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IMPROVEMENT OF SOIL PROPERTIES BY USING WASTE PLASTIC

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Abstract – *Black cotton soil contains montmorillonite clay mineral which has high expansive characteristics. Due to montmorillonite black cotton soil is an expansive soil which has undesirable plasticity characteristics it possesses high swelling and shrinkage properties and high optimum moisture content. The swelling and shrinking process of a sub grade black cotton soil results into failure of structures in the form of settlement and cracking. It may cause damage to the structure constructed on black cotton soil. Therefore, prior to construction of structures like foundation, buildings, pavements, roads on such subgrade, it is important to improve the engineering properties of soil by stabilization. Plastic bags of general use are produced from non-renewable petroleum and natural gas resources. Plastic bags are non-biodegradable. India and all over the world, facing the problem of disposal of plastic waste. In present project utilization of polyethylene shopping bags waste used for improvement of soil properties. The plastic strip of lengths 20mm,40mm,60mm and width 10mm and 15mm are mixed with the black cotton soil by 0.15%,0.30%,0.45% and 0.60% by the weight of soil and standard proctor, UCS and CBR tests are conducted on mix the results obtained form the tests are shown that mixing of this material in black cotton soils is effective for improvement of soil properties.*

Key Words: Polyethylene Plastic bags, Soil reinforcement, Ground improvement, Waste.

1.INTRODUCTION

A large part of Maharashtra are covered with black cotton soils. Black cotton soil is an expansive soil which is having undesirable plasticity . Black cotton soil contains the clay mineral montmorillonite. Montmorillonite is unstable clay mineral, thus the soil have high swelling and shrinkage characteristics. It is very difficult to construct a structure with this soil, as black cotton soil has very low bearing capacity and it do not possesses sufficient strength to support the loads imposed upon them during the service life of the structure. For building a structure on such soils, the ground properties of such soil need to be improved. The study area in the present work consist of black cotton soil, So the main objective is to stabilize the soil and improve its geotechnical properties in order to make use of the soil in the study area for construction purpose.

Plastic (polyethylene) shopping bags have been used extensively since their first introduction over fifty years ago. However, their major weakness is that they severely pollute the environment: littering parks and roadsides, clogging sewers and filling landfills. With landfills rapidly filling up, finding a solution to this non-degradable polyethylene waste is key to a sustainable environment. This research, therefore, was undertaken to investigate the potential increase in soil shearing strength when it is reinforced with plastic strips. It was anticipated that positive laboratory results could trigger field applications, success of which would permit reduction of the plastic grocery bag wastes destined to landfills bringing along environmental and economic benefits.

2. MATERIALS AND METHODS

2.1 Soil Material

Black cotton clayey soil was used in this study collected from Ganur Tal. Chandwad Dist- Nashik, Maharashtra, India. The collected soil is low plastic silt (ML). Then the soil was screened through the sieve of 4.75 mm aperture before preparing the specimen for testing. According to the Unified Soil Classification Systems soil is clay.

Table -1: Properties of Black Cotton Soil

S.NO	PROPERTY	VALUE
1	Specific Gravity	2.39
2	Liquid Limit	51%
3	Plastic Limit	40.41%
4	Shrinkage Limit	15.69%
5	Plasticity Index	10.59%

2.2 Plastic Shopping Bag

The materials used in the study were plastic grocery shopping bags sourced from the local Supermarket . The material density was measured to average 798kg/m3, with the tensile strength ranging between

14 and 20 MPa. Plastic bags of thickness 40 micron. The Three reinforcement plastic strip of width 10mm & 15mm and lengths 20 mm,40 mm,60 mm are adopt and their reinforcement concentration in 0.15%, 0.30%, 0.45% & 0.60% by mass of soil are adopt.

In order to improve the properties of black cotton soil, the plastic strips with different width and length are added to the soil with percentage of 0.15%,0.30%,0.45%,0.60% by dry weight of soil. and tests are carried out on mix. Each mix proportion is tested two times for OMC and MDD. Three samples are tested for UCS of 0 days, 7 days, 21 days and one sample for unsoked CBR.

