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Improve Soil Strength by Use of Plastic Bottles

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ABSTRACT- Any procedure that enhances the physical characteristics of soil, such as raising its shear strength or bearing capacity, is referred to as soil stabilization. This can be accomplished through the use of controlled compaction or by adding the right admixtures, such as cement, lime, and waste products like fly ash and phosphogypsum. Since good quality soil for embankments and pavements is difficult to come by, using plastic bottles as a soil stabilizer is an inexpensive use of waste materials. This project entails a thorough investigation into the potential use of used plastic bottles for stabilizing soil. In order to conduct the analysis, a CBR test was performed on soil that had been reinforced with layers of plastic bottles at varying percentages (0.5%, 0.7%, and 0.9% for distinct soils). The CBR test is carried out on red, loamy soil and black cotton soil. It is discovered that the strength of the soil is increased, resulting in a bearing ratio of 3.3 for black cotton soil and 0.7% for red soil after the addition of plastic stripes. Additionally, loamy soil's strength is boosted by adding 0.7% of plastic strips, resulting in a bearing ratio of 2.9.

INDEX TERMS – Stabilization, Admixtures, strength, plastic, soil.

I. INTRODUCTION

Both paved and unpaved roads perform poorly after every monsoon, and in most situations, these pavements exhibit substantial differential settlement at various sites as well as cracking, potholes, and wheel path routing. To maintain and enhance the performance of such pavements, it is crucial to take the design and construction approach into account. The suggested method is advantageous for building embankments and roads. Strips from plastic bottle are used as an additive in soil stabilization to boost the bearing capacity. the transformation of waste plastic into a valuable substance for soil stability. Plastic is a biodegradable and non-renewable resource. . Such plastic wastes are incorporated into stabilized soil as an addition. Plastic waste is reused because it may be repaired or recycled numerous times, reducing waste. Applications for these plastic wastes in soil stability and soil quality enhancement. Inversely, the soil's load-bearing capability and shear strength. This project involves adding appropriate admixtures, like plastic trash. Plastic bottles, a type of waste plastic, are utilized in this project. Small strips are cut out of the used plastic bottles. These tiny strips are added to the soil in varying amounts, and tests like the liquid limit, plastic limit, compaction test, CBR test, etc. are conducted. With regulated compaction, the soil is then stabilized, enhancing its capacity to support weight as well as its strength characteristics, such as shear strength. Utilizing used plastic bottles to stabilize soil greatly improves the soil's tensile strength.

II. MATERIALS USED

A. Plastic Bottles

Plastic is both a biodegradable and nonrenewable resource. Plastic bottle trash is a sustainable waste, but its disposal pollutes the environment. Plastic wastes can be processed to create usable items through recycling or reusing. Such plastic wastes are incorporated into stabilized soil as an addition.

B. Black Cotton Soil

Black cotton soil, often known as BC dirt, is quite clayey. Black cotton soil (BC soil) gets its dark color from a tiny quantity of titanium oxide. A significant amount of clay, mostly montmorillonite in structure and black or blackish grey in color, makes up the Black Cotton Soil (BC Soil). Expanding soils are those whose moisture content rises, causing them to enlarge. The expansive properties of the soil are mainly caused by the clay mineral montmorillonite. The elongate soils are sometimes known as swelling soils or soils of black cotton.

Table 1: Properties of Black Cotton Soil

S.No	Properties	Value
1	Specific gravity	2.57
2	Grain-size Analysis (%)	
3	Gravel Sand Silt Clay	2% 14% 44% 40%
3	Liquid Limit (%)	17.1
4	Plastic Limit (%)	17.1
5	dry density (g/cm4)	1.76
6	Moisture content (%)	18%

C. Red Soil

Red dirt is a common material used to build pavement shoulders. Red soil may occasionally need to be amended if it doesn't meet CBR requirements. To give the soil the appropriate properties, granular materials like sand and/or crusher dust that are readily available locally may be added in. The report outlines the findings of an experimental study in which stone dust was added to local Red soil to increase its quality. The index qualities, compaction traits, and California Bearing Ratio (CBR) parameters for the Red soil blended with varied percentages of the stone dust have been shown, and it is demonstrated that the value of the soil as a road material has been considerably boosted by simple mixing of the two.

Table 2: Properties of Red Soil

S.No	Properties	Value
1	Specific gravity	2.66
2	Grain-size Analysis (%)	
3	Gravel Sand Silt Clay	7.6% 78.6% 10.4% 4.5%
4	Liquid Limit (%)	41
5	Plastic Limit (%)	19
6	dry density (g/cm4)	1.62
7	Moisture content (%)	14.00

D. Loam Soil

The best type of soil for growing plants is called loam soil. It is essentially a mix of soil that often contains equal amounts of clay, silt, and sand and offers the advantages of each with few drawbacks. Loam, the ideal soil for growing crops, is made up of a combination of clay, silt, and sand. For the best permeability, the ideal loam soils contain an equal ratio of each. While retaining moisture and nutrients, loam also permits the drainage of extra water from the soil. Loam is extremely simple to work with and adaptable for different climates For instance, if you live in a hot environment, you could add clay to store water or sand to improve drainage if you get a lot of precipitation. The term "LOAM soil" refers to soil that contains 40% sand, 40% silt, and 20% clay particles. The LOAM soil's texture holds onto moisture and nutrients.

