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Enhancing Black Cotton Soil Properties Using Recycled Plastic Waste

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Abstract- Soil stabilization improves soil properties like strength and load-bearing capacity. In India, black cotton soil is common but prone to issues like swelling and shrinking, making construction risky. While traditional stabilization methods, such as using cement and lime, can be expensive, this study shows that using plastic waste is a more affordable and environmentally friendly solution.

To evaluate plastic waste as a stabilizer, tests like the California Bearing Ratio (CBR), Proctor test, and sieve analysis were conducted. The Modified Proctor Test is preferred for road construction because it ensures better compaction. Overall, using plastic waste for soil stabilization offers a cost-effective way to enhance soil performance.

Keywords — Optimal Plastic Content, Recycled Plastic Waste, Maximum Dry Density, Plastic Fiber Strips Shear Strength Enhancement,California Bearing Ratio (CBR) Analysis, Soil Compaction Testing

INTRODUCTION

Soil stabilization refers to improving the stability and bearing capacity of soil through controlled compaction, proper material proportions, and the addition of suitable stabilizers. Black cotton soil, prevalent in parts of India, has high clay content and is known for its dark color. While this soil is fertile and beneficial for agriculture, it poses challenges for construction due to its low bearing capacity and tendency to shrink and swell, leading to cracks. As the newly formed capital of Andhra Pradesh experiences rapid industrialization and population growth, there is an increasing need for construction on black cotton soil, which has poor shear strength. This necessitates diverse ground improvement techniques, such as soil stabilization and reinforcement, to enhance soil behavior and construction reliability.

This study focuses on stabilizing black cotton soil using waste plastics, demonstrating that plastic waste can effectively improve soil properties through various testing methods. Improper disposal of plastic waste is an environmental concern, as it clogs landfills and waterways, harms ecosystems, and poses risks to human and animal life. Polyethylene Terephthalate (PET) bottles are widely used for packaging water, but their long degradation time (over ahundred years) complicates disposal. Recycling and using PET bottles for soil stabilization in construction can help mitigate plastic waste issues, offering a sustainable alternative for the environment.

LITERATURE REVIEWS

Use of waste HDPE strips as soil reinforcement, showing that varying the length and proportion of the strips in soil improves its strength, as confirmed by CBR tests. This makes HDPE a useful material for highway construction [1].

Using plastic waste for soil stabilization provides an eco-friendly solution to waste disposal while improving soil strength and density. Tests show that adding up to 4% plastic strips increases the California Bearing Ratio (CBR), making it the optimal amount for strengthening soil. This method offers a cost-effective way to address plastic waste and the scarcity of quality soil in construction [2].

Infrastructure is vital for India's economic growth, and strong foundations are essential for stability. Expansive soils, such as black cotton soil, pose challenges like swelling and uneven settlement. Additionally, plastic waste is a growing global issue, with the usage of plastic products increasing significantly each year [3].

Incorporating plastic waste enhances the eco-friendliness, stability, and durability of the road mix, leading to significantly stronger roads than those made with unstabilized soils. This method also saves time and money by eliminating the traditional "dig and dump" process, thereby minimizing site preparation time thanks to the

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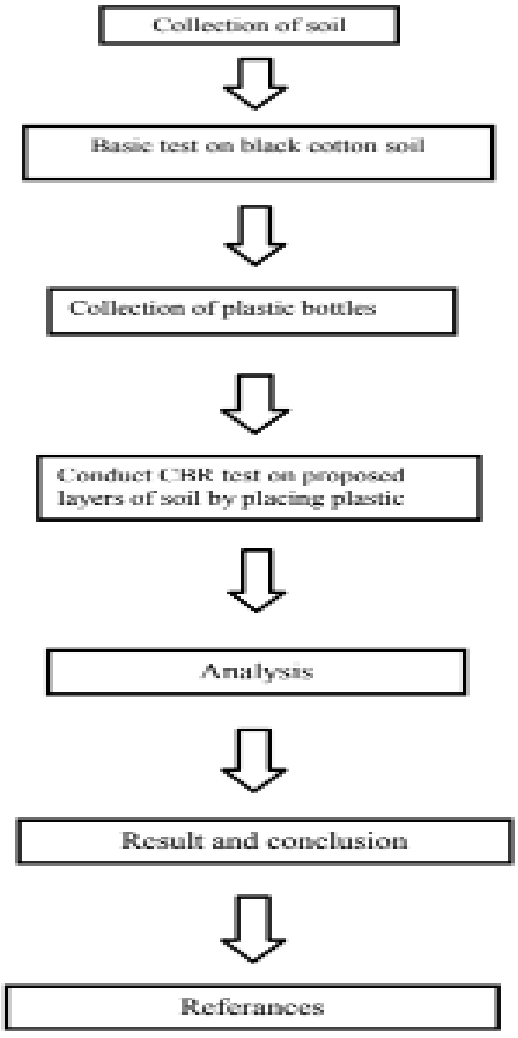
pre-stabilization of the soil [4].

