Journal of Civil Engineering and Environmental Technology
p-ISSN: 2349-8404; e-ISSN: 2349-879X; Volume 7, Issue 2; April-June 2020, pp. 78-84

http://www.krishisanskriti.org/Publication.html

LATERITE SOIL STABILIZATION BY USING WASTE PLASTIC STRIPS

Harshit Raj[1] and Shambhavi Sinha[2]

RVSCET, Jamshedpur, RVSCET, Jamshedpur
E-mail: [1]hrrocker@gmail.com, [2]shambhavisinha1432@gmail.com

Abstract—*With rapid advancements in technology globally, the use of plastics such as polyethylene bags, bottles etc. is also increasing. The disposal of thrown away wastes pose a serious challenge since most of the plastic wastes are non-biodegradable and unfit for incineration as they emit harmful gases. And the foundation is very important for any structure and it has to be strong enough to support the entire structure. For foundation to be strong, the soil around it plays a very important role. Construction of buildings and structures on expansive soil is risky due to its high compressibility, low shear strength and high permeability that results in swelling, shrinkage and unequal settlement. Expansive soils like laterite red soil always create problems in foundation. Soil stabilization improves the engineering properties of weak soils by controlled compaction or by adding stabilizers like cement, lime etc and by many other methods. But these additives also have become expensive in recent years. Experimental investigation on reinforced plastic soil results showed that, plastic can be used as an effective stabilizer so as to encounter waste disposal problem as well as an economical solution for stabilizing weak soils. A paper is presented here to focus on soil stabilization by using waste plastic waste.This study presents the use of waste plastic strips to mechanically stabilize the soil. The purpose of this research work is to conduct tests in the laboratory by mixing different percentage composition of plastic strips for reinforcing the soil. The tests such as, water content, liquid limit, plastic limit, soil classification, standard proctor compaction test and finally CBR test have been conducted. The average relative density kept up throughout all the test is 50%. The soil is reinforced by using different composition of plastic strips (50-55μ) such as 1%, 1.5%, 2%, 2.5%, 3% by weight and tests have been conducted. Finally the results of CBR test with varying composition of plastic strips as mentioned above have been compared to check the improvement of the CBR value and the properties of Laterite Red soil. From experimental results it is evident that there is appreciable increase in CBR value and bearing capacity due to reinforcement of red soil with plastic strip reinforcement.*

1. INTRODUCTION

Every man-made structure resting on the ground needs safe and stable soil. To attain this safety and stability requirements the engineering properties of the soil beneath the structure or on the structure must be identified. However, obtaining these engineering properties of soils requires relatively more time and money. On the other hand, investigating the index properties of a soil is much easier than other engineering properties. Moreover, most of the engineering properties of soils depend upon their index properties. Therefore, by obtaining the index property of soil that involves simpler and quicker method of testing, the engineering properties can be predictedsatisfactory.

Soil compaction, California bearing ratio and direct shear test are the most commonly used techniques in engineering projects such as highways, sub-grades, railways, pavements and foundations. The main purpose of these tests is to improve engineering properties of soils such as increase in dry density, reduction in compressibility leading to reduction in settlement, reduction in permeability, increase in shear strength and its load bearing capacity. Wattenberg's limits and specific gravity tests are also considered to find out the moisture content of the soil.

Ultimate bearing capacity means the load that the soil under the foundation can sustain before shear failure; while, **S**ettlement consideration involves estimation of settlement caused by load from superstructure which should not exceed the limiting value for the stability and function of the superstructure. Ultimate bearing capacity problems can be solved with the help of either analytical solution or experimental study.

The reinforcing materials like metal strip, geo- textile, plastic strips and geo-grid to enhance the ultimate bearing capacity of the foundation. Now a day's use of plastic strips has increased due to its long service life, light weight, flexibility, water resistant, chemical resistant thermal resistant. Plastic is an organic material that contains such elements as Carbon (C), Hydrogen (H), Nitrogen (N), Chlorine (Cl) and Sulphur (S). Plastic is made by the polymerization of raw materials such as oil, natural gas and coal.

1.1 SOIL STABILISATION

Soil stabilization is a process which improves the physical properties of the soil, such as increasing in shear strength, bearing capacity etc.(modifying the properties of a soil to improve its engineering performance). Stabilization is being used for a variety of engineering works, the most common

application being in the construction of road and airfield pavements, where the main objective is to increasethestrengthorstabilityofsoilandtoreduce the construction cost by making best use of locally availablematerial.

