EXPERMENTAL STUDY ON SOIL STABILIZATION BY USING WASTE PLASTIC MATERIAL

[1]Ch. Hari Prasad, [2] K. Harish Goud, [3] M. Deepika, [4] R. Kondal, [5] B. Suresh
[1]Assistant Professor, [2,3,4,5]UG Scholar
[1,2,3,4,5]Civil Engineering Department,

Abstract: Infrastructure is a major sector that propels overall development of Indian economy. The foundation is very important for any structure and it has to be strong enough to support this entire structure. For foundation to be strong the soil around it plays a very important role. Expansive soils like black cotton soil always create problems in foundations. The problems are swelling shrinkage and unequal settlement. 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. Due to which we are facing various environmental problems. A review project is presented here to focus on soil stabilization by using waste plastic products. The tests such as liquid limit, plastic limit, standard proctor compaction test, California bearing ratio (CBR) test and unconfined compressive strength (UCS) have been conducted to check the improvement in the properties of black cotton soil.

Keywords: Consistency Limits – Atterberg limits, California Bearing Ratio (CBR) test, Proctor Compaction Test.

I. INTRODUCTION

Soil stabilization may be defined as the alteration or preservation of one or more soil properties to improve the engineering characteristics and performance of a soil. Stabilization, in a broad sense, incorporates the various methods employed for modifying the properties of a soil to improve its engineering performance. Soil stabilization refers to the procedure in which a special soil, cementing material, or other chemical materials are added to a natural soil to improve one or more of its properties. One may achieve stabilization by mechanically mixing the natural soil and stabilizing material together so as to achieve a homogeneous mixture or by adding stabilizing material to an undisturbed soil deposit and obtaining interaction by letting it permeate through soil voids .Soil stabilizing additives are used to improve the properties of less-desirable rood soils. When used these stabilizing agents can improve and maintain soil moisture content, increase soil particle cohesion and serve as cementing and water proofing agents.A difficult problem in civil engineering works exists when the sub-grade is found to be clay soil. Soils having high clay content have the tendency to swell when their moisture content is allowed to increase.

II. LITERATURE REVIEW

Subhash, K.et.al. (2016) conducted experimental study on soil stabilization using glass and plastic granules mixed with varying percentage. Modified Proctor tests were carried out to study OMC and CBR. They concluded that there is a decrease in MDD on addition of glass and plastic in varying percentages. The MDD of 1.53 gm/cc was obtained at 6% of glass and plastic. The maximum OMC was obtained as 22.6% at 6% mixing of additive. Further, an increase in the OMC was observed, maximum value of OMC was obtained as 22.6%at 6 % glass and plastic additive with the soil. An increase in the UCS from 0.609 Kg/cm2to 3.023 Kg/cm2 which is about 5 times as that of virgin soil. Maximum CBR value was 7.14 %, which is 2 times of CBR of virgin soil.

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.

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. Thus authors concluded that optimum percentage of plastic was 0.5 % for optimum results.

Satyam tiwari et al. (2016): They explained the "Soil Stabilization Using Waste Fiber Materials", and investigated the use of waste fiber materials in geotechnical applications and to evaluate the effects of waste polypropylene fibers on shear strength of unsaturated soil by carrying out direct shear tests and unconfined compression tests on two different soil samples. The percentages of fiber reinforcement added are 0, 0.05, 0.15, and 0.25.Based on Specific gravity of a soil-With mixing of 0.05% fibers (PPF) specific gravity of the soil increases by0.3%. Strength of the soil is directly proportional to specific gravity, more is the specific gravity more will be the strength of soil. Based on liquid limit of a .Soil without reinforcement and with reinforcement have liquid limit difference of 18.18%.

Achmad Fauzi et.al. (2016) used two soil samples R2 andR24 collected from various sites of KUANTAN. Waste cutting HDPE and crushed waste glass were used as additives. The variations of additive contents were 4%, 8 %, 12 % by dry total weight of soil sample respectively. They evaluated engineering properties like sieve analysis, Atterberg limit, Specific gravity, Standard Compaction, soaked California bearing ratio and tri-axial test of the soil sample before stabilization and after stabilization. The result showed that on addition of waste HDPE and glass there was an increase in PI, about 10% for R24 and 2% for R2 samples respectively. The value of optimum water content decreases and MDD increases when content of waste HDPE and glass were increased but there was an increase in CBR value. Authors also observed that there was a decrease in the value of cohesion and increase in friction angle of R2 and R24 samples with additives.

