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Soil Stabilization using Plastic Waste

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Abstract: *Soil stabilization is an important process in civil engineering to increase the strength and durability of weak soils for construction purposes. In recent years, the growing accumulation of plastic waste has become a major environmental concern. The objective of this project is to use the plastic waste as a stabilizing agent to improve the soil properties and also to solve the waste management problems. The study consists in collecting and preparing plastic waste materials which are then mixed with soil in different proportions. Laboratory tests such as compaction test, California Bearing Ratio (CBR) test and Moisture Content test are performed to evaluate the improvement in soil characteristics. The effect of plastic waste in stabilization is discussed by comparing the results with the untreated soil. From the finding of this study, the use of plastic waste can significantly improve the soil strength, load bearing capacity and durability. Moreover, this method supports sustainable building practices, cutting down plastic waste and conserving natural resources. Therefore, the stabilization of soil by the use of plastic waste is a sustainable and cost effective technique for the modern engineering application*

Keywords: Plastic waste, Stabilizing agent, Natural resources, Construction purpose, Durability

I. INTRODUCTION

Soil is one of the most important natural resources used in civil engineering for construction of roads, buildings and other infrastructure But not all soils have the necessary strength and stability to carry such structures. Problems like low bearing capacity, excessive settlement and reduced durability often arise from poor soils such as clayey or sandy soils. Soil stabilization approaches are widely used to improve engineering properties of soil to overcome these challenges. At the same time, plastic has become a major environmental problem due to its non-biodegradable nature and increasing production. Improper disposal of plastic can pollute land and water, causing serious damage to ecosystems and human health. Effective management of plastic waste has become a global challenge.In this regard, the use of plastic waste for soil stabilization offers a sustainable and innovative solution. Shredded or processed plastic materials added to soil can improve its strength, stiffness and resistance to deformation. This method improves the performance of the soil and also helps to reduce plastic waste in an eco-friendly manner. The aim of this project is to examine the effectiveness of plastic waste as a soil stabilizer. Soil is blended with various ratios of plastic waste and laboratory tests are performed to assess modifications in its properties. The present study highlights the dual benefits of improving soil quality and promoting sustainable waste management practices.

II. OBJECTIVE

To increase the density and California Bearing Ratio (CBR) of soil using plastic as an admixture. To provide an alternative solution for the disposal of plastic waste. To provide an economical solution for soil stabilization using plastic waste. To determine the optimum plastic content to be used.

III.METHODOLOGY

Methodology of this study involves collection of soil samples from a selected location and plastic waste materials like bottles and carry bags which are cleaned , dried and shredded into small uniform pieces . The soil is air dried and sieved and prepared for testing. The shredded plastic is mixed with soil in different proportions (0%, 2%, 4%, 6%, 8%

by weight) to ensure uniform distribution. After that the prepared samples are tested in the laboratory by Standard Proctor Compaction Test to find out optimum moisture content and maximum dry density, California Bearing Ratio (CBR) test to evaluate load bearing capacity, Unconfined Compressive Strength (UCS) test to measure strength and Atterberg Limits test to evaluate change in plasticity. The results obtained from such tests are analysed and compared with the results of untreated soil to find out the improvement in engineering properties and to find out the optimum percentage of plastic waste suitable for effective soil stabilization.

IV. LITERATURE REVIEW

1.Wani, I.A. et al.

Experimental investigation on using plastic wastes to enhance engineering properties of soil (ScienceDirect, 2021).Focuses on using plastic waste to improve engineering properties of soils through laboratory testing (CBR, compaction).

2.Science Direct Gangwar, P.

Stabilization of soil with waste plastic bottles (ScienceDirect, 2021).Evaluates geotechnical properties of soil reinforced with shredded plastic bottles, showing improved shear strength and load-bearing capacity.

3. Science Direct Zhu, J. et al.

Performance of clay soil reinforced with PET plastic waste (ScienceDirect, 2023).Investigates the enhancement of stiffness and strength of expansive clay when PET strips are incorporated, with optimal content identified.

4. Hassan, H.J.A. et al.

Effects of plastic waste materials on geotechnical properties of soils (Springer, 2021).A comprehensive study on how fibre-shaped plastic wastes (discrete fibres) influence soil engineering properties such as UCS, CBR, and resilient modulus

5. Springer Attom, M. et al.

Soil improvement using plastic waste–cement mixture to reduce swelling pressure (MDPI, 2025).Shows how mixing shredded plastic waste with soil and cement can reduce swelling and compressibility of clay soils (useful for expansive soils)

V. MATERIALS USED

1. Natural Clay Soil
2. Waste Plastic Materials
3. Water

VI. PREPARATION OF MATERIALS

1. Collection of Soil Sample

Soil is collected from a selected location at a suitable depth to ensure it represents the natural ground conditions. Care is taken to avoid contamination with organic matter, roots, and debris so that accurate test results can be obtained.