1.2 METHODS OFSABILIZATION

Methods of stabilization may be grouped under two main types:

Modification or improvement of a soil property of the existing soil without any admixture. Examples - Compaction and drainage which improve the inherent shear strength of soil.

Modification oftheproperties withthehelp of admixtures. Examples - stabilization with plastic strips, mechanical stabilization, and stabilizationwith cement, lime, bitumen andchemicals.

1.3 FUNDAMENTAL MECHANISM

Soilhasaninherentlylowtensilestrengthbutahigh compressive strength. An objective of incorporating soil reinforcement is to absorb tensile load or shear stresses within the structure. In absence of reinforcement, structure may fail in shear or by excess of the deformation. When an axial load is applied to the reinforced soil, it generates an axial compressive strain and lateral tensile strain.

1.4 NEED AND ADVANTAGES

Soil properties vary a great deal and construction of structuresdependsonthebearingcapacityofthesoil hence, we need to stabilize the soil which makes it easiertopredicttheloadbearingcapacityofthesoil. The gradation of the soil is also a very important property to keep in mind while working withsoils.

- It improves the strength of the soil, thus, increasing the soil bearingcapacity.
- It is more economical both in terms of cost and energy to increase thebearing.
- Increases capacity of the soil rather than going for deep foundation or raft foundation.
- Sometimes soil stabilization is also used to prevent soil erosion or formation ofdust.
- Stabilization is also done for soil water- proofing which is very useful especially in dry and aridweather.
- Ithelpsinreducingthesoilvolumechange due to change in temperature or moisture content.
- Stabilization improves the workability and the durability of thesoil.

1.6 OBJECTIVES

The present objective of the present study is -

a) Toconductloadtestonmodelsquarefootingover reinforcedsoilbedsubjectedtoverticalcentricload.

b) Plastic strips are used asreinforcement.

c) To develop the empirical correlation for bearing capacity of centricallyloaded footings on reinforced soil by knowing the bearing capacity of footing under centric load.

2. MATERIALS & EXPERIMENTAL SET UP

The basic aim of the research is to discover the bearing capacity of reinforced soil. The soil is the basicmaterialwhichwasusedinthisresearchwork. Plasticstripwasusedtoreinforcethesoil.California Bearing Ratio apparatus was used to apply the concentratedload. Materials used are as follows:

2.1 SOIL

a) Sample Collection- The soil used in research work was collected from nearby Subarnarekha River.

b) Characteristics of soil- All experiments are conducted at relative density of50%.

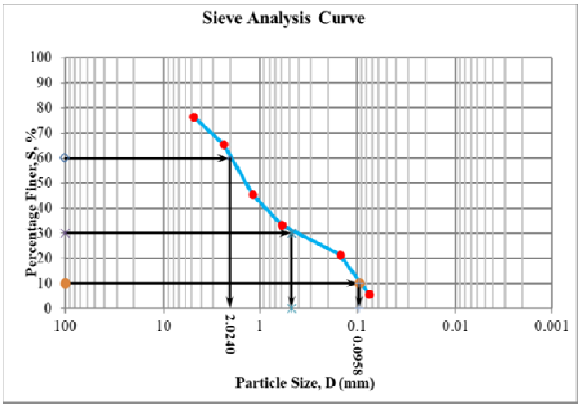

Figure 1. Graph of Particle Size Distribution

Table 1: INDEX PROPERTIES OF SOIL 1

Sl. No.	Property	Value/Description
1.	Specific Gravity	2.38
2.	Liquid Limit	25.59%
3.	Plastic Limit	13%
4.	Plasticity Index	12.59%
5.	Optimum Moisture Content (OMC)	14.65
6.	Coefficient of uniformity (C_u)	21.12
7.	Coefficient of curvature (C_c)	1.17

2.2 PLASTIC

Plastic consists of huge range of synthetic organic. It's averyhugeissuetowholeworldasitdegradesvery slowly toearth**.**

PROPERTIES OF PLASTIC

Plastic have a numerous property that make them superiortoothermaterialsinmanyapplications.The different types of properties are-

PHYSICALPROPERTIES

Plastichastransparency,flexibility, elasticity, water resistant, electricalresistanceandsoftwhen it is hot. Soil is naturally occurring materials that are used for the construction of all except the surface layers of pavements and that are subjected to classification tests to provide a general concept of their engineeringcharacteristics.

CHEMICALPROPERTIES

Chemical resistance, thermal resistance, reactivity with water, flammability, heat of combustion etc., are the basic chemical properties of plastic.