ANKIT JAIN, et al. (2016): They explained the "Effect of lime on the index properties of black cotton soil". A Serious of laboratory tests conducted on black cotton soil mixed with different proportion of lime i.e. 0%, 2%, 4%, 6%, 8%, and 10% by weight of dry soil. Based on their investigation they concluded that, liquid limit of soil decreases from 67.49% to 52.01% with increase in lime content upto 8% after that there is no significant change with increase in lime content. Plasticity index of soil decreases from 37.16% to 10.43% with increase in lime content upto 8%. Differential free swelling of soil decreases from 60% to 14% with increasing lime content. Above results shows that the swelling characteristics of soil is reduced and optimum dosage of lime is found at 8%.

III. EXPERIMENTATION AND METHODOLOGY

A series of laboratory model tests were conducted in this experimental program. The main aim of this study is to investigate the utilization of plastic material by mixing them with low-strength soil, stabilized by plastic material for improving the strength in foundations.

3.1 Soil

Soil used in this study was collected from a site in vikarabad, India at 2m depth from the ground level.

According to IS classification system, the disturbed soil samples collected from above location was air dried and pulverized thoroughly prior to laboratory testing. An initial screening is done, and soil is made free from grass and weeds. Thus, prepared soils are bagged and used in laboratory for determination of properties

3.2 Physical Properties of soil

Table 3.1 Physical properties of soil

S.NO	PROPERTY	VALUE
1	**Grain Size Distribution**	
	Sand (%)	7
	Slit (%)	14
	Clay (%)	79
	Gravel (%)	0
2	**Atterberg Limits**	
	Liquid Limit (%)	59.43
	Plastic Limit (%)	21.42
	Plasticity Index (%)	38.01
3	**Compaction Properties**	
	Optimum Moisture Content,O.M.C. (%)	14
	Maximum Dry Density, M.D.D. (g/cc)	1.684
4	**Shear Strength Parameters**	
	Cohesion © (kN/m2)	1.4
	Angle of internal friction (°)	10°
5	Specific gravity (G)	2.52
6	IS Classification	CH
7	C.B.R. (%)	29.38
8	Free Swell (%)	35

IV. CALCULATIONS AND RESULT

4.1 Specific Gravity Test Result for Untreated Soil

Table 4.1 Specific Gravity of Soil

S.No	Observations and Calculations	Sample 1	Sample 2	Sample 3
1	Mass of empty pycnometer (M_1) gms	512	513	513
2	Mass of pycnometer and dry soil(M_2) gms	712	713	712
3	Mass of pycnometer, soil and water(M_3) gms	1562	1569	1560
4	Mass of pycnometer filled with water(M_4)gms	1448	1447	1435
	$M_2 – M_1$	200	200	199
	$M_3 – M_4$	114	122	125

Calculations

Mass of empty pycnometer (M_1) =512 gms Mass of the pycnometer and dry soil (M_2) =712 gms Mass of the pycnometer, soil and water (M_3) =1548 gms Mass of the pycnometer filled with water only (M_4) =1469 gms

$$G_S = \frac{\text{Mass of soil}}{\text{Mass of water displaced by soil}}$$

$$= \frac{M_2 - M_1}{(M_4 - M_1) - (M_3 - M_2)}$$

Results: The specific gravity of the soil is = 2.52

4.2 Liquid limit for untreated soil sample

Table 4.2 Liquid Limit for Soil Sample

S.No	Observations and calculations	1	2	3
1	No of blows	52	45	36
2	Mass of empty can (M_1)(gms)	21	21	21
3	Mass of can + wet soil (M_2) (gms)	35	39	43
4	Mass of can+ dry soil(M_3) (gms)	30	32	36
5	Mass of water (M_2-M_3)	5	7	7
6	Mass of dry soil (M_3-M_4) (gms)	9	11	15
7	Water content %	55	63.36	60

Result

Average Water content= (55+63.36+60)/3
=59.43%

4.3 Plastic Limit of Soil Sample

Table 4.3 Plastic Limit

S.No	Observation and calculations	sample
1.	Mass of empty can, M_1(gm)	21
2.	Mass of can +wet soil (M2) (gm)	38
3.	Mass of can + dry soil (M_3) (gm)	35
4.	Mass of water (M_2-M_3) (gm)	3
5.	Mass of dry soil (M_3-M_1) (gm)	14
6.	Water content%	21.42

