International Journal of Theoretical & Applied Sciences, 9(1): 21-27(2017)

ISSN No. (Print): 0975-1718
ISSN No. (Online): 2249-3247

Improvement of Engineering Properties of soil Using Waste Plastic Bottles Sttips (Polyethylene Tereohthalate)

Jaswinder Singh [*] ***and Vinod Kumar Sonthwal*** [**]
[*]Lecturer, Department of Civil Engineering, SUS Polytechnic college, Tangori (Mohali), Punjab, India
[**]Associate Professor, Department of Civil Engineering, NITTTR, Chandigarh, India

(Corresponding author: Jaswinder Singh, civilsuspc@gmail.com)
(Received 22 November, 2016 accepted 05 January, 2017)
(Published by Research Trend, Website: www.researchtrend.net)

ABSTRACT: From the ages, researchers are trying to find the best and the economical material for the soil stabilization including the virgin and waste materials of any kind which could be useful for the purpose. But the research does not end and everyday some new idea is evolved. So I am being a research student when I began to think of some novel method of stabilization of soil I through of using the waste plastic empty PET bottles of soft drinks etc being thrown in the waste by the people. One day when I came to know about the astonishing statistics (online), that about no.PET bottles in the world are consumed by the people and which are not being recycled (due to health reasons) it is strictly a huge problem to dispose of such a large quality of such type of waste plastic. These are not being used and a huge burden and a big problem for the civil administration as it creates a lot of problem in managing their disposal. So to convert a nuance into an absolute beneficial use I chose it as a mode of my research for soil stabilization in some different type of manner as it might have been used by some researches in a different way. So it is the topic of my research "Improvement of properties of clayey soil using waste plastic bottles strips". In this research work, an extensive laboratory work have been done to investigate the use of the waste fibres of the plastic bottles for the improvement of the various properties of the Clayey (CL) type of soil obtained from Banur City, SAS Nagar Mohali, Punjab (India). The physical properties of the "Plain Soil" as well as "Reinforced Soil" such as Maximum Dry Density at Optimum Moisture Content, Unconfined Compressive Strength and Socked California Bearing Ratio have been determined with the use of waste plastic bottles fibres in different sizes (5mm, 10mmm, 15mm) in width and (25mm, 35mm, 50mm) in length with percentages (2%, 4% & 6%) of waste plastic bottles material by weight of the dry soil sample.

Keywords: Soil Stabilisation, Fibres of Waste Plastics, Reinforcement, Polyethylene Terephthalate, Maximum Dry Density, Optimum Moisture Content, Unconfined Compressive Strength. Soaked Californea Bearing Ratio test.

I. INTRODUCTION

The soil is weak and does not have enough stability to bear heavy loads. The aim of the study is to make use of waste material for stabilization of soil. A number of materials of reinforcement are available for stabilization of soil which is generally different type of fibre. For this project I have selected the use of waste plastic PET bottles of cold drinks which are generally found available as waste in abundance in every nook and corner of not only in our country but in the whole world as these days everyday is found of consuming it as a food. After consumption all the empty bottles are thrown into the waste baskets or in the open. These are not recyclable and create hazards in the environment and to leaves a huge adverse impact on the health of people. If these empty bottles are reused as a construction material instead of being burnt or disposed of in any other way. Their unique properties once again can be exploited in a beneficial manner. The benefits of using scrap are particularly enhanced if they can be used to replace virgin construction materials made from in renewable sources. The mixture of plastic strips with soil for embankment/ construction will not only provide alternative means of reusing this types of fibre to address economic and environmental concerns but also will help to solve geotechnical problems associated with low soil shear strength. If the PET waste are reused instead of being disposed of or burnt their unique properties can once again be beneficial in sustainable material stream. There are many available techniques for improving the mechanical properties of soil. The techniques employed to improve the properties of soil in respect of strength and other relevant characteristics of soil can be put into the following categories.

(i) Soil stabilization
(ii) Soil reinforcement with continuous planer members/sheets
(iii) Soil reinforcement with randomly mixed fibres/discrete members called ply soil.

II. MATERIALS USED

A. Soil

In the present study the soil procured from Banur City, SAS Nagar Mohali, Punjab (India) had been investigated and depending on the properties given below in Table 1 the soil had been classified as CL (Clayey Soil with Low Compressibility).

