International Journal of Engineering Research
Volume No.5, Issue Special 1, pp 290-292

ISSN:2319-6890)(online),2347-5013(print)
8-9 Jan. 2016

Experimental Review for Utilisation of Waste Plastic Bottles in Soil Improvement Techniques

Abhishek Patil[1], Girish Waghere[2] , Niranjan Inamdar[3], Pranav Gavali[4], Roshan Dhore[5], Shreyash Shah[6]
Pimpri Chinchwad College of Engineering,Nigdi,Pune-411044,India
E-mail :[1]abhishekpatil5755@gmail.com ,[4]pranny1911@gmail.com, [6]mksshah62@gmail.com

Abstract : ***Soil Improvement Technique is the technique which improves the physical properties of soil, such as increasing shear strength, bearing capacity etc. which can be done by use of controlled compaction or addition of suitable admixtures. The cost of introducing these additives has also increased in recent years which opened the door widely for the development of soil by using plastic. This new technique can be effectively used to meet the challenges of society, to reuse the waste materials. Use of plastic bottles is increasing day by day leading to various environmental concerns. Therefore the disposal of the plastic wastes without causing any ecological hazards has become a real challenge. Thus using plastic bottles to improve the strength parameters of soil is an economical utilization since there is scarcity of good quality soil for embankments. This project involves the detailed study on the possible use of waste plastic bottles for soil improvement. The analysis was done by conducting "Tri-Axial Test & Direct Shear Test" on soil reinforced with Plastic Bottles Strips of size 1cm x 1cm. The comparison of test results showed that the soil sample using plastic strips gives better result than soil without plastic. The size and content of strips of waste plastic bottles have significant effect on the enhancement of strength of the soil. In this review paper, we have taken Black Cotton Soil. The soil is tested with 1% plastic by weight & with naturally obtained soil. The test results are compared for above conditions and obtained the change in the strength parameters of soil.***

Keywords— Black Cotton Soil, Plastic Waste Bottles, Tri-axial Test, Direct Shear Test, Reuse of Plastic.

I. Introduction

Soil improvement technique means the improvement of stability or bearing capacity of the soil by the use of controlled compaction, proportioning and/or the addition of suitable admixtures. The basic principles of soil improvement are:

- Evaluating the properties of given soil.
- Deciding the lacking property of soil and choose effective and economical method of soil improvement.

By soil improvement we can increase the shear strength of a soil and/or control the shrink-swell properties of a soil, thus improving the load bearing capacity of a sub-grade to support pavements and foundations. The most common improvements achieve for better soil gradation, reduction of plasticity index or swelling potential, and increases in durability and strength. These types of soil quality improvement are referred to as soil modification. Benefits of this technique are higher resistance values, reduction in plasticity, lower permeability, reduction of pavement thickness, elimination of excavation, material hauling and handling, and base importation, aids compaction, provides all-weather access onto and within projects sites.

As good soil becomes scarcer and their location becomes more difficult and costly, the need to improve quality of soil using new techniques is becoming more important. This technique using raw plastic bottles is an alternative method for the improvement of strength parameters of soil. It can significantly enhance the properties of the soil used in the constructions.

Plastic waste management institute in 2002 reported about 55% of waste plastic are effectively being utilized in energy recovery and feed stock recycling. All the plastics are not recyclable due to their thickness of material. A common problem with recycling plastics is that they are often made up of more than one kind of polymer (heterogeneous character) or some sort of fibres added to the plastics (a composite) to give added strength. The above characteristics are helpful for using the waste materials in soil of poor strength to improve geotechnical properties of soil.

Reusing plastic waste from water bottles has become one of the challenges worldwide. The bottled water is the fastest growing beverage industry in the world. It is reported that annual consumption of PLASTIC bottles in the world are approximately 10 million tons and it grows about 15% every year.

Plastic bottles made of Polyethylene Terephthalate (PET) are one of the most abundant plastics in solid urban waste. On the other hand, recycling of plastic water bottles is very low. And hence there is need of reuse of the plastic water bottles. The best way to handle such waste is to utilize them for engineering applications. The use of plastic waste in

ISSN:2319-6890)(online),2347-5013(print)
8-9 Jan. 2016

engineering applications reduces the problem of disposal of this non-biodegradable waste causing environmental hazards.