Table 3: Properties of Loam Soil

S.No	Properties	Value
1	Specific gravity	2.67
2	Grain-size Analysis (%)	
3	Sand Silt Clay	44.2% 45.8% 20.8%
4	Liquid Limit (%)	1.74
5	Plastic Limit (%)	57.4
6	dry density (g/cm4)	1.44

III. METHODOLOGY

A. Soil Stabilization

Enhancing soil characteristics and pavement system performance through soil stabilization is a practical strategy. Any stabilization method utilized should aim to improve the soil's workability and constructability, raise its strength and stiffness, and decrease its plasticity index. Instead of removing the soil and replacing it, numerous stabilization techniques using various stabilizing chemicals may be useful in improving the soil qualities. The choice of a stabilizing agent may also be influenced by factors like availability or cost. The varied soil samples acquired from Telangana State Engineering Research Laboratories underwent a number of laboratory tests to determine their geotechnical features and strength. The several assessments made to determine geotechnical factors include:

- Liquid Limit Test
- Plastic Limit Test
- Shrinkage Limit Test
- Unconfined Compression Test
- CBR Test

IV. RESULTS

A. Plastic Limit

Table 4: Results of Plastic Limit Without Plastic

S.NO.	OBSERVATIONS AND CALCULATIONS	DETERMINATON OF DIFFERENT SOIL		
		Black Cotton	Loamy	Red soil
1.	MASS OF EMPTY CONTAINER(M1)	24.12 g	24.12 g	24.12 g
2.	MASS OF CONTAINER +WET SOIL(M2)	31.28 g	31.82 g	30.28 g
3.	MASS OF CONTAINER +DRY SOIL(M3)	30.23 g	29.01 g	29.12 g
4.	MASS OF WATER= M2-M3	1.05 g	2.81 g	1.16 g
5.	MASS OF DRY SOIL= M3-M1	6.11 g	4.89 g	5.00 g
6.	WATER CONTENT W= (5)/(6)X100	17.1 %	57.4 %	23.2%

B. Liquid Limit

Table 5: Results of Liquid Limit Without Plastic

S.NO.	OBSERVATIONS AND CALCULATIONS	DETERMINATON OF DIFFERENT SOIL		
		Black cotton	Loamy	Red soil
1.	NO OF BLOWS(N)	39.00	33.00	35.00
2.	WATER CONTENT CAN NO.	5	5	5
3.	MASS OF EMPTY CONTAINER(M1)	10.19	10.19	10.19
4.	MASS OF CONTAINER +WET SOIL(M2)	21.92	21.90	20.21
5.	MASS OF CONTAINER +DRY SOIL(M3)	17.60	15.80	14.81
6.	MASS OF WATER= M2-M3	4.30	6.10	5.40
7.	MASS OF DRY SOIL= M3-M1	7.41	5.61	4.62
8.	WATER CONTENT W= (6)/(7)X100	58.02%	17.3%	16.88%

C. Shrinkage Limit

Table 6: Results of Shrinkage Limit Without Plastic

S.NO.	OBSERVATIONS AND CALCULATIONS	DETERMINATON OF DIFFERENT SOIL		
		Black cotton	Loamy	Red soil
1.	VOLUME OF SHRINKAGE DISH,V1=(3)/13.6	21.1 ml	21.1ml	21.1ml
2.	MASS OF EMPTY SHRINKAGE DISH	17.48	17.48	17.48
3.	MASS OF SHRINKAGE DISH +WET SOIL	91.61	91.61	89.82
4.	MASS OF WET SOIL M1=(3)-(2)	74.13	74.13	72.34
5.	MASS OF SHRINKAGE DISH +DRY SOIL	59.66	55.56	55.62
6.	MASS OF DRY SOIL ,Ms=(5)-(2)	42.18 ml	38.08 ml	38.14 ml

D. C.B.R Test With Plastic

- **Black Cotton Soil**

Table 6: Results of C.B.R Test With Plastic

Percentageof plastic content	CBR value
0.0	2.7
0.2	2.5
0.4	2.6
0.5	3.3
0.7	2.1
0.9	2.1

- **RED SOIL**

Table 7: Results of C.B.R Test With Plastic

Percentageof plastic content	CBR value
0.0	2.3
0.2	2.0
0.4	2.1
0.5	2.4
0.7	2.9
0.9	1.8

- **Loamy Soil**

Table 7: Results of C.B.R Test With Plastic

Percentageof plastic content	CBR value
0.0	2.1
0.2	1.9
0.4	1.7
0.5	2.2
0.7	2.5
0.9	1.6

V. CONCLUSION

The CBR was performed on soil that had plastic strips mixed it. The CBR test is carried out on red soil, loamy soil, and black cotton soil. It is discovered that the strength of the soil is increased, resulting in a bearing ratio of 2.9 for red soil and 3.3 for black cotton soil after adding 0.7% of plastic strips to red soil and 0.5% to black cotton soil. Additionally, loamy soil's strength is improved by adding 0.7% of plastic strips, yielding a bearing ratio of 2.5. It is one of the best solutions for recycling waste plastic because it is risk-free and economical in nature.

CONFLICTS OF INTEREST

The authors declare that they have no conflicts of interest.

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