The various engineering properties of the plain soil have been determined and are tabulated as given below:

Table 1: Determination of Classification of Soil Depending on the Index Properties.

S. No	properties	Value
1	Liquid limit (%)	31%
2	Plastic limit (%)	22.80%
3	Plasticity index (%)	8.2
4	Soil type as per IS: 1498	CL

Table 2: Values of Engineering Properties of the Plain Soil.

S. No	properties	Value
1	Optimum water content	12.7%
2	Maximum dry density (g/cc)	1.95
3	Soaked California bearing ratio	1.50
4	Unconfined Compressive Strength (kg/cm2)	2.17kg/cm^2

B. Stabilising Material

In this research work, soil stabilisation have been carried out with waste plastic PET bottles of cold drinks which are generally found available as waste in abundance in every nook and corner or which are generally after consumption thrown into the waste baskets or in the open.

III. METHODOLOGY ADOPTED

Laboratory investigations were conducted on the plain soil and the fibres of the waste plastic bottles strips in variation of length of (25mm, 35mm & 50mm) in (5mm, 10mm, & 15mm) in width at different percentage (2%, 4% and 6%) of waste fibre material by weight of the dry soil sample for the improvement of Compressibility (MDD), Unconfined Compressive Strength (UCS) & California Bearing Ratio of the soil (CBR).

IV. EXPERIMENTAL INVESTIGATIONS AND RESULTS

A. Compaction Test

The Modified Proctor's Test have been conducted for the determination of the Optimum Moisture Content (***w***) and Maximum Dry Density (γ_d(max)) of the plain (Table 3) as well as reinforced soil (Table-4) by compacting the soil samples manually.

The maximum dry density of the plain soil has been found as 1.95g/cc at 12.7% of optimum moisture content from the curve drawn in fig.1 and tabulated given below in Table 5.

Table 3: Data for OMC-MDD of Plain Soil Samples.

Sr. No	Water content (%)	Dry unit weight (g/cc)
1	8.6	1.773
2	9.6	1.898
3	11.2	1.933
4	12.9	1.939
5	16.1	1.830

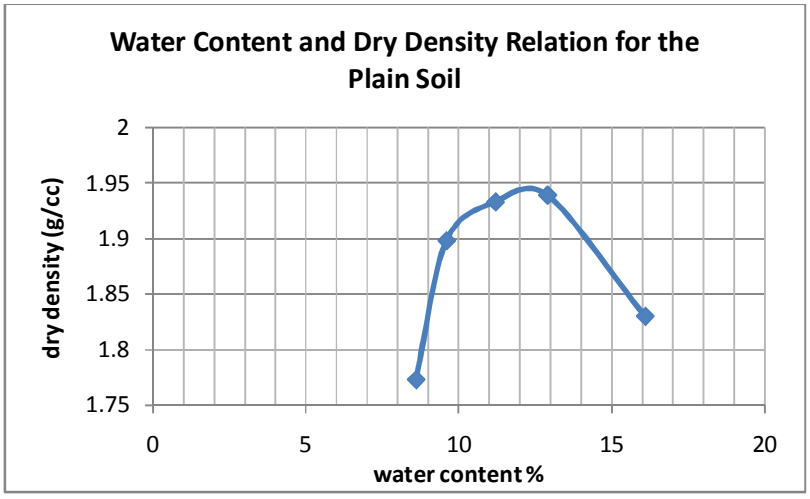

Fig. 1. OMC – MDD Curve for Plain Soil Sample.

Table 4: Data of OMC – MDD for the Soil Reinforced with waste plastic bottles strips.