II. Material and Methodology

A) Material

i. Black cotton soil

The soil has a swelling property and settling properties due to the presence of montmorillonite mineral. In India, expansive soils are called as Black Cotton soil. The name "Black Cotton" as an agricultural origin.

The characteristics of the test soil are as follows :

Table 1: Characteristics of Black Cotton Soil

Sr. No.	Description of Experiment	Calculated Results	Remarks
1.	Permeability Test	$1.3x10^{-4}$ cm/sec	Silty Sand
2.	Liquid Limit	46 %	Very Soft
3.	Plastic Limit	37 %	
4.	Shrinkage Limit	13.7 %	
	Consistency Index((2-W)/(2-3))	2	
5.	Differential Free Swell Test	10 %	Low expansive
6.	Swell Pressure Test	1.877 N/cm^2	-

ii. Plastic

In this project we have used Waste Plastic Water Bottles. We have cut these plastic water bottles with a aspect ratio of 1 i.e the strips of size 1cm x 1cm. The main aim of using plastic is to reduce the amount of plastic waste that dumped in land, oceans and to reduce hazardous effects on environment.

B) Methodology

i. Tri-Axial Test

Today Tri-axial test is the most commonly used Strength Test in research laboratory. In this test the solid specimen, cylindrical in shape, is subjected to direct stresses acting in 3 mutually perpendicular directions. This test gives shear strength parameters of soil

ii. Direct Shear Test

This is the simple and commonly used test on soil. This test is used to determine the shear parameters of soil by using shear box apparatus

III. Results and Tables

As per mentioned above Tri-axial test had been performed on Black cotton soil without any addition of plastic and with addition of plastic strips 1% by weight. Their test results are given below.

Table 2: Observations of Tri-axial test

		Without Plastic		With 1% Plastic	
Sr. No	Cell Pressure	Deviator Stress	Normal Stress	Deviator Stress	Normal stress
1	1.2	0.65	1.85	1.35	2.55
2	1.6	0.93	2.53	2.74	4.34
3	1.8	1.04	2.84	2.29	4.09
4	2	1.07	3.07	2.65	4.65
5	2.2	1.10	3.30	3.10	5.30

Similarly Direct shear test also performed on soil samples and their results are as follows.

Table 3: Observations of Direct shear test

		Without Plastic	With 1% Plastic
Sr. No.	Normal Stress	Shear Stress	Shear Stress
1	0.2	0.32	0.39
2	0.5	0.45	0.50
3	0.7	0.62	0.74

Note: All stresses are in kg/cm^2.

From the obtained test results graphs are plotted as shown below. Fig.1 indicates increase in normal stress while performing Tri-axial test on soil sample with 1% of plastic as compared to soil sample without addition of plastic.

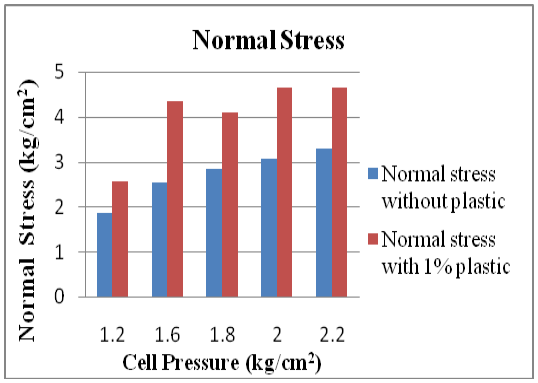

Figure 1 Comparison of normal stress at same cell pressure

Similarly Fig. 2 shows increase in strain and stress carrying capacity of soil by addition of plastic by 1%.

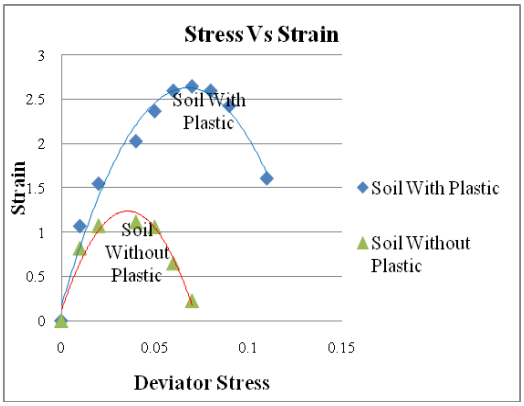

Figure 2 Deviator stress versus strain while performing Tri-axial test

doi : 10.17950/ijer/v5is1/069

ISSN:2319-6890)(online),2347-5013(print)
8-9 Jan. 2016

Now, in Fig.3 a graph is platted which is normal stress versus shear stress based on results obtained from Direct shear test on soil sample with 1% plastic and soil sample without any plastic addition. The passing through these point intercepts Y-axis shows value of cohesion of soil. So from the graph it is concluded that the cohesion of soil increases by addition of plastic.