RAW PLASTIC STRIPS

The disposal of waste plastic bottles causes environmental pollution, it is a sustainable waste. Plastic can be recycled or reused. Such wastes of plastics can be used as additives for stabilized soil. We had cut plastic waste into strips of length 20mm andwidth10mm.Thethicknessofplasticusedis50- 55µ.

Figure 3 Raw Plastic Strips

2.3 EQUIPMENT USED

CALIFORNIA BEARING RATIOTEST

The California bearing ratio result test apparatus is usedtodeterminetheCaliforniabearingratioandas well as settlement will be measure.

PROVINGRING

Proving ring of 5kN, 10kN, 15kN, 20kN, 25kN till to 100kN is used during experiment to measure the applied load on the foundation during the experimentalwork.

DIAL GAUGE

Two number of dial gauge which can measure settlement up to 50mm with least count of 0.01mm is used during the experimental work. Needle of the dial gauge is placed on the two diagonally opposite corner of the footing.

DETAILS OF EXPERIMENTS PERFORMED

To study the bearing capacity, laboratory test has been performed on red soil with and without plastic strips. CBRtest was performed withreinforcements variedsuchas 1%, 1.5%,2%,2.5%and3% by weight.Metallic plunger was used as load transferring medium.

SAMPLE PREPARATION

Asampleofsoilweighing5kgwastakenandmixed with water. The amount of waterthathadbeen taken to mix the soil sample was optimum moisture content which was determined from the compaction curve.

The spacer disc was placed on the base plate with thethreadedfacefacingthebaseplate.Athickfilter paper was placed overit. Theextensioncollarwhich was attached to the base plate was clamped into the mould. The wet soil was compacted into the mould in three layers, each being given 56 blows using the rammer weighing 4.89 kg dropping from a heightof 450mm. the blows were distributed uniformly over the surface of each layer. Each layer of compacted soil was scoured off for proper bonding with the succeeding layer. The amount of soil was just sufficient to fill the mould leaving about 5mm to be struck off when the total volume of soil compacted since it had been found that if the soil struck of after removing the extension collar thetest result will be inaccurate. The extension collar was removed and trimmed carefully the compacted soil even with the to pofthemouldbymeansofastraight edge. All the holes were patched up that may develop on the surface of the compacted soil by removal of course material using the smaller sized material. The mould was dismantled from the base plate. He spacer disc was removed from the plate and placed a filter paper over it. The mould was inverted and clamped it to the baseplate.

ADDING OF PLASTIC STRIPS

Different percentage composition (1%, 1.5%, 2%, 2.5% and 3%) of plastic strips having dimension of (2cm X 1cm) were added to the soil while soil was mixed with water. These percentage compositions of plastic strips were the percentage of soil sample taken by weight. The composition of plastic is properly mixed with wet soil sample before putting it into the mould. Same process was repeated to prepare the mould after properly mixing the plastic strips with the wet soil.

Figure 4. Sample Preparation

3. EXPERIMENTAL RESULTS

The compaction was done to assess the amount of compaction and the water content required. The water content at which the maximum dry density is attained is obtained from the relationships provided by the tests. Load tests has been performed on cylindricalCBRmouldofsize10cmdiameterx12.7 cm height filled with unreinforced as well as reinforced soil. For preparing reinforced soil, varying percentage (1%, 1.5%, 2%, 2.5% and 3%) of plastic strips has been added and mixed with the soil. The California Bearing Ratio test is conducted for the reinforced soil to determine the strength of soil until the strength reaches the highest level and stop at the interval when strength decreasing from the highest. The bearing value for 2.5 mm penetration and 5 mm penetration was calculated. Standard load for 2.5 mm penetration and 5 mm penetration is 1370 kg and 2055 kgrespectively.

Table 2: UNREINFORCED SOIL SAMPLE

Sl. No.	Penetration (mm)	Proving ring dial gauge reading	Load (kg)	CBR value
1	0.0	0	0	
2	0.5	6	6.6	
3	1.0	11	12.1	
4	1.5	20	22	
5	2.0	28	30.8	
6	2.5	35.4	38.94	2.84
7	3.0	43.4	47.74	
8	3.5	51	56.1	
9	4.0	57.3	63.03	
10	4.5	62.8	69.08	
11	5.0	68.1	74.91	3.645
12	5.5	73	80.3	
13	6.0	77	84.7	
14	6.5	81	89.1	