S. No	Length of strips	Percentage of waste bottles strips (2%)		Percentage of waste bottles strips (4%)		Percentage of waste bottles strips (6%)	
		Optimum Water Content (%)	Maximum Dry Density (g/cc)	Optimum Water Content (%)	Maximum Dry Density (g/cc)	Optimum Water Content (%)	Maximum Dry Density (g/cc)
1	25mmx5mm	5.9	1.767	9.8	1.79	10.9	1.736
		8.2	1.816	11.3	1.85	11.8	1.793
		12.2	1.912	13.9	1.88	14.3	1.833
		14	1.927	17.5	1.79	15.6	1.81
		15.5	1.85	19.5	1.73	18.4	1.739
		17.2	1.791				
2	35mmx10mm	10.28	1.79	10.5	1.738	9.7	1.69
		12.53	1.86	13.6	1.839	13.2	1.776
		15.27	1.83	15.4	1.834	16.4	1.787
		17.88	1.76	18.1	1.723	18.7	1.698
		21.79	1.67				
3	50mmx15mm	9.6	1.793	11.9	1.778	9.16	1.731
		11	1.835	15.1	1.842	11.58	1.756
		13.8	1.889	17.5	1.77	13.7	1.78
		16.4	1.808	19.9	1.672	15.5	1.796
		19.1	1.729			17.6	1.773

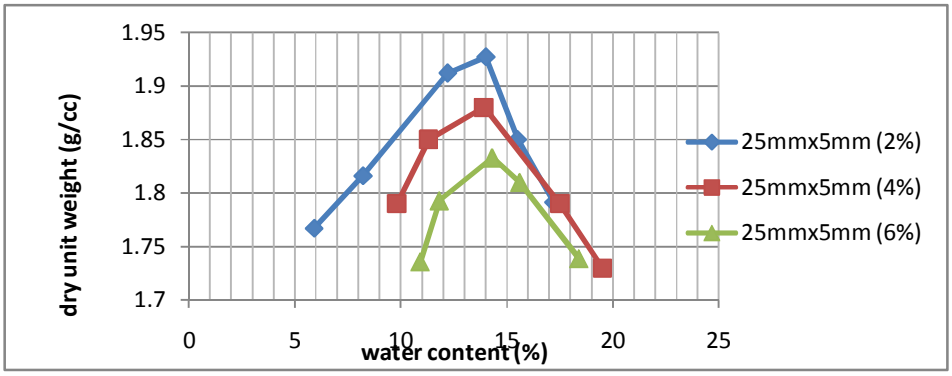

Fig. 2. OMC–MDD Curve for the Soil Reinforced with plastic bottles strips at size 25mm x 5mm.

The maximum dry density of the soil reinforced with different percentages of strips at size 25mm x 5mm has been found from the curve drawn in fig. 2 and are tabulated given below in Table 5.

The maximum dry density of the soil reinforced with different percentages of strips at size 35mm x 10mm has been found from the curve drawn in fig. 3 and are tabulated given below in Table 5.

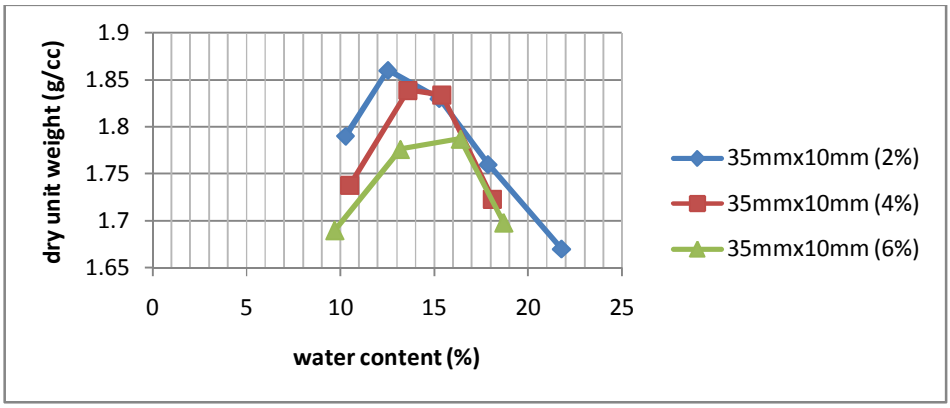

Fig. 3. OMC–MDD Curve for the Soil Reinforced with plastic bottles strips at size 35mm x 10mm.

