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ENHANCING THE GEOTECHNICAL PROPERTIES OF RED SOIL USING POLYPROPYLENE AND LIME

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Abstract - *In civil engineering, the foundation is critical for any land base construction and must be able to withstand the incoming loads without failing. In some areas, the soil may be poor and unable to withstand the incoming stresses. Soil stabilization is required in such circumstances. Red soil covers 10.6% of the Indian geographical area. The colour of red soil is due to a high percentage of iron in the soil. Red soil is used in this research. In this research an attempt to study various geotechnical properties and improved the red soil properties by adding different percentages of polypropylene and lime.*

In this study red soil is collected and transported from the district of Jalgaon in northern Maharashtra. For this study we take polypropylene as 0.5%, 1%, 1.5% and constant 4% of Lime added to the soil.

Key Words: Soil stabilization, Red Soil, Polypropylene, Lime, CBR etc.

1. INTRODUCTION

Soil stabilization is a process that alters and improves the engineering properties of the soil in order to make it more suitable for building. Soil stabilization is a civil engineering technique for refining and improving soil engineering properties including mechanical strength, permeability, compressibility, hardness, and plasticity. The base soil serves as the foundation for any construction project, for a house, a road, or an airport. Furthermore, soil is an essential building material to stand any structure. As a result, soil should have properties that enable it to form a solid base.

Soil stabilization is a common practice in the construction of airfields, parking lots, landfills, embankments, highways and foundations, waterway maintenance, agriculture, and mining sites.

Soil stabilization is a critical component of various civil engineering projects. Without removing the entire soil, the most effective technique is to use appropriate accessible methods and materials to enhance the soil qualities. As a result, soil stabilization is thought to be the best strategy for improving soil geotechnical parameters. Chemical additives, thermal energy, compaction, and plant-based or synthetic fiber reinforcing are all common stabilization approaches. Straw, coir, palm, sisal, and jute are examples of plant-based fiber reinforcement materials that are inexpensive. Synthetic fiber reinforcing materials, such as polypropylene, nylon, rubber, or plastic, can also help reduce waste. Research into the use of waste materials to stabilize soil is currently a global trend, as surplus waste materials pose public safety and logistical issues in terms of disposal.

2. MATERIAL USED

In this study, the following materials were used:

i) Red Soil
ii) Polypropylene
iii) Lime

2.1 RED SOIL

The soil sample for this study was taken in the district of Jalgaon in northern Maharashtra. The earth is a bright crimson color. Red soil is a type of soil that forms in warm temperatures and is common in damp climates with deciduous or mixed woods. The red soil's texture ranges from sandy to clay, with loam accounting for the majority of it.

Table -1: Geotechnical Properties of Red Soil

Specific Gravity	2.63
Liquid Limit	31.03%
Plastic limit	20.67%
Plasticity Index	10.36%
Max Dry Density	1.88 gm/cc

Optimum Moisture content	14.5%
CBR (2.5mm penetration)	6.64
Cohesion (C)	0.72kg/cm^2
Angle of internal friction (Φ)	14^o

2.2 POLYPROPLYENE

Polypropylene's starting material is nonnumeric C_3H_6, a completely hydrocarbon compound. Polypropylene fibers have particularly beneficial qualities due to their form of polymerization, high molecular weight, and the way they are processed into fibers. Polypropylene fiber is a single fiber with a diameter of 0.034mm and comes in lengths of 6mm, 12mm, and 20mm.