Result: The plastic limit of sample is 21.42 %

4.4 Plasticity Index

$I_P = W_L - W_P$ =59.43-21.42

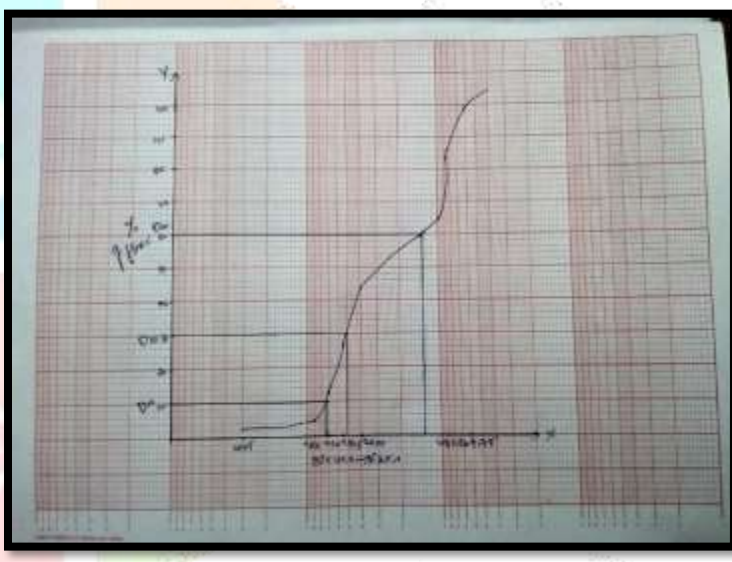
I_P = 38.01%

4.5 The C_U and C_C Value of The Untreated Soil

Table 4.4 Sieve Analysis

S.No	Sieves sizes	soil retained (gms)	% of soil retained	Cumulative % of soil retained	% of soil passed
1	4.75	0	0	0	100
2	2.36	140	14	14	86
3	1.18	260	26	40	60
4	600	330	33	73	27
5	425	141	14.1	87.1	12.9
6	300	60	6.0	93.1	6.9
7	150	33	3.3	96.4	3.6
8	75	19	1.9	98.3	1.7
9	pan	17	1.7	100	0

Graph 4.1 Sieve Analysis



Calculations

If we draw a graph, between % of finer and the sieve size on semi log graph, then we obtain the values of D_{10}, D_{30}, D_{60}.

Hence, D_{10} is the diameter of sieve size corresponding to 10% finer than that size and then

Co-efficient of uniformity $C_u = D_{60}/D_{10}$

Co- efficient of curvature $C_c = (D_{30})^2/ (D_{10} \times D_{60})$

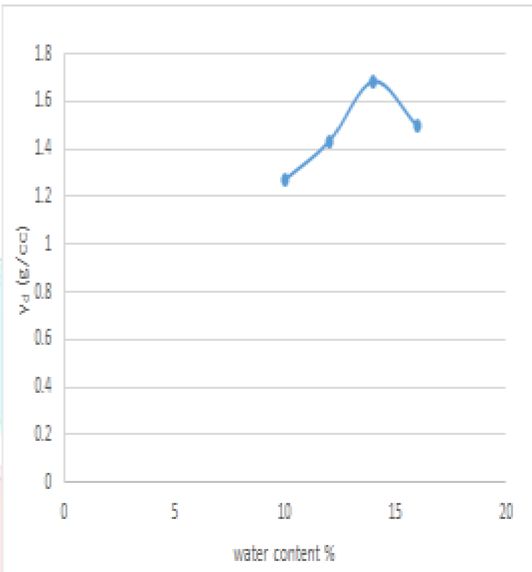
Result

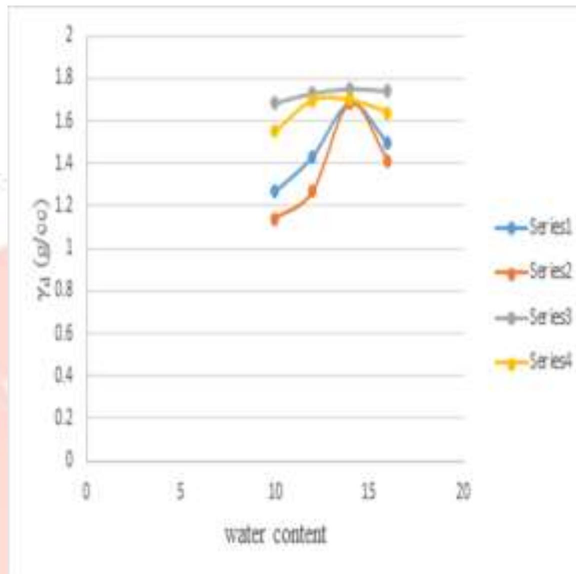
Co-efficient of uniformity of given sample, $C_U = 4.5$

