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ENGINEERING PROPERTIES IMPROVEMENT OF BLACK COTTON SOIL BY USING IRON ORE TAILING AND POLYPROPYLENE FIBRE

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Abstract - *The vast majority of soils on Earth are composed mostly of active clay minerals. Clayey soils are characterised by poor lasting ability and high settlement. Geotechnical engineers must consider a wide range of technical difficulties while planning a building's foundation. Engineers can gain from improving the soil by adding fibres, Iron Ore Tailings, and other elements. With a rise of 0.20% PPF to 0.60% and a constant 10% dose of Iron Ore Tailings by the weight of soil, numerous tests are conducted on black cotton soil. The final strength level is reached at 0.4% PPF and a constant 10% Iron Ore Tailing dosage.*

Key Words: **Iron Ore Tailings, PPF (Polypropylene Fibre), stabilization.**

1. Introduction

The stability of the base is significantly influenced by the soil around the structure. It is crucial to stabilise the soil in order to get the ideal soil properties. Iron Ore Tailings soil stabilisation is made possible by adding polypropylene fibre and improving the strength. Strong foundations are essential for any construction that is load-based and needs a certain amount of structural strength to hold it up against failure. Iron Ore Tailings and randomly distributed polypropylene fibres from waste materials are used in this project to stabilise the soil. With the addition of PPF and Iron Ore Tailings, OMC decreases and MDD rises. The swelling of the soil decreases together with the L.L. and P.L.

2. LITERATURE REVIEW

Mohammed SaqibQadeer and Vinod Kumar Sonthwal (2021)[3] conducted there explorations into expansive earth. Clayey soils have increased settling and poor lasting ability. Geotechnical engineers have many challenges while designing foundations. Research studies benefit from being able to focus on better ways to address those problems by incorporating lime, fibres, etc. into the soil. Numerous studies are conducted on BC soil with an increased PPF of 0.25 to 0.75% and a constant 4% lime by soil weight. Finally, a steady lime dose of 4% and 0.50% PPF yield the maximal strength.

Supritha and J Ranjitha, et al. (2016)[1] uses admixture made from iron ore tailings to stabilise the black cotton soil. To start, various laboratory experiments were conducted on BCS to ascertain its MDD, OMC, LL, PL, Specific Gravity, and CBR values. In order to execute the aforementioned test, stabilising agents like IOTs are added at various percentages, including 10%, 15%, and 20%. The field-collected soil sample is dried in the sun or in the open air. With the aid of the proper tool, the clods are shattered to speed drying. The soil sample had the organic material, such as tree roots and bark fragments, removed. The soil sample is dried in an oven for 24 hours at a temperature between 110°C and 150°C.

The MDD of the plain soil is raised by the addition of iron ore tailings in percentages of 10, 15, and 20%..

Saurabh. Sanjay Deshpande and M.M. Puranik (2018)[4] The goal of this study was to examine how adding fly ash and polypropylene fibre to black cotton soil affected its various engineering qualities. As the percentage of polypropylene grew, the maximum dry density fell and the ideal moisture content rose. As the amount of polypropylene grew, so did the soil's unconfined compressive strength. It was discovered that 15% and 1.5%, respectively, of fly ash and polypropylene fibre, were the ideal amounts.

3. OBJECTIVES

1. To measure the increase in soil strength caused by the addition of fibre and Iron Ore Tailings at various percentages.

2. To determine the impact of fibre and iron ore tailings on the CBR value of the Black Cotton soil.

3. To identify the Black Cotton soil's index qualities.

4. Conduct a variety of strength tests on different fibre percentages to determine the ideal proportion of polypropylene fibre..

4 EXPERIMENTAL INVESTIGATIONS

4.1 SCOPE OF WORK

Following steps consists in the experimental work:

1. To calibrate specific gravity of soil sample.
2. To calibrate L.L,P.L and P.I. of soil sample.

3. To determine the OMC and MDD of the Black cotton soil corresponding to it by performing SPT test .

4. Calculation of CBR to determine strength of soil.

4.2 MATERIALS

4.2.1 Black Cotton soi

A significant soil category in India is made up of BC soil, an inorganic clay with a medium to high compressibility. They typically exhibit strong swelling and shrinking characteristics. The BC soil is a challenge to the engineers who construct foundations due to its significant swell and shrinkage characteristics. Regur and expansive soils are some names for the BC soil.