2.Drying of Soil

The collected soil is air-dried under normal environmental conditions to remove its natural moisture content. This step helps in obtaining consistent results during mixing and laboratory testing

3. Sieving of Soil

After drying, the soil is sieved using standard sieves to remove stones, gravel, and other unwanted particles. This ensures uniformity in the soil sample and improves the accuracy of test results.

4. Collection of Plastic Waste

Plastic waste materials such as plastic bags, bottles, and covers are collected from nearby sources. Only suitable plastic materials are selected for the stabilization process

5. Cleaning of Plastic Waste

The collected plastic waste is thoroughly washed to remove dirt, dust, and other impurities.Clean plastic ensures better bonding and mixing with the soil.

6. Drying of Plastic Waste

After cleaning, the plastic materials are dried completely to remove any moisture content before further processing.

7. Shredding of Plastic Waste

The dried plastic waste is cut or shredded into small, uniform pieces or strips. Uniform size is important to achieve proper distribution and effective reinforcement within the soil

8. Proportioning of Materials

The shredded plastic waste is added to the soil in different percentages (such as 0%, 0.5%,1%, 1.5%, and 2% by weight of dry soil). This helps in analyzing the effect of varying plastic content on soil properties.

9. Mixing Process

The Soil and plastic waste are thoroughly mixed to obtain a homogeneousmixture proper mixing ensures that that plastic pieces are evenly distributed throughout the soil,which is essential for consistent performance.

VII. NUMBER OF TESTS TAKEN

1. Specific gravity test
2. Sieve Analysis test
3. Moisture content test
4. Maximum dry density test
5. California bearing ratio test

1. SPECIFIC GRAVITY TEST

TEST NO	1
Mass of Density Bottle, W1(g)	434
Mass of Density Bottle + Dry Soil, W2(g)	611
Mass of Density Bottle + Soil + Water, W3 (g)	1475
Mass of Density Bottle + Water,W4(g)	1362

SG = W2-W1/W2-W1-(W3-W4)

= (611-434)/(1362-434)-(1475-611)

SG = 2.76

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2. SIEVE ANALYSIS TEST

Sieve size (mm)	Mass of sieve(g)	Mass of Sieve+soil(g)	Soil Retained (g)	Percent Retained %	Cummulative Percentage %	% Finner
4.75	4.23	4.23	0	0	0	100
2.36	418	433	15	3	3	97
1.18	398	426	28	5.6	8.6	91.4
0.600	372	391	19	3.8	12.4	87.6
0.425	359	371	12	3.4	14.8	85.2
0.300	368	384	16	3.2	18	82
0.150	357	381	24	4.8	22.8	77.2
0.075	336	350	14	2.8	25.6	74.4
PAN	448	820	372	74.4	100	0

RESULT: Gravel = 0 % of sand = 25.6% % of Silt and Clay = 74.4%

3.MOISTURE CONTENT TEST

SAMPLE DESCRIPTION	OMC(%)
Soil	20.5
Soil with 2% plastic	19.0
Soil with 4% plastic	18.5
Soil with 6% plastic	18.0
Soil with 8% plastic	17.4

4. MAXIMUM DRY DENSITY TEST

SAMPLE DESCRIPTION	MDD(gm/cc)
Soil	1.62
Soil with 2% plastic	1.75
Soil with 4% plastic	1.81
Soil with 6% plastic	1.71
Soil with 8% plastic	1.65

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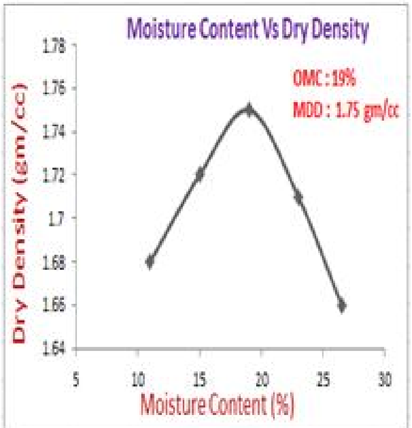
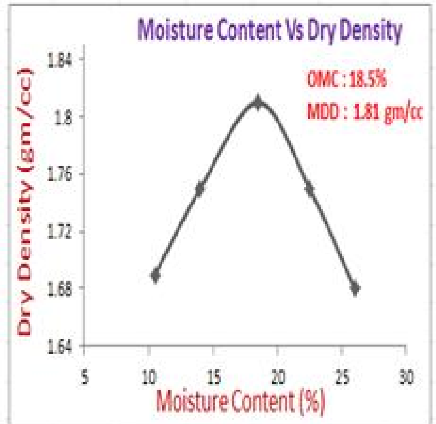
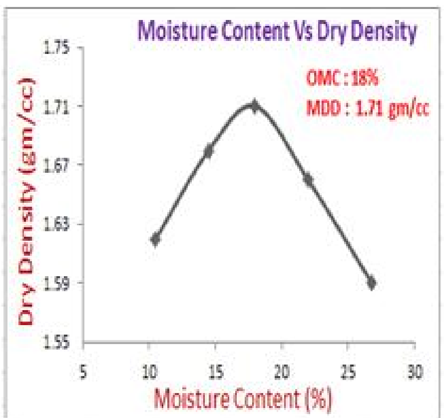


