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Use of Plastic Bottle Strips as an Admixture in the Soil Sub-grade for Road Construction

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Abstract - *Through this project laboratory investigation is carried out on sub-grade soil sample admixed with plastic bottle strips to study the strength and drainage characteristics. The index properties of the soil are determined first. Then plastic bottle strips are cut in definite dimensions(in aspect ratio 1,3 and 4) and are added to the soil sample at different percentages(0.25%,0.5% &1%) and they are tested to find out the California Bearing Ratio and Permeability. Then the experimental data is analysed to find the variation in properties of the plastic admixed soil with respect to the blank soil.*

***Key Words*: CBR, permeability, maximum dry density, optimum moisture content, aspect ratio (AR).**

1. INTRODUCTION

Over the last few decades there has been a considerable rise in the use of plastic products which caused a proportionate increase in the plastic waste. But only a small quantity of such materials are recycled and reused and rest of them are kept in storage or thrown to the disposal. These plastic waste pollutes the soil mass and causes health issues.

These plastic materials are used in little for engineering purpose. Preliminary studies have shown that the addition of plastic waste in soil will cause an improvement in the strength characteristics of soil but a detailed study is needed to do in this direction.

With an increase in population the availability of land for construction activities are reduced. So engineers are forced to construct on a given site with given soil conditions. This is same in case of road construction also. With existing environmental regulations, protest from people and other land acquisition problems it is not possible to get suitable site with required soil properties for road construction. So it is necessary to reinforce the available soil stratum to get the required strength and other properties.

2. MATERIALS USED

The major materials which have been used in the experimental investigation include:

2.1. Soil

Soil used is of Red Earth collected from Alwaye, Kerala, India.

2.2. Plastic Bottles

Waste plastic bottles, which are of uniform size and shape collected from food catering industries.

3. TESTS CONDUCTED

The various index and engineering properties of the soil sample collected were determined first, using the various standard tests.

3.1. Grain Size Analysis

Grain size analysis has been conducted on the soil sample as per IS 2720 (Part IV) 1985. Washing has been conducted to determine the percentage of Fine Grains and Coarse Grains in the soil sample.

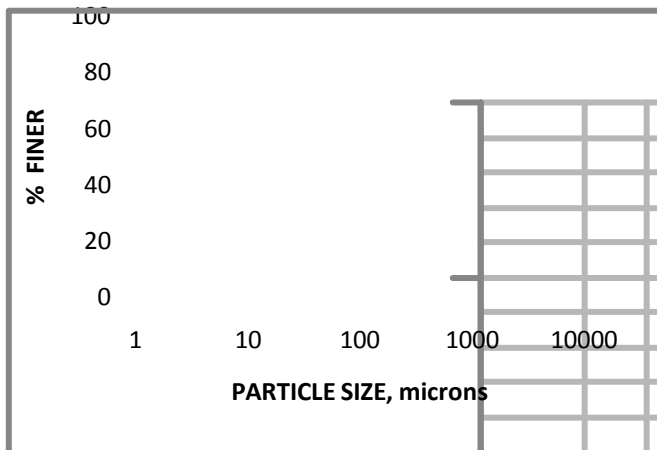

Chart -1: Gradation Curve

3.2. Permeability Test

The permeability of the soil sample has been determined by falling head Permeability Test and the coefficient of permeability, k has been determined.

3.3. Specific Gravity Test

The specific gravity (G) has been determined using Pycnometer as per IS 2720 (Part III/sec I) 1980.

3.4. Consistency Limits

The liquid limit has been determined using Casagrande Apparatus. The Plastic Limit has been determined by rolling a thread of 3mm diameter. The shrinkage limit has been determined using shrinkage Dishes.

3.5. Standard Proctor Test

Standard Proctor Test has been conducted as per IS 2720 Part (XXVIII). The Dry Density has been determined and has been plotted against the corresponding water Content to find the Optimum moisture Content and the Maximum Dry density.

Test Specifications:

The Volume of mould = 1000cc
Hammer weight = 2.60 kg
Drop = 310mm
Number of blows = 25

3.6 Direct Shear Test

The angle of internal friction (ϕ) and the Cohesion (c) of the plane soil sample have been determined by conducting Direct shear Test. The normal Stress against Shear Stress curve has been plotted and the results have obtained from the curve.

3.7 California Bearing Ratio

California Bearing Ratio Test has been conducted to determine the CBR value of soil sample. The test has done with procedure conforming to Indian standards (IS 2720 Part XVI: 1979).

Test Specifications:

Volume of mould = 2250 cc
Hammer weight = 4.89 kg
Drop = 450 mm
Number of blows = 56

Dynamically Compacted Soaked Specimen
OMC = 17%
Maximum Dry Density = 1.685 g/cc

Table -1: Properties of Blank Soil.

