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Stabilization of Clay Soil by Using Glass and Plastic Waste Powder

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Abstract:

Clay soils exhibit generally undesirable engineering properties. They tend to have low shear strength which reduces further upon wetting or other physical disturbances. Hence, soil before construction by soil stabilization techniques. The main objective of this study is to investigate the use of glass and plastic waste powder in geotechnical applications to evaluate the effects of glass and plastic waste powder on Specific gravity test, Atterberg limits test, Compaction test, and CBR test. The powdered glass and plastic waste powder material is added to the soil in different proportions like 2%, 4%, 6%, 8% find the percentage of which the maximum soil strength is obtained. Also a comparative study on the properties of untreated clay soil and clay soil treated with glass and plastic waste powder was also done. The glass and plastic waste powder is effectively reduced and clay soil fit for pavement construction.

Keywords — **Clay soil, CBR, Plastic Waste, Glass.**

I. INTRODUCTION

The growth of the population has created a need for better and economical operation which requires having good proper condition and maintenance of soil. They have to be maintained so that comfort, convenience and safety are provided to the soil. Cost effective construction are very vital for economical growth in any country. There is an urgent need to identify new materials to improve the soil. Commonly used materials are fast depleting and this has led to an increase in the cost of construction. Hence, the search for new materials and improved techniques to process the local materials has received an increased impetus. When poor quality soil is available at the construction site, the best option is to modify the properties of the soil so that it meets the pavement design requirements. This has led to the development of soil stabilization techniques. Since the nature and properties of natural soil vary widely, a suitable stabilization technique has to be adopted for a particular situation after considering the soil properties.

II. MATERIAL USED

A. Expansive soil

The soil was collected from a depth of 1m, since the volume change behaviour mainly occurs in the active zone. The soil was sun dried initially and powdered to a fraction less than 4.75 mm. The physical properties of clay soil obtained from the preliminary laboratory studies are listed in Table.

I. TABLE
PROPERTIES OF CLAY SOIL

SI. No	Properties of Soil	
	Soil Properties	Values
1	Size	Below 0.002 mm
2	Hardness	Fall below 2.5
3	Specific gravity range	2 to 3.3
4	Refractive indices range	1.47 to 1.68
5	Permeability	Low
6	Water-holding capacity	High
7	Color	Red or brown

B. Plastic waste

Plastic waste, a part of waste by – product of plastics, was collected from the waste plastic shell.

The specific gravity of plastic waste pith was obtained as 0.12 and the average length of plastic waste present in it was 12mm.

Fig. 1 Plastic Powder

II. TABLE
PROPERTIES OF PLASTIC WASTE

Physical Properties of Plastic waste	
Abbreviation	Polyethylene
Density (g.cm^3)	1.3 – 1.4
Usage temperature	115-125^{o}C
Specific gravity	1.56
Mechanical properties	Relatively low tensile Strength at yield and surface hardness, high viscosity, soft to rigid.

III. TABLE
PROPERTIES OF PLASTIC WASTE

Chemical Properties of Plastic Waste	
Lignin	45.84%
Cellulose	43.44%
Hemi –Cellulose	0.25%
Pectin's and related Compound	3.0%
Water soluble	5.25%
Ash	2.22%

C. Glass

One commercially available glass has been used in the present investigation. It is available as a concentrated powder form and is to be diluted with water in specified proportion before mixing with the soil. The manufacturer's information available for this product is presented in Table. According to the literature, when mixed with water and applied, the glass powder combines the inorganic and organic material. Soil stabilization using enzymes is a relatively new approach to soil improvement. Enzyme promotes the development of cementations compounds using the following, general reaction.

Fig. 2 Glass Powder

IV. TABLE
PROPERTIES OF GLASS

Physical/Chemical Characteristics	
Compression resistance	800-1000Mpa
Density	2500 Kg/m^3
Modulus of elasticity	70000Mpa
Hardness	5.5 mohs Hardness
Bending strength	45Mpa

III. EXPERIMENTAL INVESTIGATION

Modified Proctor compaction tests were conducted on both control and stabilized soils to measure the compaction characteristics of the soft soil. Modified Proctor test results were then used to conduct strength studies by means of CBR test. The results obtained from the experimental programme are discussed in detail.