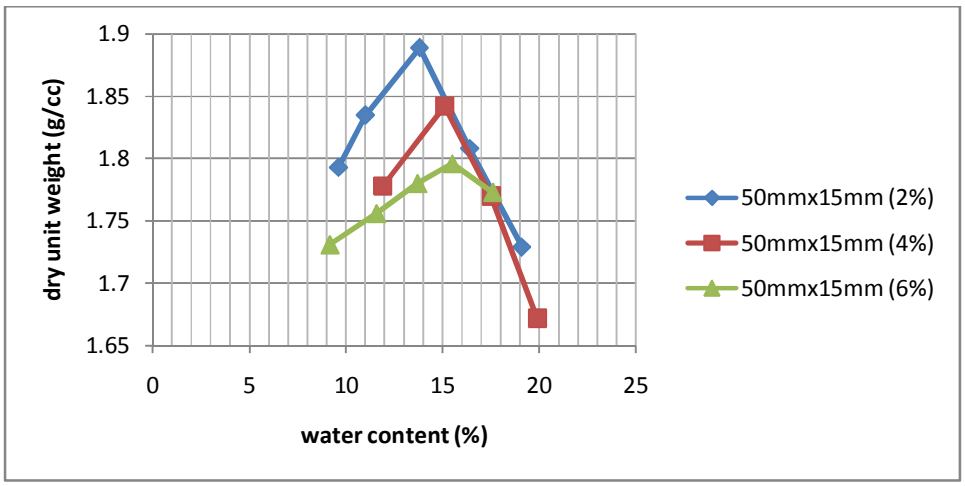

Fig. 4. OMC–MDD Curve for the Soil Reinforced with plastic bottles strips at size 50mm x 15mm.

Table 5: Values of OMC-MDD.

S. No	Length of strips	Percentage of waste bottles strips (0%)		Percentage of waste bottles strips (2%)		Percentage of waste bottles strips (4%)		Percentage of waste bottles strips (6%)	
		Optimum Water Content (%)	Maximum Dry Density (g/cc)	Optimum Water Content	Maximum Dry Density (g/cc)	Optimum Water Content	Maximum Dry Density (g/cc)	Optimum Water Content	Maximum Dry Density (g/cc)
1	25mmx5mm	12.7	1.95	13.5	1.935	13.1	1.873	13.9	1.890
2	35mmx10mm			13.7	1.880	14.5	1.854	15.0	1.845
3	50mmx15mm			14.2	1.830	15.4	1.795	15.5	1.795

The maximum dry density of the soil reinforced with different percentages of strips at size 50mm x 15mm has been found from the curve drawn in fig.3 and are tabulated given below in Table 5.

B. California Bearing Ratio (Soaked) of the Soil

The clayey soil samples of plain soil and reinforced with the fibres of waste plastic bottles had been tested by using the soaked California bearing ratio test apparatus at the maximum dry density ($\square_d$ (max)), and optimum moisture content (*w*), for the analysis of the Bearing ratio and the results for the same has been tabulated as Table 6:

(i) CBR value of plain soil at 2.5 mm penetration is 1.50%

(ii) CBR value of plain soil at 5.0 mm penetration is 1.23%

Therefore CBR value of the plain soil is **1.50%.**

The comparisons of California bearing ratio of the plain soil with the California bearing ratio of the reinforced soil are as Table 7:

Table 6: Values of CBR of the Soil.

S.NO	PENETRATION (MM)	DIAL GAUGE READING (MM)	LOAD (KG)
1	0	0	0
2	0.5	26	11.7
3	1	33	14.85
4	1.5	38	17.1
5	2	42	18.9
6	2.5	46	20.7
7	4	52	23.4
8	5	56	25.2
9	7.5	62	27.9
10	10	70	31.5
11	12.5	80	36

Table 7: Variation in CBR of Reinforced Soil with Plain Soil.