Co-efficient of curvature of given sample, $C_c = 0.586$

4.6 Proctor Compaction Tests

Graph 4.2: Proctor Compaction Test Results





Sample 1

The maximum dry density and optimum moisture content of the untreated soil, it can be observed that the maximum dry density as 1.68 g/cc and optimum moisture content is 14%

Sample 2, Plastic 1%

The maximum dry density and optimum moisture content of the untreated expansive clay and 1% of plastic material ,it can be observed that the maximum dry density as 1.686 g/cc and optimum moisture content is 15.2%.

Sample 3, Plastic 3%

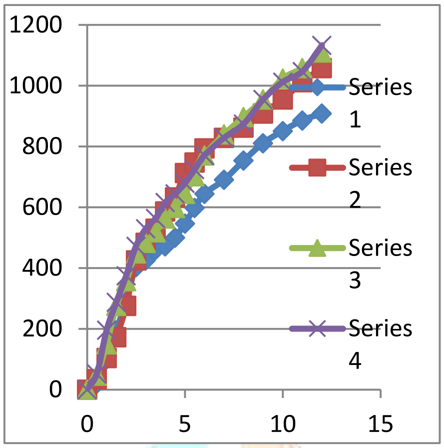
The maximum dry density and optimum moisture content of the untreated expansive clay and 3% of plastic material it can be observed that the maximum dry density as 1.75 g/cc and optimum moisture content is 16%.

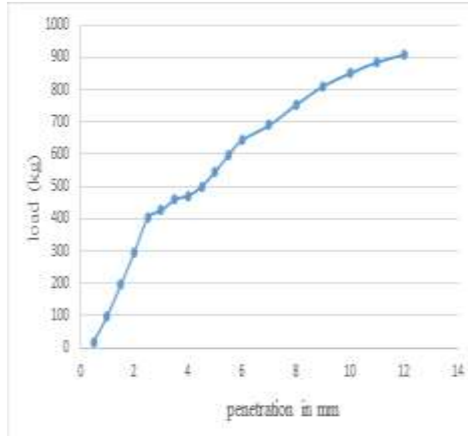
Sample 4, Plastic 5%

The maximum dry density and optimum moisture content of the untreated expansive clay and 5% of plastic material, it can be observed that the maximum dry density as 1.70 g/cc and optimum moisture content is 22.22%.

4.7. CBR Test of Soil Sample

Graph 4.3: CBR Value of Soil Samples





Sample 1

The load vs. penetration for the untreated soil, it can be observed that the UN soaked CBR value is 29.38%.

Sample 2, Plasti material 1%

The load vs. penetration for the untreated soil and 1% plastic material, it can be observed that the UN soaked CBR value is 31.058%.

Sample 3, Plastic material 3%

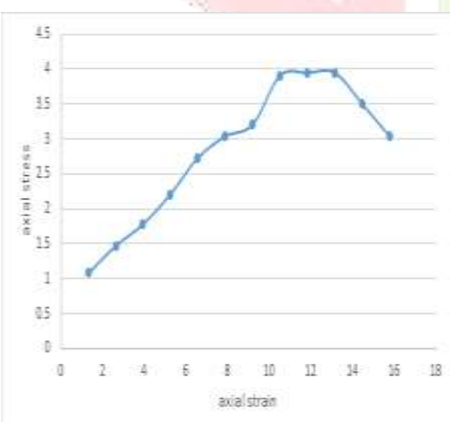
The load vs. penetration for the untreated soil and 3% plastic material, it can be observed that the UN soaked CBR value is 32.73%.