Table - 2: Characteristics of Polypropylene

Length	6mm
Diameter	0.034mm
Specific Gravity	0.91
Moisture absorption	0% to 0.05%
Relative Density	0.91
Tensile Strength	550-700 MPa
Percentage Elongation at failure	21%
Modulus of Elasticity (E)	3.5-6.8 GN/m^2
Thermal Conductivity	6(with air as 1)
Melting Point	165^{o}C
Softening Point	140^{o}C
Alkali Resistance	Low

2.3 Lime

Lime is also known as calcium oxide and has the chemical formula CaO. It is manufactured by heating Calcium carbonate (CaCO3). When lime is being used in soil stabilization process, it primarily increases strength and minimizes swells and shrinks. However, more additions may reduce soil plasticity, and excess lime application promotes brittle failure, a type of soil failure that results in a rapid and significant loss of strength when it happens. The Percentage of lime used in this experiment is constant at 4%.

3. LITERATURE REVIEW

Some researchers have attempted to substitute standard stabilizers with a variety of waste materials that are both cost-effective and improve soil geotechnical qualities.

R.S Balagoudra et.al, (2017) carried study on black cotton soil with PPF (0%, 0.25%, 0.50%, 0.75%, and 1%) and constant 4% lime. The best result shows at 0.75% PPF with 4% lime

S.A. Hussein, A.A Hussein (2019) conducted a study on the effect of polypropylene fiber on expansive soil. they use polypropylene as 0.5%, 1%, 2% of the dry weight of soil and test conducted on 1 D consolidation test, UCS, cyclic swell, and swelling test. They discovered that mixing 2% PPF produces the best results. and with increased PPF percentage, there an increase in UCS up to 51% and reduced the swelling pressure and free swell about 69% and 79.1%. Compressibility also decreased by adding 2%PPF

T.N Dave et.al (2020) The use of polypropylene fires (PPF) for the stabilization of expansive soil obtained from Dedicated Freight Corridor (DFC) project site Bhestan near Surat. In this research.PPF has been mixed with soil in proportions of 0.75%, 1.5%, 2.0%, 2.25%, and 2.5%.

Tharini et.al (2020) the laboratory conducted for study the performance on Black cotton soil reinforced with polypropylene fiber mixed at 0.2%, 0.3%, 0.4%, and 0.5%.. The soil was gathered near PSNA College of Engineering and Technology, Dindigul, Tamil Naidu, India

4. METHODOLOGIES

For this study we take polypropylene as 0.5%, 1%, 1.5% and constant 4% of Lime added to the soil and done the experiment on red soil. In Laboratory we have done experiments on Atterberg Limit (Liquid limit and Plastic limit), Compaction Test, California Bearing Ration (CBR), and Unconsolidated Undrained Triaxial Test (UU triaxial test).