Sr. No.	Plain Soil	Percentage of waste plastic bottles strips	Size of Strips		
			25mmx5mm	35mmx10mm	50mmx15mm
			CBR of reinforced soil, (kg/cm^2)		
Penetration					
1.	1.50	2%	1.68%	1.51%	1.47%
2.		4%	1.81%	1.44%	1.31%
3.		6%	1.91%	1.41%	1.01%

The variation in CBR of soil with the addition of waste plastic bottles fibres has been graphically shown in fig.5

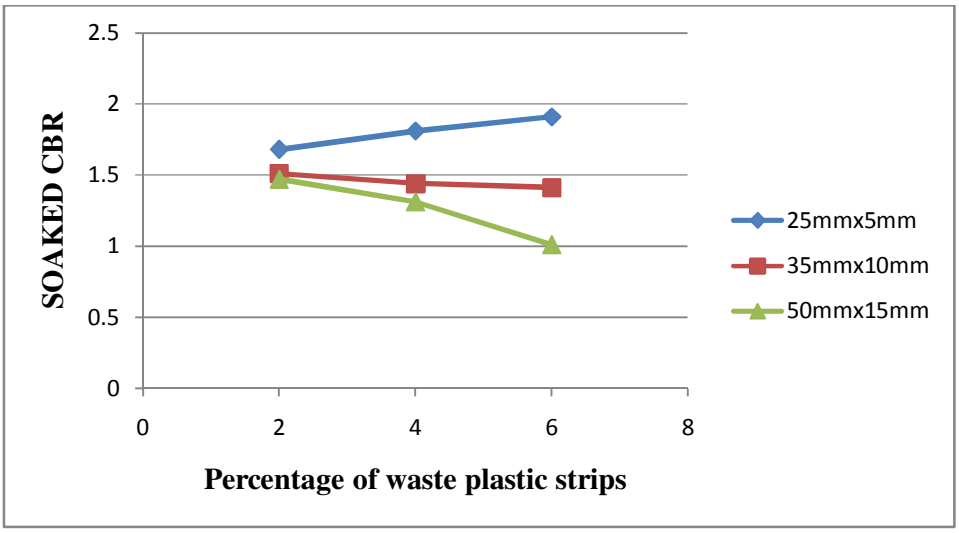

Fig. 5. Variation in soaked CBR with the Increase in Waste plastic bottles strips.

It has been observed from the experimental investigations that the California Bearing Ratio of the soil varied with the addition of the waste plastic bottles strips, depending on which the incremental increase in CBR of the reinforced soil has been tabulated as given below in Table 8.

Table 8: Comparison of soaked California Bearing Ratio of virgin soil with reinforced soil.

Sr. No.	Virgin Soil	Percentage of waste plastic bottles strips	Size of Strips		
			25mmx5mm	35mmx10mm	50mmx15mm
			CBR of reinforced soil, (kg/cm^2)		
Penetration					
1.	1.50	2%	(+) 12.00%	(+) 0.66%	(-) 2.00%
2.		4%	(+) 20.67%	(-) 4%	(-) 12.65%
3.		6%	(+) 27.33%	(-) 6.63%	(-) 32.68%

V. CONCLUSIONS OF THE STUDY

On the basis of the analysis and interpretations of the results obtained from the experimental investigations carried out in the present research work, the following conclusions are drawn:

A. Compressibility of the Soil

The optimum moisture content (OMC) is increase and Maximum Dry Density (MDD) is decrease in addition of waste plastic bottles strips.

B. California Bearing Ratio of the Soil

The strength of the sub grade was studied in terms of California Bearing Ratio value, in soaked conditions. The following conclusions are drawn with the studies made:

(i) The CBR is found to increase with the increase in the percentage of plastic bottles strips content.

(ii) The 6 % bottles strips by weight of size 25mm x 5mm content is the specific value, where the CBR has got the improvement of 27.33 % than in comparison of the plain soil.

(iii) The percentage improvement in CBR value in stabilized soil is 27.33 %. An increase in CBR value of 27.33 % can significantly reduce the total thickness of the pavement and hence the total cost involved in the project.

VI. RECOMMENDATIONS

From the research work conducted and the conclusion drawn the recommendations are as follows:

(i) For the clayey soil sample with Inorganic clay of low plasticity (CL) which was collected from Banur (SAS Nagar, Mohali), the engineering properties can be improved by the use of waste plastic bottles strips.

(ii) From the experimentation it has been observed that the CBR value of 6 % by weight of soil of size 25 mm × 5 mm is 1.91 % which is higher than the experimentation soil (1.50%). Therefore it is recommended that 6 % by weight of size 25mm x 5mm plastic bottles strips are the optimum dose for this soil.

