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Analysis of CBR value of Soil Reinforced with PET Bottles

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Abstract - *Soil is a most important component of the earth's ecosystem but now a day's soil is getting polluted because of waste disposal directly into it. One of the major waste is plastic. This paper explains the stabilization of soil using PET (Polyethylene Terephthalate) which is found frequently on earth surface. Use of PET as a reinforcing material will help in reducing the amount plastic waste on earth surface and also it will help in improving the physical properties of soil like shear strength, bearing capacity. PET bottles are used in the form of chips in different proportion (0.0%, 0.25%, 0.50%, 0.75%, 1.00%, 1.25% and 1.50%), then CBR test is conducted.*

Key Words: **PET, CBR value, Soil Stabilization, Bearing Capacity, Plastic Waste.**

1. INTRODUCTION

In this study PET (Polyethylene Terephthalate) plastic has been used as reinforcing material in soil which is most commonly used to make plastic bottles, plastic carry bags, cold drink bottles, shopping bags. PET has been used in different proportion (0.0%, 0.25%, 0.50%, 0.75%, 1.00%, 1.25% and 1.50%) and a series of CBR tests were conducted on soil sample with these varying percentages of PET plastic. Results of CBR tests showed that addition of waste PET in soil has improved the CBR value of soil. The PET content was taken by weight of dry sample prepared for CBR test. Using waste PET in soil makes the soil stabilization technique economical and also solves the problem of waste disposal.

2. MATERIAL

2.1 Soil Sample

The soil type used in this study was alluvial soil which was collected from the DIT University Campus and then tested for its physical properties.

2.2 PET Plastic

PET consists of polymerized units of the monomer ethylene terephthalate, with repeating ($C_{10}H_8O_4$) units. PET bottles were collected from local market and used in the form of chips of size 1cm*2cm in different proportion of 0.0%, 0.25%, 0.50%, 0..75%, 1..00%, 1.25% and 1.50%.

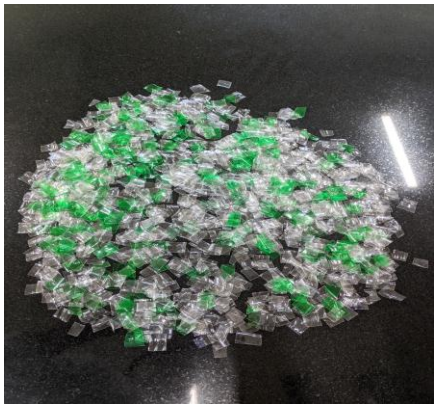

Figure 1: PET Chips

3. METHODOLOGY

3.1 Laboratory Tests

3.1.1 Bulk Density & Dry Density

Table 1: Observation table for Core Cuter test

Observation	Value
Weight of empty core cutter (W1)	0.980 Kg
Weight of core cutter + soil (W2)	2.869 Kg
Height of core cutter (W3)	127.5 mm
Internal diameter of core cutter (W4)	100mm

Bulk density (γ_b) of soil sample = 1.88 g/cm^3
Dry density (γ_d) of soil sample = 1.63 g/cm^3

3.1.2 Liquid Limit

Table 2: Observation table for liquid limit test

Observation	1	2	3	4
No. of Blows	35	26	15	9
Mass of Empty Container (M_1) in gm	12	15	10.5	11

Mass of container + wet soil (M_2)	19	18	15	18
Mass of container+ dry soil (M_3) in gm	18	16	13.5	15.5
Water Content (%)	25	44.4	50	55.5

Liquid limit (WL) of soil sample = 47.11%

3.1.3 Optimum Moisture Content

Table 3: Observation table for Optimum Moisture Content

Determination No.	1	2	3	4	5
Wt. of mould + compacted soil (kg)	5.992	6.045	6.258	6.162	6.626
Wt.of compacted Soil(kg)	1.749	1.802	2.015	1.919	1.814
γb (g/cm3)	1.80	1.86	2.08	1.98	1.90
container no.	1	2	3	4	5
Container + wet soil(gm)	44.60	43.01	39.28	38.59	42.83
Container + dry soil (gm)	42.40	40.26	36.21	35.72	38.93
Wt. of water (g)	2.2	2.75	3.07	2.87	3.9
Wt. of water container(gm)	15.11	12.60	10.05	15.20	14.56
Wt. of dry soil(gm)	27.29	27.66	25.36	20.52	24.37
water content %	8	10	12.15	14	16
Dry density (γd)	1.67	1.69	1.85	1.74	1.64