Serial no	Properties	Result
1	**Grain size analysis**	
	D_{10}	210 microns
	D_{30}	500 microns
	D_{60}	1400 microns
	Cu	6.67
	Cc	0.85
	Sand+Gravel (%)	55.70
	Silt+Clay (%)	44.30
2	Specific gravity G	2.50
3	**Consistency limits**	
	Liquid limit (w_L) (%)	36
	Plastic limit (w_P) (%)	23
	Shrinkage limit (w_s) (%)	25
	Flow Index I_F (%)	12
	Plasticity Index I_P (%)	11
	Toughness Index I_T (%)	0.916
	Shrinkage Ratio SR	1.88
4	Coefficient of permeability k (cm/sec)	$1.57x10^{-4}$
5	**Standard proctor test**	
	Maximum dry density (g/cc)	1.685
	Optimum moisture content (%)	17
6	**Direct shear test**	
	Cohesion (Kg/cm^2)	0.18
	Angle of internal friction	39^o
7	CBR value (%)	2.00

4. RESULTS OF PLASTIC ADMIXED SOIL

Permeability test, CBR test and Proctors Compaction Test have been conducted on soil admixed with plastic strip with percentage by weight of soil, of 0.25%, 0.5% and 1% for

aspect ratio 1(10mmx10mm), 3(30mmx10mm) and (40mmx10mm).

4.1 Standard Proctor Test

The test has been conducted in soil admixed with plastic bottle strips of different aspect ratios (10mmX10mm, 30mmX10mm and 40mmx10mm) with varying quantities (0.25%, 0.50% and 1.00% by weight of soil sample taken).

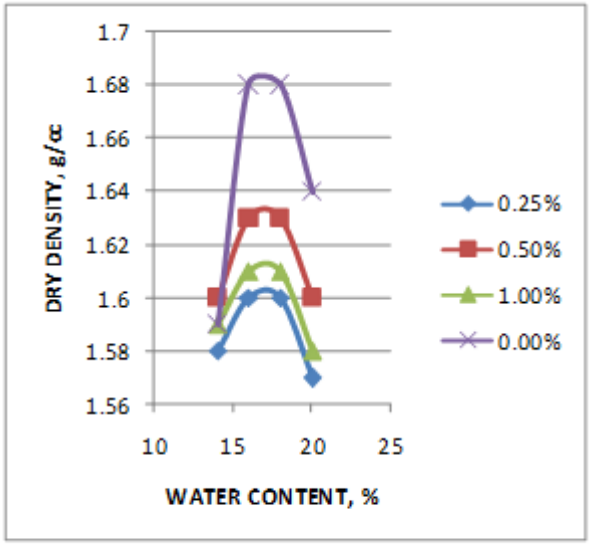

Chart -5: SPT curve for AR 1

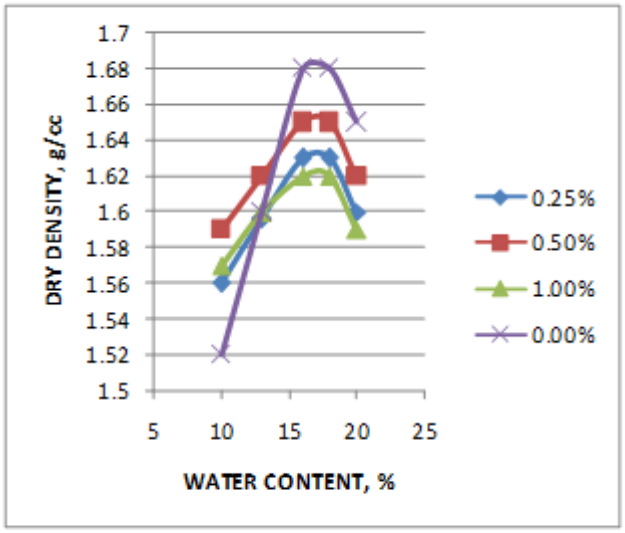

Chart -6: SPT curve for AR 3

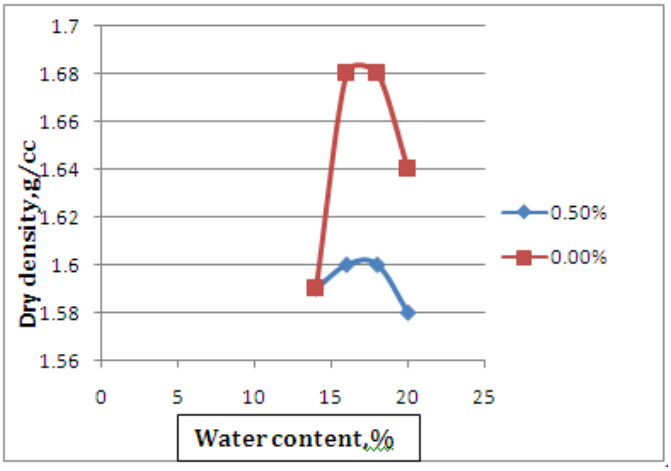

Chart -7: SPT curve for AR 4 and at 0.50% Strip Content

4.2 CALIFORNIA BEARING RATIO TEST

The test has been conducted in soil admixed with plastic bottle strips of different aspect ratios (10mmX10mm, 30mmX10mm) with varying quantities(0.25%, 0.50% and 1.00% by weight of soil sample taken).