Fig -1: Waste plastic bag and Plastic Strips

3. EXPERIMENTAL WORK

Soil samples for the tests were oven dried in order to eliminate any effects of moisture and the plastic strips mixed with the soil to form a composite . The plastic strips used were of lengths 20mm,40mm, 60mm and widths of 10mm and 15mm. The strips were added to the soil at concentrations of 0.15%,0.30%,0.45% and 0.60% by weight of soil.

Fig -2: Plastic Strips with Soil

Fig -3: Plastic Strips with Soil

Fig -4: UCS Testing Machine

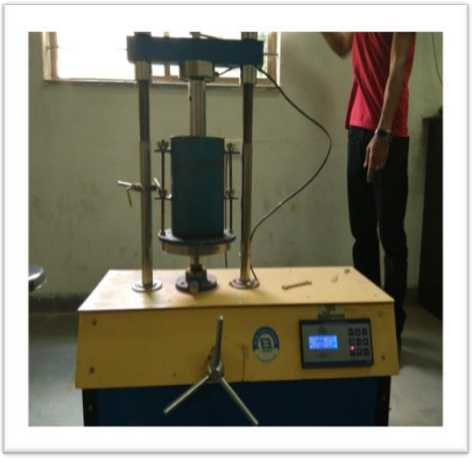

Fig -5: CBR Testing Machine

3. RESULTS

The Standard proctor test is conducted and following results are obtained.

3.1 Standard Proctor Test

Table -1: Results for Compaction Characteristics

Width	10mm				15mm			
Length	20mm		40mm		20mm		40mm	
Proportion	OMC	MDD	OMC	MDD	OMC	MDD	OMC	MDD
0%	20.05	1.53	20.05	1.53	20.05	1.53	20.05	1.53
0.15%	23.93	1.514	18.48	1.559	19.11	1.589	22.18	1.523
0.30%	11.4	1.667	23.05	1.529	20.75	1.502	23.22	1.524
0.45%	19.17	1.551	19.25	1.535	18.30	1.594	23.62	1.519
0.60%	22.01	1.521	18.5	1.557	20.00	1.572	24.11	1.502

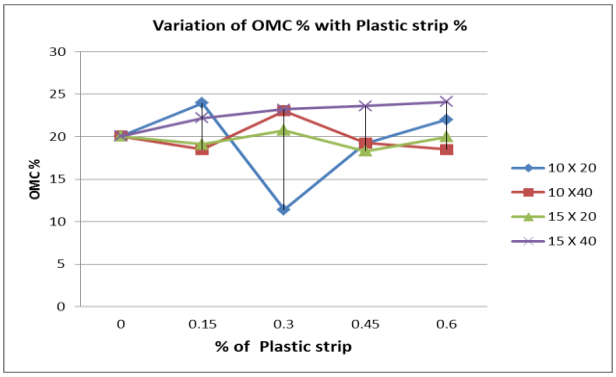

Fig -6: Variation of OMC with Plastic strip %

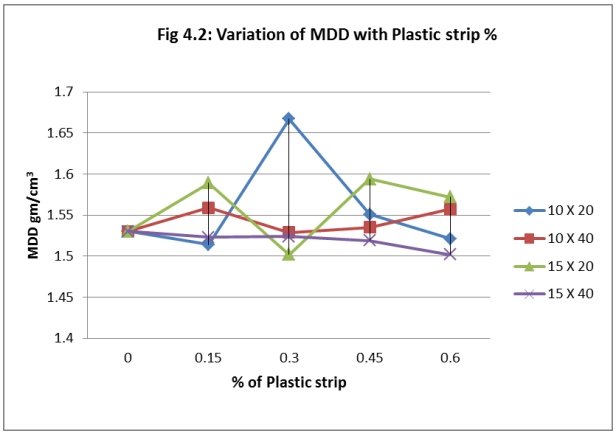

Fig-7: Variation of MDD with Plastic strip

3.2 Unconfined Compression Test

The UCS test is conducted and following results are obtained.