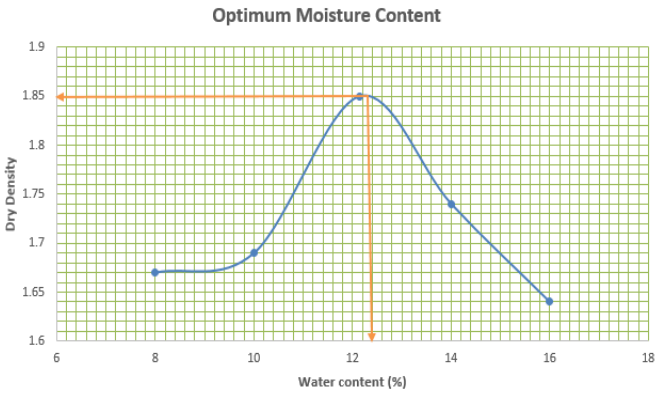

Figure 2: OMC Graph

The Optimum Moisture Content of soil sample = 12.2%

3.1.4 California Bearing Ratio Test

Table 4: Observation table of CBR Test for different PET %

Penetration (mm)	Load on Plunger (Kg)						
	0.0% PET	0.25 % PET	0.50 % PET	0.75 % PET	1.00% PET	1.25 % PET	1.50% PET
0	0	0	0	0	0	0	0
0.5	19	19	26.6	9.5	24.7	9.5	11.4
1	39.9	39.9	55.1	38	51.3	28.5	17.1
1.5	60.8	60.8	85.5	64.6	77.9	49.4	28.5
2	83.6	83.6	115.9	87.4	98.8	64.6	45.6
2.5	100.7	114	142.5	104.5	112.1	77.9	64.6
3	110.2	133	163.4	125.4	121.6	89.3	79.8
4	125.4	157.7	197.6	153.9	133	106.4	104.5
5	144.4	167.2	228	178.6	140.6	133	119.7
7.5	182.4	190	283.1	229.9	152	155.8	146.3
10	210.9	205.2	328.7	275.5	163.4	197.6	163.4
12.5	222.3	216.6	362.9	332.5	167.2	228	190

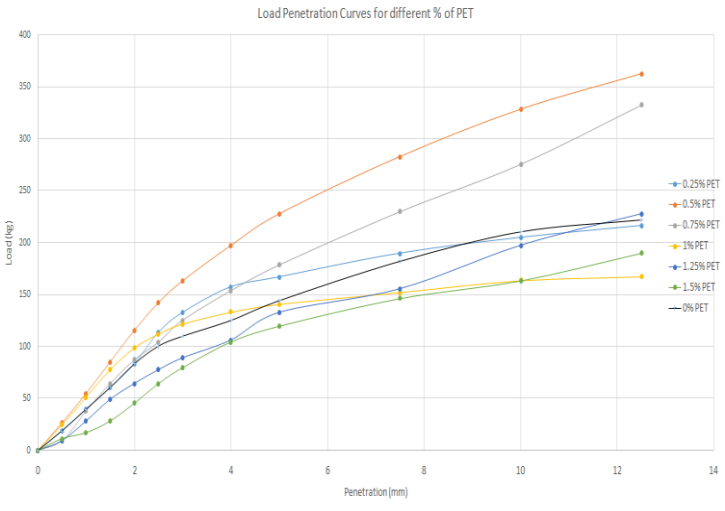

Figure 3: CBR Curves with different % of PET

4. RESULT

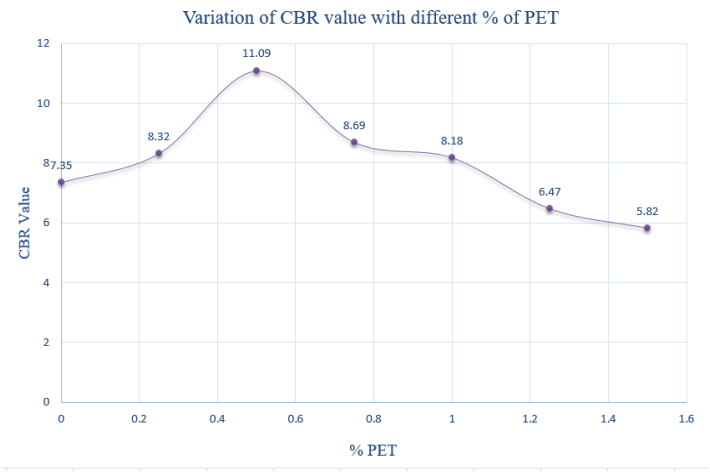

Figure 4: Variation of CBR Value with different % of PET

It was observed that CBR value increased from 7.35 % at 0% PET to 11.09 % at 0.5 % PET. Beyond 0.5% PET, the CBR value was observed to decrease. It may be inferred that the strength of soil increases with plastic reinforcement. Hence it may be concluded that the optimum content of PET plastic for improving the CBR value of soil is 0.5%.

5. CONCLUSION

Laboratory Experiments conducted on Soil Sample shows that Specific Gravity of soil is 2.18, Bulk Density of soil is 1.88 g/cc, Dry density of soil is 1.63 g/cc, Liquid Limit is 47.11 %, and Optimum Moisture Content of Soil is 12.2%.

California Bearing Ratio Value of unreinforced soil has found to be 7.35 %. Figure 4 shows that CBR value is increasing with increase in PET percentage because PET causes increase in hardness of soil layer. Relation between Ultimate Bearing Capacity & CBR value is given by q_u = 65* (CBR – 1.5) hence ultimate bearing capacity (q_u) of soil directly depends upon CBR value, so it can be concluded higher the CBR value higher will be the value of q_u. The maximum CBR value of a reinforced soil has found to be approximately 1.5 times that of an unreinforced soil. Therefore it can be concluded that base course thickness can be significantly reduced if waste plastic chips is used as soil stabilizing agent for sub-grade material. Overall it can be concluded that PET reinforcement in soil can be considered as a good ground improvement technique especially in engineering projects on weak soil where it can reduce the cost of project as well as energy.

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