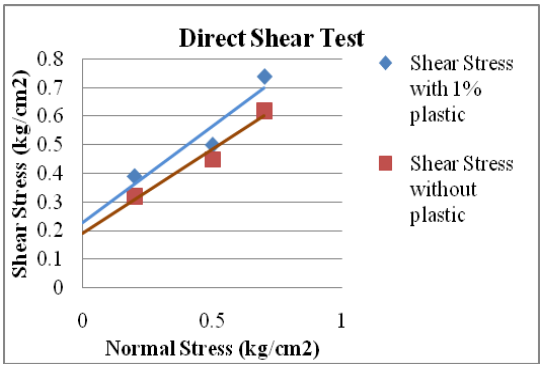

Figure 3 Direct shear test results comparison

Similarly, based on Tri-axial test results graphs are plotted using Mohr's circle method and values of cohesion (C) and angle of friction(Φ) are calculated and compared as shown in table below **Table 4** Comparison of test results

Test	Without Plastic	With 1% Plastic	% Change
Tri-axial Test	C=0.21 kg/cm^2	C=0.64 kg/cm^2	% increase=67
Direct Shear Test	C= 0.19 kg/cm^2	C=0.25 kg/cm^2	% increase=24

Acknowledgement

We express our sincere thanks to our Project Guide **Prof. S. S. Shah** for his encouragement and support throughout our project, especially for the useful suggestions given during the course of project and having laid down the foundation for the success of this work.

IV. Conclusion

Use of plastic products such as bottles is increasing day by day. The disposal of the plastic wastes without causing any ecological hazards has become a real challenge to the present society. Thus using plastic bottles as a soil stabiliser is an economical and gainful utilization since there is scarcity of good quality soil for embankments and fills. Thus this project is to meets the challenges of society to reduce the quantities of plastic waste, producing useful material from non-useful waste materials that lead to the foundation of sustainable society. Our experimental results shows that, after adding plastic in soil, cohesion of soil increased by 67.18% by Tri-axial test similarly we have performed Direct Shear test on the same soil where we have found that the cohesion increased by 24%. On the above basis we observed the increase in cohesive property of soil so bearing capacity of soil increases and settlement as well as compressibility decreases.

References

i. *Anas Ashraf and Arya Sunil (2011) Soil Stabilization Using Raw Plastic Bottles. Indian Geotechnical Conference (Paper no. H-304)*

ii. *Arpan Laskar, Dr. Sujit Kumar Pal "Effects of Waste Plastic Fibres on Compaction and Consolidation Behavior of Reinforced Soil" Vol. 18 [2013], Bund. H*

iii. *Rajkumar Nagle, Prof. R.Jain, "Comparitive study of CBR of soil, reinforced with natural waste plastic material" IJESR/June 2014/ Vol-4/Issue-6/304-308*

iv. *Shewbridge, S.E., Sitar, N. (1989). Deformation characteristics of reinforced sand in direct shear. J. Geotech. Eng. ASCE 115 (8), 1134–1147IS: 1888(1982), Method of Load Test on Soils. Indian Standards Institutions, New Delhi*

v. *Consoli, N.C., Casagrande, M.D.T., Prietto P.D.M. and Thome, A. (2003) "Plate load test on fibre-reinforced soil," J Geotech Geoenv Eng ASCE 129(10), pp. 951–955*

vi. *Hataf, N., Rahimi, M. (2006). "Experimental investigation of bearing capacity of sand reinforced with randomly distributed tire shreds." J. Constr. Build. Mater. 20 (10)*

vii. *Sivakumar Babu, G.L., Vasudevan, A.K. (2008b). "Use of coir fibers for improving the engineering properties of expansive soils." J. Nat. Fibers 5 (1), 61–75*

viii. *B. C. Punmia (2005). Soil Mechanics and Foundations. Laxmi Publictions*

ix. *Arora, K. R. (2004). Soil Mechanics and Foundation Engineering. Standard Publishers Distributors*

x. *IS: 1888(1982), Method of Load Test on Soils. Indian Standards Institutions, New Delhi.*