5	Water content of soil (W%)	5	12.5	15	15.88	16.66
6	Dry density	1.24	1.39	1.43	1.26	1.08

Soil with 20% plastic waste with 5,10,15,20,25% of water:

Sr. No.	Observations	5% water	10% water	15% water	20% water	25% water
	Mass of empty mould (M1	5390	5390	5390	5390	5390
	Mass of mould + compacted soil+ plastic (20%) (M2	6398	6972	7001	7001	6948
	Mass of compacted soil (M2-M1)	1008	1582	1611	1611	1558
	Bulk density	1.00	1.58	1.61	1.61	1.55
	Water content of soil (W%)	14.28	15.38	26.31	26.31	27.7
	Dry density	0.87	1.37	1.27	1.27	1.22

IV. RESULTS

CBR can be said as the indirect measure of the strength as soil deformed was shear in nature. From the results, it is evident that waste plastic increases the CBR value. There is a increase in CBR value when the soil is incorporated with Plastic waste and compared to that of soil with no plastic. The results are tabulated and presented below in Table.

CBR test is performed on the samples with varying percentages of Plastic waste i.e., 5%, 10%, 15% and 20%. In this regard, the CBR value has been increasing up to 5% plastic content and thereon it started to decrease. From this, it can be inferred that, 5% plastic content is the OPTIMUM CONTENT of utilization of waste plastic in the soil.

Plastic %	CBR at 2.5	CBR at 5	Remark
Unit	%	%	As per IS:2720 (Part-16): 1987:2021
Soil	22.35	18.55	
5% plastic	24.91	21.29	
10% plastic	21.44	19.16	
15% plastic	13.59	11.80	
20% plastic	10.95	9.85	

Sample Description	MDD (gm/cc)	OMC (%)	CBR (%)
Soil	1.53	14.8	22.35
Soil with 5% plastic	1.50	19.64	24.91
Soil with 10% plastic	1.58	17.3	21.44
Soil with 15% plastic	1.43	15	13.59
Soil with 20% plastic	1.37	15.38	10.95

Where,

MDD is maximum dry density
OMC is optimum moisture content
CBR is California bearing ratio

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