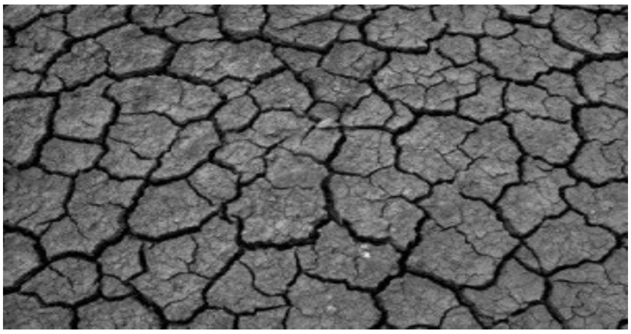


Figure : 1 Black Cotton Soil

4.2.2 Polypropylene fibre:

Table – 1

Serial number	Physical and chemical properties	Values
1.	Fibre	Single fibre
2.	Per Unit weight of fibre	0.95g/cm^3
3.	Avg. Diameter of fibre	0.038
4.	Avg. length of fibre	8mm or 12mm
5.	Breaking strength of fibre	355 MPa
6.	Elasticity modulus of fibre	3700 M Pa
7.	Flash point	170°C
8.	Burning point	600°C
9.	Acid and base	Excellent
10.	Dispersity	Excellent

Polypropylene Fibre, also known as polypropene or PP, is a synthetic fibre, transformed from 85% propylene, and used in a variety of applications. The fibre is thermoplastic, resilient, light weight and resistant to mildew and many different chemicals.**Polypropylene (PP)** is the first stereo regular polymer to have reached industrial importance.

Figure – 2 Polypropylene Fibre

4.2.3 Iron Ore Tailings

Iron Ore Tailing (IOT) are a form of solid waste produced during the beneficiation process of**Iron Ore** concentrate. Among all kinds of mining solid waste, IOT are one of the most common solid wastes in the world due to their high output and low utilization ratio.

Figure-3 Iron Ore Tailings

4.3 PREPERATION OF SAMPLES

The various steps performed while mixing the fibre to the soil are as followed:-

1. The soil samples are compacted at their OMC and MDD in accordance with the SPT test..

2. The soil's fibre content was added in proportion to the soil's weight.

3. Fibre reinforcement is added in the varied percentages 0%, 0.2%, 0.4% and 0.6% and a constant 10% IOT is added for varying percentages of fibre.

4. When preparing a soil sample, water is added to air-dried soil depending on the OMC of the BC soil if IOT and fibre are not present.

5. After thoroughly combining the Iron Ore Tailing and fibre with the oven-dried soil material, water should be added to create a fairly uniform mixture.

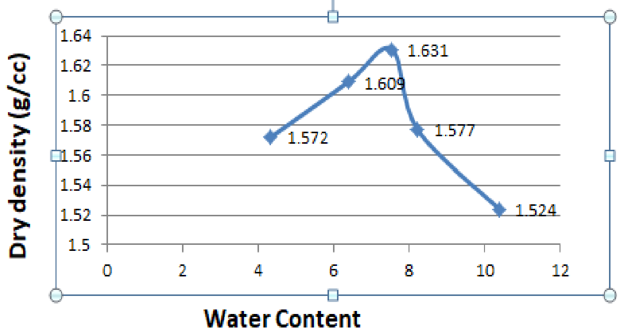
4.4 STEPS TO BE FOLLOWED IN EXPERIMENT

4.4.1 Plastic Limit

The P.L. is the water content at which, in a typical test, a moisture paste transforms from having a semisolid to a plastic consistency when rolled into a 3,175 mm (1/8-inch) diameter thread. The L.L. is evaluated as the second parameter in the Atterberg's Limits Test.

4.4.2 Standard Proctor compaction test

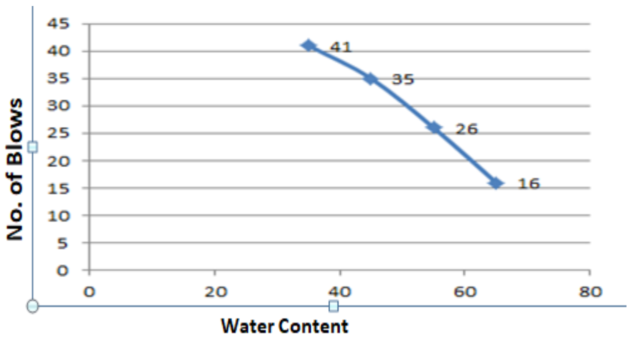
The OMC at which soil reaches its MDD and gets denser is determined by the Standard Proctor Test. The same soil should be placed in the moisture containers before measuring its moisture content. To determine the wet or bulk mass, the weight of the soil sample is divided by the usual volume of the mould. The dry density can be determined using the moisture content.



4.4.3 Liquid limit by Casagrande's Apparatus

A technique for determining a soil's liquid cap is the Casagrande instrument. In a shallow cup with a deep groove dividing it into two halves, a soil and water paste is made. The cup is continuously lowered until the groove closes from paste flow. The liquid limit indicates how shearing resistant a soil is when combined with water. The soil's liquid limit can be ascertained using either the Cone Penetrometer method or the Casagrande method.