V. TABLE
PROPERTIES OF CLAY SOIL

SI. NO	**PROPERTY**	**VALUE**
1.	Specific Gravity	2.18
2.	Liquid Limit	54.2%
3.	Plastic Limit (W_p)	39.3%
4.	Plasticity Index(I_p)	14.9%
5.	Maximum Dry Density	1.875 gm/cc
6.	Optimum Moisture Content	17.63
7.	Unconfined Compressive Strength (q_n)	199.13 kN/m^2
8.	CBR (2.5mm)	9.40
9.	CBR (5mm)	8.50

A. Specific Gravity

This method covers determination of the specific gravity of soils by means of a Specific gravity bottle. The specific gravity test is made on that portion of soil which passes the No.2.00 mm sieve.

The definition of specific gravity is the ratio of the weight in air of a given volume of a material at a stated temperature to the weight in air of an equal volume of distilled water at a stated temperature.

Specific Gravity,

$$G_s = (W2 - W1) / ((W2 - W1) - (W3 - W4))$$

Where,

W1 = weight of Pycnometer
W2 = weight of Pycnometer + soil
W2 = weight of Pycnometer + Water + soil
W4 = weight of Pycnometer + water

Data

Weight of Pycnometer (W1) = 0.63 Kg
Weight of Pycnometer + Water (W2) = 1.495Kg

VI. TABLE
SPECIFIC GRAVITY TEST

Description	Material (Plastic powder + Glass powder) %				
	0%	2%	4%	6%	8%
weight of soil	0.4	0.415	0.42	0.43	0.44
weight of water and soil	1.07	1.09	1.09	1.07	1.08
Specific Gravity of Clay Soil	2.05	2.18	2.15	1.9	1.9

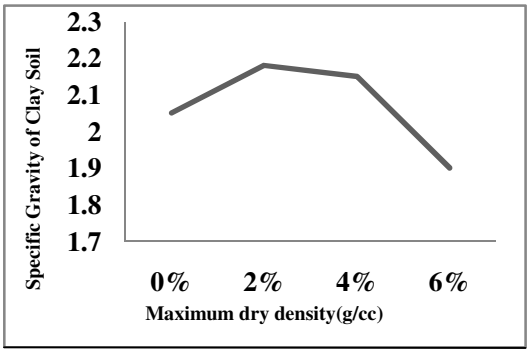

Fig. 3 Specific gravity test

B. California Bearing Ratio (CBR)

It is the ratio of force per unit area required to penetrate a soil mass with standard circular piston at the rate of 1.25 mm/min. to that required for the corresponding penetration of a standard material.

C.B.R. = {Test load/Standard load} ×100

Test Results

VII. TABLE
CALIFORNIA BEARING RATIO TEST
(WITHOUT GLASS AND PLASTIC WASTE POWDER)

Penetration (mm)	Proving Ring (div)	Test load (kg)
0.5	10	11.2
1.0	15	16.8
1.5	19	21.28
2.0	24	26.88
2.5	30	33.60
3.0	32	35.84
4.0	41	45.92
5.0	43	48.16

Penetration Value

For 2.5mm = 2.45 %
For 5mm = 2.34 %

Fig 4. CBR Test

IV. COMPARISON OF RESULTS & DISCUSSIONS

VIII. TABLE
COMPARISON OF CALIFORNIA BEARING RATIO TEST PENETRATION VALUE

Penetration Value	2.5mm	5mm
Without glass and plastic powder	2.45	2.64
2% glass and plastic waste powder	6.13	5.12
4% glass and plastic waste powder	8.91	7.63
6% glass and plastic waste powder	9.40	8.50
8% glass and plastic waste powder	8.11	7.22

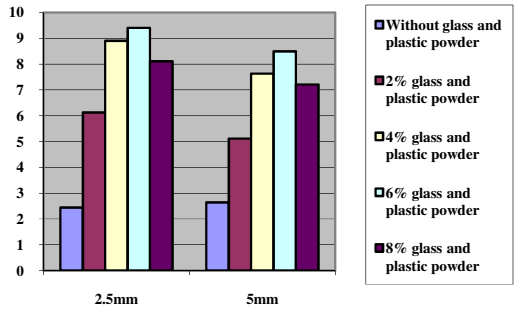

Fig. 5 Comparison test

V. CONCLUSION

The experimental investigations done so as to bring out the effect of stabilization of Clay soil using Glass & Plastic gave a good result.

- The optimum percentage of glass and plastic waste powder mix for improvement in geotechnical properties of the expansive soil is found to be 6%.
- The maximum dry density goes on increasing and optimum moisture content goes on decreasing with increase in percentage of addition of plastic waste powder and year.
- The percentage quantity of the plastic and glass powdered required achieving the best results in terms of the clay soil properties lies between 4% and 6% by mass of the soil.
- The liquid limit, plastic limit and plasticity index conducted to the expansive soil.

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