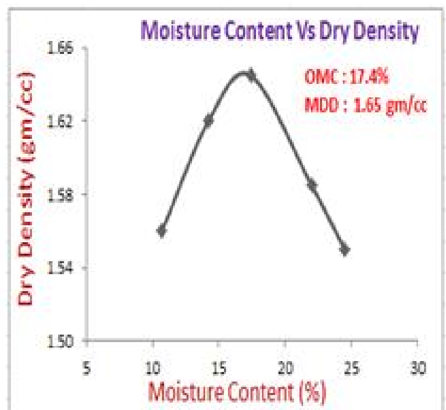
Soil with 2% plastic



Soil with 4% plastic



Soil with 6% plastic



Soil with 8% plastic

5.CALIFORNIA BEARING RATIO TEST

SAMPLE DESCRIPTION	CBR%
Soil	1.00
Soil with 2% plastic	2.02
Soil with 4% plastic	11.70
Soil with 6% plastic	4.80
Soil with 8% plastic	4.40

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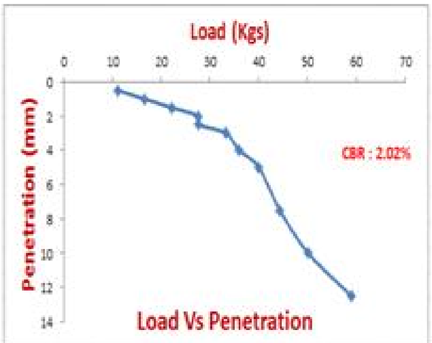
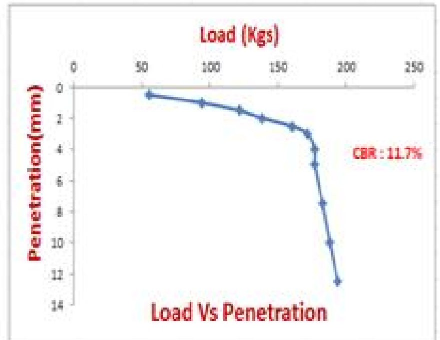
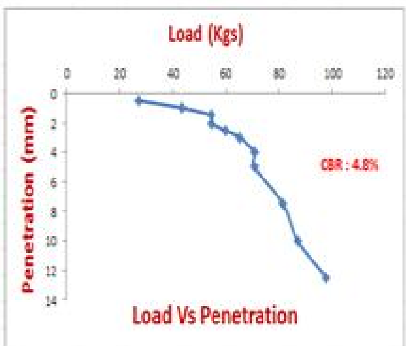


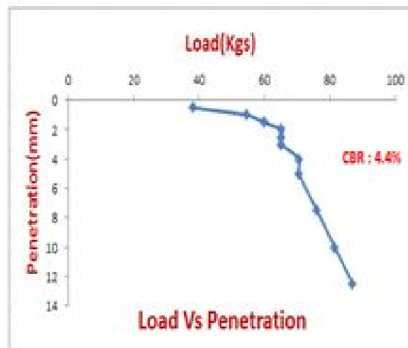
Soil with 2% plastic



Soil with 4% plastic



Soil with 6% plastic



Soil with 8% plastic

VIII. COMPARISON TABLE

Sample Description	MDD (gm/cc)	OMC (%)	CBR (%)
Soil	1.62	20.5	1.00
Soil with 2% plastic	1.75	19.0	2.02
Soil with 4% plastic	1.81	18.5	11.70
Soil with 6% plastic	1.71	18.0	4.80
Soil with 8% plastic	1.65	17.4	4.40

IX. CONCLUSION

In the present study, the improved CBR value of the soil is due to the addition of plastic strips. Plastic can be utilized as one of the material that can be used as a soil stabilizing agent but the proper proportion of plastic must be there, which helps in increasing the CBR of the soil.

It can be concluded that CBR percentage goes on increasing up to 4% plastic content in the soil and thereon it decreases with increase in plastic content. Hence, we can say that 4% plastic content is the optimum content of plastic waste in the soil.

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