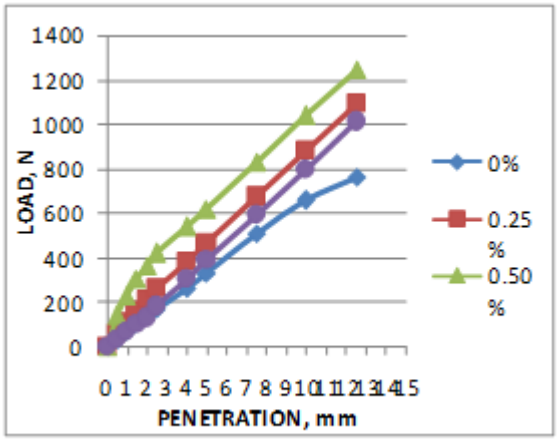

Chart -8: Load v/s Penetration for AR 1

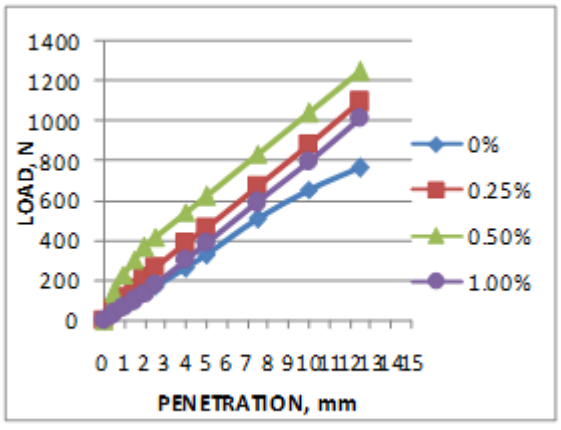

Chart -9: Load v/s Penetration curve for AR 3

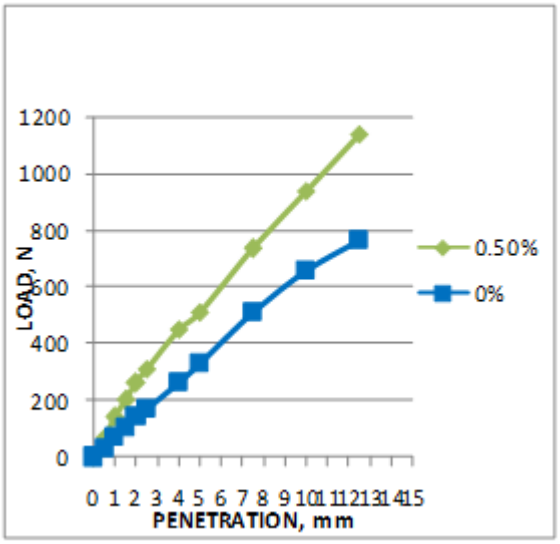

Chart -10: Load v/s Penetration curve for AR 4 for 0.50 % strip content

4.3 Permeability Test

The permeability test has been conducted for plastic strips of different aspect ratio by varying the percentage of addition into the soil. But the soil has become so impermeable that there has been no flow through the Permeameter.

Table -2: Results of test conducted on plastic admixed soil.

Serial No.	Test conducted	Properties	Result	Remarks
1	Standard proctor test	Maximum dry density(g/cc)	1.66	Maximum for 0.50% strip content of 30mmX10mm strips.
		Optimum moisture content (%)	17%	Remain unchanged.
2	Permeability test	Coefficient of permeability k (cm/sec)	No flow of water through soil.	Soil become impermeable.
3	California bearing ratio	CBR value (%)	4.10	Maximum for 0.50% strip content of 30mmX10mm strips.

3. CONCLUSIONS

After analyzing the test results it has been found that on adding plastic strips into the soil, there has been a positive impact on properties of soil in favor of road construction. So use of plastic as a soil stabilizer in road soil sub-grade can be recommended as it increases the CBR value and make the sub grade impermeable.

It has been found that the maximum CBR is obtained when plastic strips are cut in the Aspect Ratio 3 and have been added to the soil at a percentage of 0.5% by weight of soil.

As a conclusion use of plastic strips as an admixture in road soil sub-grade soil has the following advantages:

- It will offer an economical soil stabilizer compared to cement, lime etc.
- It will provide another method for plastic waste management.

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