Figure 5. Penetration Occurred inReinforced Soil Sample after CBRTEST

Table 3: REINFORCEMENT OF 1% PLASTIC IN SOIL SAMPLE

Sl. No.	Penetration (mm)	Proving ring dial gauge reading	Load (kg)	CBR Value
1	0	0	0	
2	0.5	7.5	8.25	
3	1.0	12	13.2	
4	1.5	22	24.2	
5	2.0	35.5	39.05	
6	2.5	40	44	3.21
7	3.0	46	50.6	
8	3.5	53	58.3	
9	4.0	60	66	
10	4.5	64	70.4	
11	5.0	73	80.3	3.90
12	5.5	80	88	
13	6.0	86	94.6	
14	6.5	94	103.4	
15	7.0	100	110	
16	7.5	106	116.6	
17	8.0	113.5	124.85	
18	8.5	119	130.9	
19	9.0	126	138.6	
20	9.5	132	145.2	
21	10.0	140	154	
22	10.5	145	159.5	
23	11.0	151	166.1	
24	11.5	160	176	

Figure 6. Penetration Occurred in Unreinforced Soil Sample after CBR TEST

Table 4: REINFORCEMENT OF1.5% PLASTIC IN SOILSAMPLE

Sl. no.	Penetration (mm)	Proving ring dial gauge reading	Load (kg)	CBR value
1	0.0	0	0	
2	0.5	8.3	9.13	
3	1.0	15	16.5	
4	1.5	25	27.5	
5	2.0	39	43	
6	2.5	47	51.7	3.77
7	3.0	58	63.8	
8	3.5	69.5	76.48	
9	4.0	81	89.1	
10	4.5	90	99	
11	5.0	105	115.5	5.62
12	5.5	112	123.2	
13	6.0	121	133.1	
14	6.5	128	140.8	
15	7.0	136	149.6	
16	7.5	145	159.5	
17	8.0	156	171.6	
18	8.5	163	179.3	
19	9.0	173	189.2	
20	9.5	180	198	
21	10.0	189	207.9	
22	10.5	198	217.8	
23	11.0	205.5	226.05	
24	11.5	212	233.2	

Table 5: REINFORCEMENT OF 2% PLASTIC IN SOIL SAMPLE

9	4.0	95	104.5	
10	4.5	108	118.8	
11	5.0	120	132	6.42
12	5.5	127.5	140.25	
13	6.0	137	150.7	
14	6.5	144	158.4	
15	7.0	152	167.2	
16	7.5	160	176	
17	8.0	167	183.7	
18	8.5	175	192.5	
19	9.0	183	201.3	
20	9.5	191	210.1	
21	10.0	200	220	
22	10.5	207	227.7	
23	11.0	213	234.3	
24	11.5	219	240.9	

Table 6: REINFORCEMENT OF 2.5% PLASTIC IN SOIL SAMPLE

Sl. No.	Penetration (mm)	Proving dial	Load (kg)	CBR value
1	0.0	0	0	
2	0.5	15	16.5	
3	1.0	28	30.8	
4	1.5	43	47.3	
5	2.0	56	61.6	
6	2.5	69	75.9	5.54
7	3.0	80	88	
8	3.5	91	100.1	
9	4.0	106	116.6	
10	4.5	116.5	128.15	
11	5.0	126	138.6	6.74
12	5.5	135	148.5	
13	6.0	144	158.4	
14	6.5	152	167.2	
15	7.0	160	176	
16	7.5	167.5	184.25	

17	8.0	176	193.6	
18	8.5	184	202.4	
19	9.0	192.5	211.75	
20	9.5	200	220	
21	10.0	208	228.8	
22	10.5	215	236.5	
23	11.0	221	243.1	
24	11.5	227	249.7	

Table 7: REINFORCEMENT OF 3% PLASTIC IN SOIL SAMPLE

Sl. No.	Penetration (mm)	Proving dial	Load (kg)	CBR value
1	0.0	0	0	
2	0.5	11	12.1	
3	1.0	20	22	
4	1.5	35	38.5	
5	2.0	43	47.3	

Table 8: COMPARISON ON PERCENTAGE OF STRIPS AND CBR VALUE

Sl. No.	**Percentage composition of Plastic Strips added**	**CBR Value at 2.5 mm Penetration**	**CBR Value at 5 mm Penetration**
1.	0.0	2.84	3.64
2.	1.0	3.21	3.90
3.	1.5	3.77	5.62
4.	2.0	4.85	6.42
5.	2.5	5.54	6.74
6.	3.0	4.33	5.45