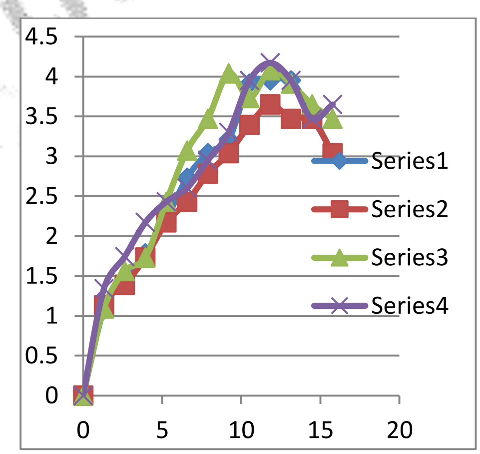
Sample 4, Plastic material 5%

The load vs. penetration for the untreated soil and 5% plastic material, it can be observed that the UN soaked CBR value is 34.41%.

4.8 UNCONFINED COMPRESSIVE STRENGTH TEST

Graph 4.4: UCS Value of Soil Samples





Sample 1

The stress vs strain for the untreated expansive clay is given in fig it can be observed that the unconfined compressive strength test value (q_u) = 3.95 kg/cm^2.

Sample 2, Plasti material 1%

The stress vs strain for the untreated expansive clay and 1% of plastic material is given in fig it can be observed that the unconfined compressive strength test value (q_u) = 3.65 kg/cm^2.

Sample 3, Plastic material 3%

The stress vs strain for the untreated expansive clay and 3% of plastic material is given in fig it can be observed that the unconfined compressive strength test value (q_u) = 4.08 kg/cm^2.

Sample 4, Plastic material 5%

The stress vs strain for the untreated expansive clay and 5% of plastic material is given in fig it can be observed that the unconfined compressive strength test value (q_u) = 4.17 kg/cm^2.

CONCLUSION

The following conclusions are drawn based on the laboratory studies carried out in the work.

i. When plastic material is added to soil up 3% there is a considerable increase in MDD values where as a further increase of plastic material leads to decrease in MDD values.

ii. When soil is treated with plastic material there is increase in CBR value upto 3% where further increase in plastic material decrease in CBR value.

iii. Where the increase of CBR value is 2 times of the virgin soil.

iv. The unconfined compressive strength tests were carried out for 3 different percentages like soil and 1% plastic material, soil and 3% plastic material and 5% plastic material.

v. From the stress strain behaviour is increased from the combination of soil plus 3% of plastic material.

FURTHER SCOPE OF WORK

i. Similar work can be done using other additives and also admixtures to arrive the optimum combination used in foundations on expensive clay sub grades.

ii. This study can extend for the use of various stabilized materials like slag, pond ash, GGBS as a sub base course and fill material in foundation.

iii. The reinforcement technique can be adopted for higher load carrying capacity of the foundation sub grades.

REFERENCES

[1] Subhash, K. et.al. "Stabilization of black cotton soil using glass and plastic granules" Int. J. of Engineering Research and Technology, Vol.5, Issue: 4, pp, 480- 483, 2016.

[2] Harish.C and Ashwini, H. M., "Stabilization of soil by using plastic bottle strips as a stabilizer", Int. Res. J. of Engineering and Technology, Vol.4, pp1877, 2016

[3] Jasmin Varghese Kalliyath, et.al. "Soil stabilization using plastic fibres" Int.J. Of Science Technology and Engineering, Vol.2, Issue: 12, 2016.

[4] Satyam Tiwari and Nisheeth Tiwari (2016) "Soil stabilization using waste fiber materials". Int. J. of Innovative Technology and Research, Vol.,4 Issue:3, pp: 2927 2930, 2016

[5]Achmad Fauzi, et al. "Soil engineering properties improvement by Utilization of cut waste plastic and crushed waste glass as

additive", Int. J. of engineering and Technology, Vol. 8, Issue No. 1, pp.15-18, 2016.

[6] Ankit Jain, et al. (2016), "Effect of lime on the index properties of black cotton soil".

[7] Dhatrak, A. I. and Konmare, S.D, "Performance of randomly oriented plastic waste in flexible pavement", Int. J. of pure and applied research in Engineering and Technology, Vol.3, Issue No. 9, pp-193-202, 2015.

[8] Mercy Joseph Poweth et. al., "Effect of plastic granules on the properties of soil", Int. J. of Engineering Research and Applications, Vol. 4, Issue:4, pp:160 2014.

[9] Chebet, F.C. and Kalumba, D., "Laboratory investigations on reusing polythene (plastic) bag waste material for soil reinforcement in geotechnical Engineering", Civil Engg. &. Urban Planning: An Int. J. (CIVEJ), Vol.1, Issue No.1, pp-67-82, 2014.