5. TEST RESULTS AND DISCUSSIONS

5.1 Effect of Polypropylene and Lime on Heavy Compaction on Red Soil

5.1.1 Effect on Maximum Dry Density

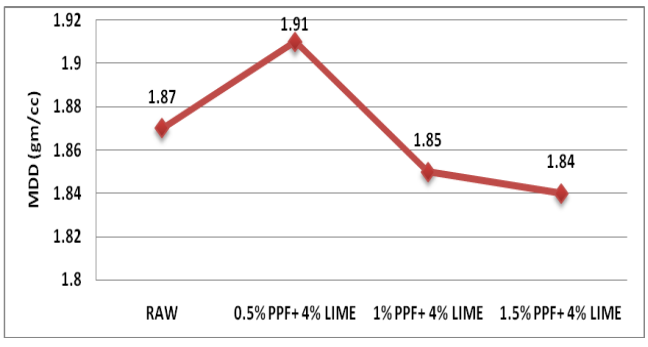

Chart -1: Variation of MDD

5.1.2 Effect of Optimum Moisture Content

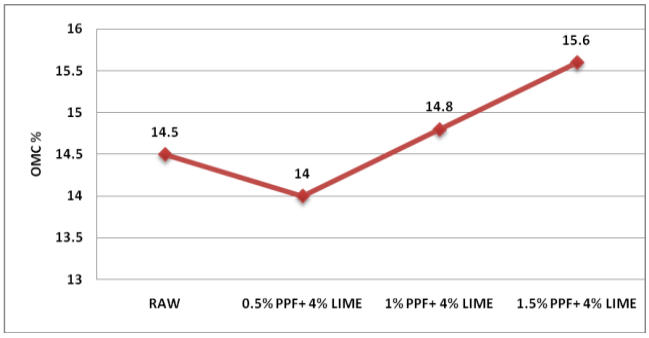

Chart -2: Variation of OMC

5.2 EFFECT OF PPF AND LIME ON CBR VALUES OF RED SOIL

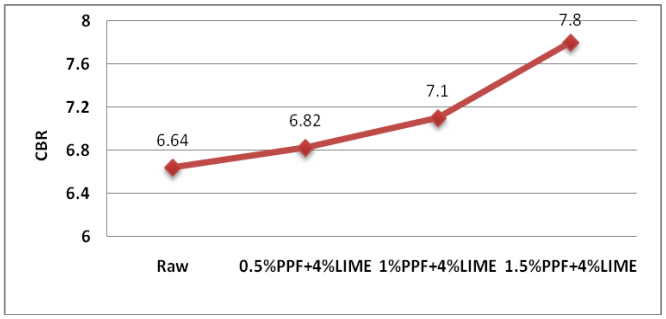

Chart -3: Variation of Soaked CBR

5.3 EFFECT OF PPF AND LIME ONSHEAR STRENGTHPARAMETERS OF RED SOIL

5.3.1 Effect on Cohesion

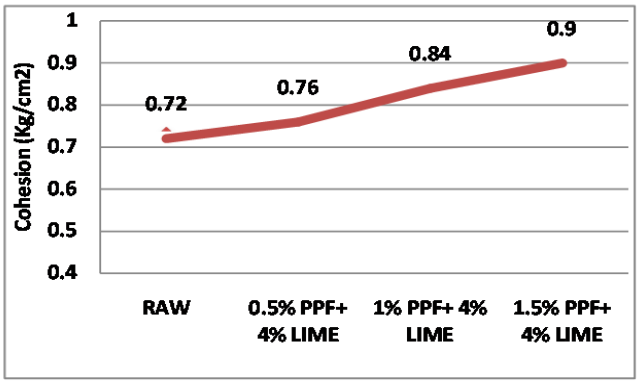

Chart -4: Variation of cohesion

5.3.2Effect on Angle of Internal Friction

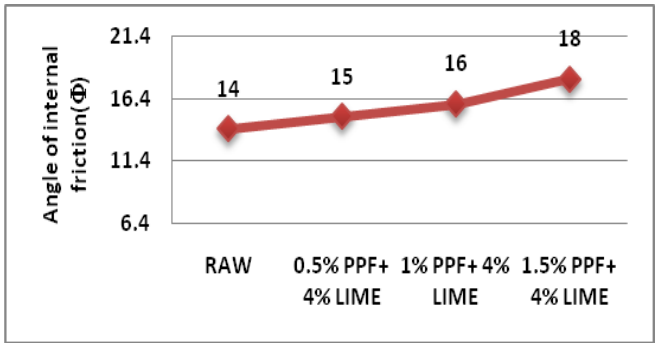

Chart -5: Variation of Angle of Internal Friction

6. CONCLUSIONS

1) When we stabilized the red soil with 0.5% PPF and 4% lime, OMC decreased to 14% and MDD increased to 1.91gm/cc. Then after increasing the Percentages of PPF and lime OMC value goes on increasing and the MDD value decreases. From the Compaction Point of view, 0.5% of PPF and 4% Lime gives the best result

2) The soaking CBR value increases as the percentages of PPF and Lime increases. The percentage increased in CBR value when red soil is blended with polypropylene fiber with constant Lime is 17.46% when compared to raw soil.

3) The Percentage increased in cohesion is 25% as the PPF and Lime increases and the percentage increased in angle of internal friction is 28.57%.

4) Angle of friction increases when the percent of PPF and Lime in Red soil increases.

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