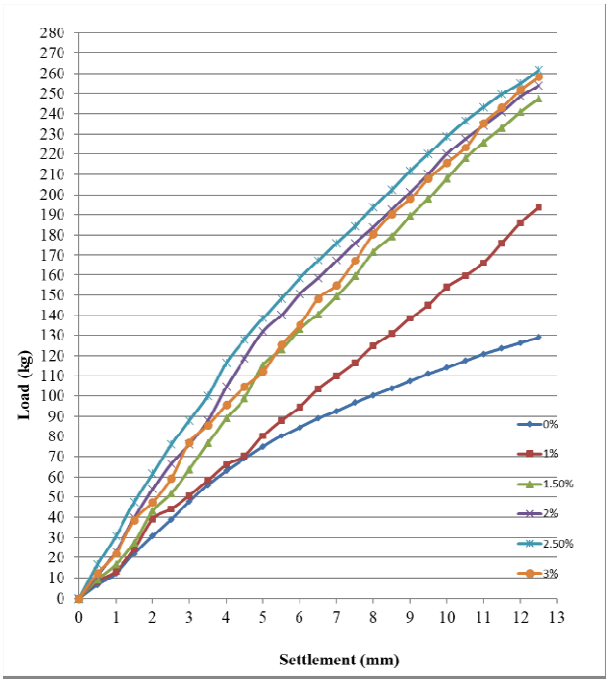

Figure 7. Graph of Comparison on Percentage of Strips

RESULTS AND DISCUSSION

Number of laboratory test have been conducted to determine the CBR value of plastic stripsreinforcedsoilandsubjectedtoverticalload. All the tests have been conducted on redsoil.

The following are the summarized result of present research work-

Based on CBR test on soil with strips of dimension 2x1 cm,

1. With strips reinforcement of 0.00%, the CBR test value was found to be 2.84 at 2.5mm and 3.645 at 5mm
2. With strips reinforcement of 1.00%, the CBR test value was found to be 3.21 at 2.5mm and 3.90 at 5mm
3. With strips reinforcement of 1.5%, the CBR test value was found to be 3.77 at 2.5mm and 5.62 at 5mm
4. With strips reinforcement of 2.00%, the CBR test value was found to be 4.85 at 2.5mm and 6.42 at 5mm
5. With strips reinforcement of 2.5%, the CBR test value was found to be 5.54 at 2.5mm and 6.74 at 5mm
6. With strips reinforcement of 3%, the CBR test value was found to be 4.33 at 2.5mm and 5.45 at 5mm
7. On comparing the test result from CBR test conducted on red soil with adding different percentageofplasticstrips,itisfoundthatthevalues of CBR test are increases up to certainpercentage.

8. From above result using 2cm length of plastic strips with percentage 2.5% is to be recommended for foundationconstruction.
9. Overall it can be concluded that plastic strips reinforced soil can be considered to be good ground improvement technique specially in engineering projects on weak soil where it can act as a substitute to deep/raft foundations, reducing the cost as wellas energy.

4. CONCLUSION

The CBR was conducted for soil mixed with plastic strips.TheCBRtestisconductedforthesoil,adding the1%,1.5%,2%,2.5%,3%ofplasticstripestosoil anditisfoundthatthestrengthofthesoilis

Increases with resultant bearing ratio of 3.21, 3.77, 4.85, 5.54, 4.33 respectively.

As it is economic in nature and hazard free, it is the one of the best solutions for reutilization of the plastic wastage. Producing useful materials from non-useful waste materials that lead to the foundation of sustainable society.

REFERENCES

[1].Arora,K.R.(2004)-“SoilMechanicsandFoundation Engineering”, Standard PublishersDistributors.

[2]. Kumar, M. A., Prasad, D. S. V. and Prasadaraju, G.

V. R. (2009) - “Utilization of industrial waste in flexible pavement construction. Electronic Journal of Geotechnical Engineering”, Vol. 13

[3]. Bateni, F. (2009) - “Stabilization Mechanisms of oil- palm fruit bunch fibre reinforced silt sand” Unpublished Ph.D. Thesis, University of Auckland.

[4]. Purushothama Raj, P. (2005) - “Soil Mechanics and Foundation Engineering” Pearson Education.

[5]. Mercy Joseph Poweth, Solly George and Jessy Paul (2013) - "Study on use of plastic waste in road construction".

[6]. Dr. A.I. Dhatrak, S.D. Konmare (2015) - "performance of randomly oriented plastic waste in flexible pavement".

[7]. A.K. Choudhary, J.N. Jha and K.S. Gill (2010) - "A study on CBR behaviour of waste plastic strip reinforced soil".

[8].RajKumarNagle(2014)-"comparativestudyofCBR of soil, reinforced with natural waste plasticmaterial".