Table -2: UCS Test Results For size 10mm x 20mm

Percentage of plastic strips	Unconfined Compressive Strength (kg/cm²)		
	0 Days	7 Days	21 Days
0	2.21	2.32	2.55
0.15	3.17	3.41	5.13
0.30	9.49	9.68	10.75
0.45	3.37	4.84	5.003
0.60	2.21	3.41	5.19

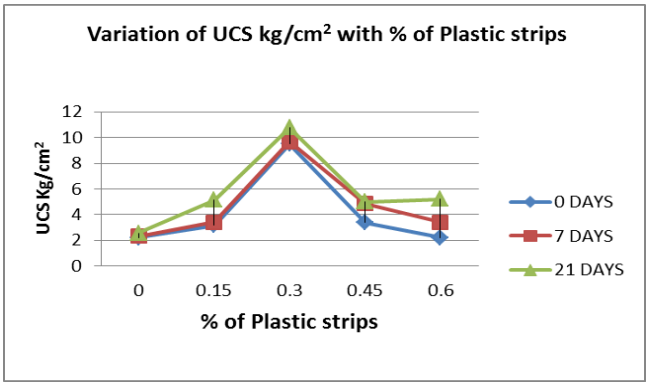

Fig-8: Variation of UCS kg/cm² with % of Plastic strips

Table -3: UCS Test Results For size 10mm x 40mm

Percentage of plastic strips	Unconfined Compressive Strength (kg/cm²)		
	0 Days	7 Days	21 Days
0	2.21	2.32	2.55
0.15	2.24	2.35	3.40
0.30	4.35	4.85	5.12
0.45	3.35	4.28	4.35
0.60	3.15	3.42	3.11

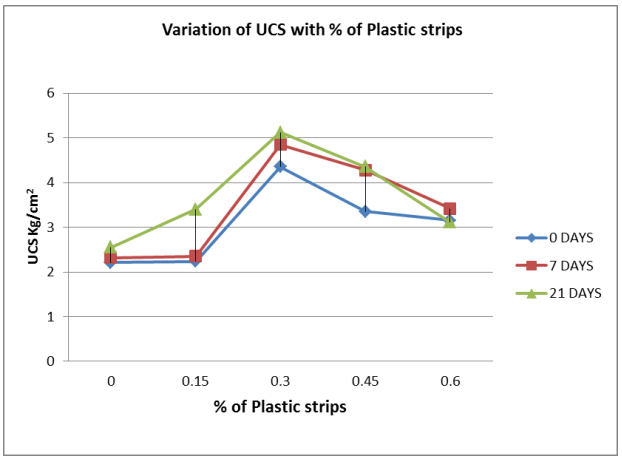

Fig -9: Variation of UCS kg/cm² with % of Plastic strips

Table-4: UCS Test Results For size 15mm x 20mm.

Percentage of plastic strips	Unconfined Compressive Strength(kg/cm²)		
	0 Days	7 Days	21 Days
0	2.21	2.32	2.55
0.15	2.21	3.61	3.84
0.30	3.41	4.28	5.12
0.45	3.17	3.51	4.85
0.60	2.56	3.40	4.36

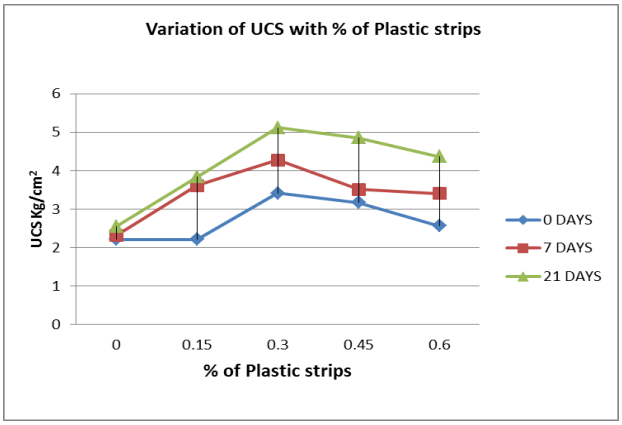

Fig -9: Variation of UCS kg/cm² with % of Plastic strips

Table-5: UCS Test Results For size 15mm x 40mm.