The effectiveness of stabilization hinges on the chemical interactions between the stabilizer and the soil minerals. Some common stabilizers include Portland cement, lime cement (fly ash), plastic, bitumen, and lime. As this is a central aspect of our study, it will be examined in greater depth [5].

METHODOLOGY

This chapter outlines the step wise procedure that we are going to follow to complete the project. In a quantitative experimental study, we aim to produce generable knowledge about using plastic bottle to increase stability of soil with respect to engineering and geological properties. This requires a carefully designed study under controlled condition that can be replicated by other researchers. As a consequence, we are facing a range of environmental challenges. This review paper emphasizes the application of waste plastic products for soil stabilization. Several tests, including the liquid plastic limit, standard Proctor compaction test, California Bearing Ratio (CBR) test, and unconfined compressive strength (UCS) test, have been conducted to evaluate the improvements in the properties of black cotton soil.



RESULTS

TABLE 01

% of plasticcontent	CBR VALUE	
	Before Adding Plastic	After Adding Plastic
0.0	1.5	1.9
0.2	1.6	1.7
0.4	1.4	1.8
0.6	1.9	2.5
0.8	1.2	1.3
1.0	1.2	1.3

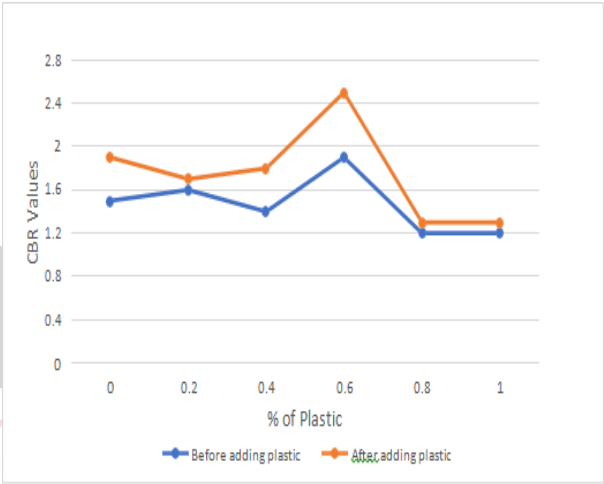


Fig. Graphical Representation Of CBR Test

Explanation of Graph:-

From above graph we have taken readings before adding plastic and after adding plastic. We got results as shown in above graph. After adding plastic the apex of curve rises at 0.6% of plastic. So addition of plastic increases the stability of foundation soil.

"Increase of CBR value shows the increase in strength of foundation soil"

TABLE 02

Penetration	Before AddingPlastic	After AddingPlastic
	Load DialReading	Load DialReading
0	0	0
16	2	16
22	3	22
27	4	27
30	5	30
34	7	34
36	8	36
37	9	36.5
38	10	38
40	11	40

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45	12	45
47	13	47
50	15	50

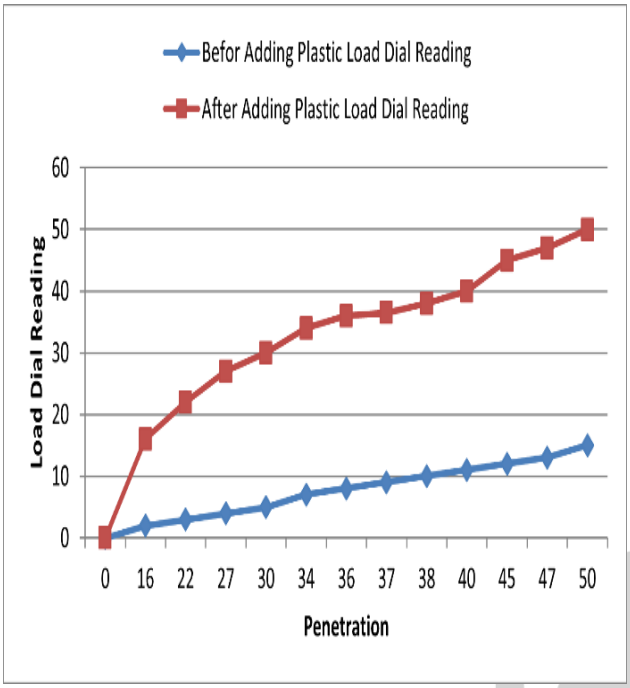

Fig:-Graphical Representation of penetration v/s load

CONCLUSION

The study after several experiments, found following significances in using plastic strips as stabilizing agent.

a) The addition of reclaimed plastic waste material to local soil increases the CBR.

b) The maximum improvement in CBR is obtained while using 0.6% plastic.

c) The CBR value at 2.5 and 0.6% plastic strip increased.

- Using plastic bottle mesh for stabilizing black significantly increases cotton soil is a promising approach. It has the potential to improve soil stability, reduce erosion, and enhance load-bearing capacity.
- The plastic bottle mesh used to stabilize soil gives long- term environmental impact of using plastic materials in this contex.

The reusing of plastic waste in construction is an eco-friendly approach. However, careful engineering design and thorough testing are essential to ensure its suitability for the specific project

a)

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