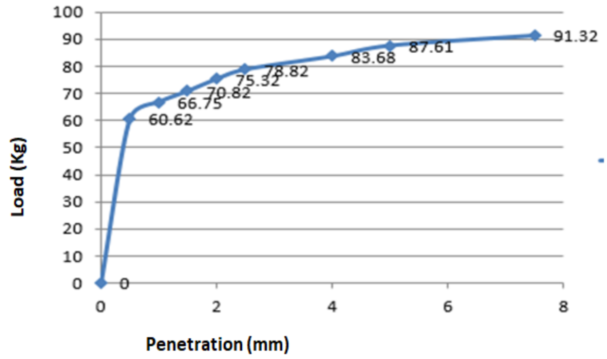
It may be demonstrated that the water content is comparable to 16 blows by plotting these points on a semi-log graph with the abscissa representing the number of blows and the coordinate representing the water content.



4.4.4 California Bearing Ratio Test

For the examination of pavement and foundations, the CBR test is a penetration test that is required. Calculations are done to establish the foundation thickness required for a road or other project using a graph that depicts the connection between penetration and load. The C.B.R. values for 2.5 mm and 5 mm penetration are typically tested. In this scenario, the former value is used for design considerations; typically, the C.B.R. value must be more than 5 mm at 2.5 mm.

CBR=100x100x100(PT/PS)

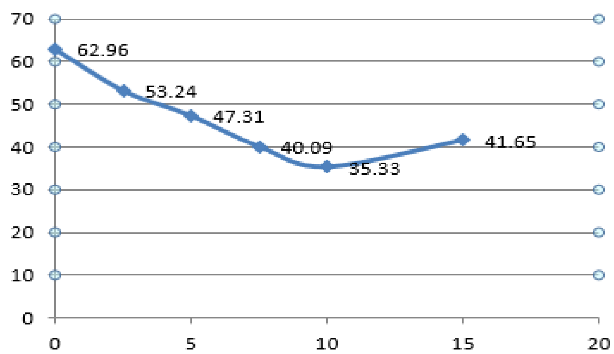


4.4.5 Free Swell Index Test

The potential for structural failure from the growing soil's propensity to swell must be assessed. The free swell index can be used to calculate the soil's capacity to swell. The soil index value should be less than 40% for structural stability.

Table-2

Sl.No.	Mix Designation	Swell Index
1	Black Cotton Soil + 0 % IOT	**62.96**
2	Black Cotton Soil + 2.5 % IOT	**53.24**
3	Black Cotton Soil + 5 % IOT	**47.31**
4	Black Cotton Soil + 7.5% IOT	**40.09**
5	Black Cotton Soil + 10 % IOT	**35.33**
6	Black Cotton Soil + 15% IOT	**41.65**



5. RESULTS AND DISCUSSION

Table 3 The results of the black cotton soil experiment's index properties are tabulated below.

Table-3 Summary of Results

Specific gravity (G)	2.26
L.L. of soil	47.69%
P.L of soil	31.44
P.I	16.25
MDD	1.631g/cc
OMC	7.53%
CBR Value	5.75mm

5 CONCLUSION

1. OMC and MDD values of soil sample initially tested are 14.25 and 1.429g/cc.

2. MDD value increases considerably on adding Iron Ore Tailings reaching maximum value of 1.470, also OMC decreases and reaches a minimum value of 12.35%.

3. With the addition of polypropylene fibre in two different lengths—6mm and 12mm—at a constant dose of 10% IOT MDD increases to 1.626 and OMC decreases to 7.52% in the case of the 6mm length of fibre, with only a very slight reduction in MDD and OMC observed.

4. The CBR of natural Black Cotton soil on testing is 2.208.

5. The percentage increase in CBR value over plain soil is 42.51%, 63.66%, and 65.53%, respectively, based on the soaked CBR values at 5%, 10%, and 15% IOT. These values are 3.40%, 4.27%, and 4.36%, respectively..

6. When a constant IOT dose of 10% in 0.40% is applied to polypropylene fibre with lengths of 8mm and 12mm. The soil sample's CBR value increases by up to 89.01% for 8mm fibre and 90.80% for 12mm fibre.

7. The ideal IOT dose and fibre dose for CBR are 10% and 0.40%, respectively.

8. Plain soil's free swell index is 62.96%.

9. Free swell index with 0%, 5%, 10% and 15% IOT is 62.96%, 47.31%, 35.33% and 41.65% respectively.

10. In comparison to natural Black soil, the free swell index of a sample of Black Cotton soil increased by 28.38%, 56.22%, and 40.74%, respectively, at the 5%, 10%, and 15% levels.

11. The free swell index increases exponentially when fibre is introduced to soil because fibre does not have the ability to drain itself and retains a significant amount of water.

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