Percentage of plastic strips	Unconfined Compressive Strength(kg/cm²)		
	0 Days	7 Days	21 Days
0	2.21	2.32	2.55
0.15	2.55	3.84	6.85
0.30	7.01	9.02	15.4
0.45	3.52	4.29	4.36
0.60	2.32	3.62	4.28

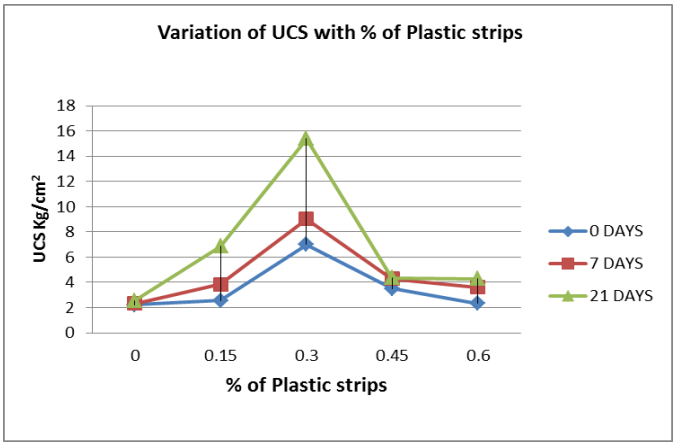

Fig -10: Variation of UCS kg/cm² with % of Plastic strips

3.3 California Bearing Ratio

The CBR Test are conducted and following results are obtained.

Table-6: CBR Tests Results

Percentage of Plastic strips	Width 10mm		Width 15mm	
	Length-20mm	Length 40mm	Length 20mm	Length 40mm
0	2.34	2.34	2.34	2.34
0.15	2.05	3.97	2.78	2.39
0.30	12.37	7.85	5.02	3.14
0.45	2.81	4.19	4.19	2.49
0.60	2.54	2.69	3.53	2.18

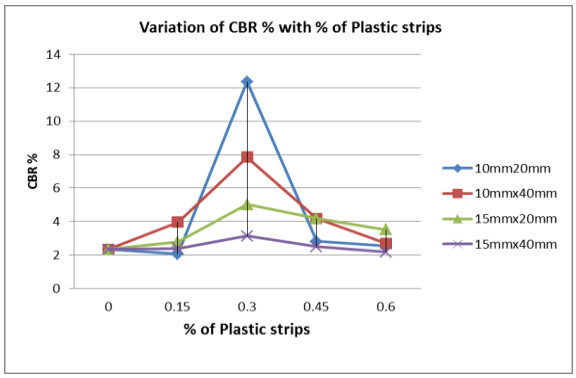

Fig-11: Variation of CBR % with % of Plastic strips

3. CONCLUSIONS

The following conclusion can be drawn based on the various tests conducted.

1. For plastic strips of size 10mm x 40mm Optimum Moisture Content found to be increase with increase in percentage of plastic strips up to 0.30% of plastic strips and again decrease to 0.60% of plastic strips. OMC increases from 20.05% at 0% of plastic strips to 23.05% at 0.30% of plastic strips. OMC again decreases to 18.55 at 0.605 of plastic strips.
2. For plastic strips of size 15mm x 20mm Optimum Moisture Content found to be increase with increase in percentage of plastic strips up to 0.30% of plastic strips and again decrease to 0.60% of plastic strips. OMC increases from 20.05% at 0% of plastic strips to 20.75% at 0.30% of plastic strips. OMC again decreases to 20.005 at 0.60% of plastic strips.
3. As the OMC increases MDD decreases for plastic strips of size 10mm x 40mm Maximum Dry Density (MDD) decreases from 1.53gm/cm3 at 0% of plastic strips to 1.529gm/cm3 at 0.3% of plastic strips. MDD again increases to 1.557gm/cm3 at 0.60% of plastic strips.
4. As the OMC increases MDD decreases for plastic strips of size 15mm x 20mm Maximum Dry Density (MDD) decreases from 1.53gm/cm3 at 0% of plastic strips to 1.502gm/cm3 at 0.3% of plastic strips. MDD again increases to 1.572gm/cm3 at 0.60% of plastic strips.
5. UCS value increases with increase % of plastic strips from 0% to 0.3% and then it decreases for 0.45 and 0.6%.
6. From above results is can be conclude that as the day increases strength increases.
7. CBR increases with increase in percentage of plastic strips from 0 to 0.30% and further increase in plastic strip causes decrease in CBR value.
8. From the above results it can be conclude that 0.30% of plastic strips is optimum percentage to be used as a stabilizing agent for sizes 10mm x 40mm and 15mmx 40mm.
9. Plastic shopping bags can be effectively and economically used to improve the geotechnical properties of soil.

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