REFERENCES

[1]. Bala Ramudu Paramkusam, (2013). "A Study on Cbr Behavior of Waste Plastic (PET) On Stabilized Red Mud And Fly Ash" *Int. J. Struct. & Civil Engg. Res.* 2013.

[1]. Achmad Fauzi, & Zuraidah Djauhari, (2016). "Soil Engineering Properties Improvement by Utilization of Cut Waste Plastic and Crushed Waste Glass as Additive" *IACSIT International Journal of Engineering and Technology,* Vol. **8**, No. 1, February 2016.

[3]. T. Murali Krishna and Sd. Shekun Beebi "Soil Stabilization by Groundnut Shell Ash and Waste Fiber Material" *International Journal of Innovations in Engineering and Technology (IJIET).*

[4]. Satyam Tiwari and Nisheet Tiwari (2016). "Soil Stabilization Using Waste Fiber Materials" (IJITR) *International Journal Of Innovative Technology And Research*, Volume **4**, Issue No.3, April – May 2016, 2927 – 2930

[5]. Shish Pal, Vinod Kumar Sonthwal, Jasvir S Rattan, (2015). "Soil Stabilisation Using Polypropylene as Waste Fibre Material" *International Journal of Innovative Research in Science, Engineering and Technology* (An ISO 3297: 2007 Certified Organization) Vol. **4**, Issue 11, November 2015.

[6]. Pragyan Bhattarai & Bharat Kumari, **"**Engineering Behavior Of Soil Reinforced With Plastic Strips" *Journal International Journal of Civil, Structural*, *Environmental and Infrastructure Engineering Research and Development (IJCSEIERD),* ISSN 2249-6866.Vol. **3**, Issue 2, Jun 2013, 83-88.

[7]. Tom Damion, Muhammed Ashique. M .E, Paul Immanuel Varkey, Keerthi P. S., Dr. Solly George (2016). Use of Plastic Bottle Strips as an Admixture in the Soil Subgrade for Road Construction" *International Research Journal of Engineering and Technology (IRJET).*

[8]. Abhishek Patil, (2016). "Experimental Review for Utilisation of Waste Plastic Bottles in Soil Improvement Techniques" *International Journal of Engineering Research* ISSN: 2319-6890) Vol. **5**, 8-9 Jan. 2016.

[9]. F.C. Chebet and D. Kalumba, (2014). "Utilisation of polyethylene (plastic) shopping bags waste for soil improvement in sandy soils" *Civil Engineering and Urban Planning: An International Journal (CiVEJ)* Vol. **1**, No.1, June 2014.

[10]. Meera Manuel and Shyla Joseph (2014). "Stability Analysis of Kuttanad Clay Reinforced with PET Bottle Strips**"** *International Journal of Engineering Research & Technology (IJERT)* November-2014.

[11]. Anas Ashraf *et al* (2011). "Soil Stabiliisation Using Raw Plastic Bottles**"** *Proceedings of Indian Geotechnical Conference December 15-17, 2011, Kochi (Paper No. H-304).*

[12]. Apurva J Chavan, "Use of plastic waste in Flexible pavements" *International Journal of Application or Innovation in Engineering & Management (IJAIEM.)* Volume **2**, Issue 4, ISSN 2319 – 4847, pp 540-552, 2013.

[13] Pramod S. Patil, J.R. Mali, Ganesh V. Tapkire, H. R. Kumavat,"Innovative techniques of waste plastic used in concrete mixture" *International Journal of Research in Engineering and Technology*, Volume-**03**, Special Issue : 09, NCETCE-2014, pp 29-32, 2014.

[14] Yetimoglu, T., Inanir, M., O.E., " A study on bearing capacity of randomly distributed fiber-reinforced sand fills overlying soft caly" *Geotextiles and Geomembrane* **23**(2), pp174-183, 2005.

[15] Central Pollution Control Board, "Assessment of plastic waste and its management at airport and railway stations in Delhi" Parivesh Bhawan,CBD-cum-Office Complex, East Arjun Nagar, Delhi-110032, India, 2009.

[16] Banerjee, P.K., "Development of new geosynthetic products through blends of natural fibers," Proceedings of the International Seminar and Technomeet on Environment Geotechnology with geosynthetics, New Delhi, 1966.