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ENGINEERING PROPERTIES ENHANCEMENT OF BLACK COTTON SOIL BY USING LIME AND POLYPROPYLENE FIBRE

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Abstract: Soils that generally consist of active clay minerals and are expansive are found in many part of the world. Clayey soils have bad enduring ability and extra settlement. When designing foundation, various issues are faced by geotechnical engineers. Adding lime, fibres, etc. to the soil helps researches to concentrate on improvement methods to overcome those issues. Many tests is performed on BC soil with an increase of 0.25% PPF to 0.75% and a constant 4% lime by the weight of soil. At last the maximum strength is achieved at 0.50% PPF and by constant lime dose of 4%..

Keyword: lime, fibres, soil stabilization

1. INTRODUCTION

In order for the base of the structure to be strong, key role is played by the soil around the structure. The soil stabilization plays a key role in order for the soil properties to be satisfied, by adding polypropylene fibre, lime soil stabilization is achieved by improving the strength. The foundations are very much important for any structure based on load and the structure needed to have a strength of supporting the structure against failure. Here in the project, the stabilization of soil is done by the help of polypropylene fibres extracted from waste materials and are distributed randomly and lime. By adding Lime and PPF, OMC decreases and MDD increases. Also the swelling of soil decreases as well as the L.L and P.L.

2. LITERATURE REVIEW

SATYAM TIWARI, et al (2016): He explains the "Use of Fibre Materials Waste for the Stabilization of Soil", and had an investigation on how the polypropylene fibre waste affects the unsaturated soil's shear strength by conducting a direct shear stress test on two different samples of soil. The added fibre reinforcement percents are 0.25, 0.15, 0.5, and 0, based on the increase of 0.3% in specific gravity of the soil. Soil with reinforcement and without reinforcement has a difference of 18.18% in their liquid limit.

SHAILENDRA SINGH, et al (2013): He stated that by using lime in three different ratios i.e. 6%, 4% and 0% we can stabilize the BC soil. Many tests have been done on BC soil with the lime in the above percentages for the soil to be stabilized. It is founded that MDD decreases by 5.6% at 4% lime content and 2.4% at 4% lime content. It is concluded that if we add 4% lime the L.L down by 12.1% and if we add 6% lime, the L.L. down by 17.7%. Mixing various lime proportions i.e. 10%, 8%, 6%, 4%, 2%, 0%, So the tests are conducted on BC on soil in the laboratory.

ANKIT JAIN, et al (2016): He gives the "Effect of lime on the index properties of black cotton soil". Swelling property of BC soil goes down 60% to 14% by adding lime content in increasing ratio. P.I. of soil goes down from 37.16% to 10.43% when Lime is added to soil by 8% and he also shows that, L.L. of soil goes down from 67.49% to 52.01% with increase in lime content by 8%. Swelling characteristic of soil is goes down at an optimum dose of lime 8%.

3. OBJECTIVES

- To identify the increase in strength of soil by addition of Lime and fibre to the soil at various percentages.
- To find out the effect of lime and fibre on CBR value of the BC soil .
- To found out index properties of BC soil.
- The find out optimum % of polypropylene fibre by various strength tests to various % of fibres.

4. EXPERIMENTAL INVESTIGATIONS

4.1 Scope of work

Following steps are consists in the experimental work:

1. To find out the soil's specific gravity
2. To determine index properties of soil, L.L,P.L and P.I.
3. To determine the MDD and OMC of the soil corresponding to it by performing SPT test on BC soil.
4. To determine of strength by CBR.

4.2 Materials

4.2.1 Black Cotton soil

BC soil is a inorganic clay of medium to high compressibility and form a major soil group in India. They are usually having high swelling and shrinkage

properties.. Because of its high swelling and shrinkage nature, the BC soil is a challenge to the foundation design engineers. The BC soil is also called as regur and expansive soils.

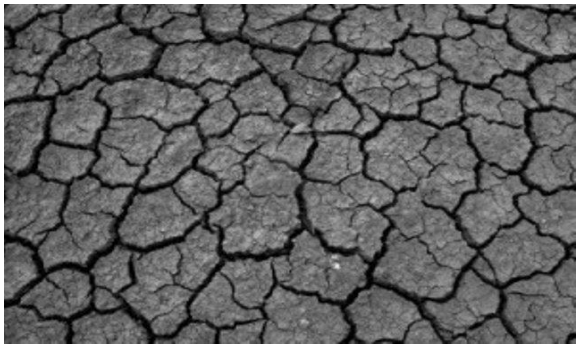


Figure 1: Black Cotton Soil

4.2.2 Polypropylene fibre:

Table-1

Serial number	Physical and chemical properties	Values
1.	Fibre'type	Single fibre
2.	Unit weight	0.91g/cm³
3.	Avg. Dia.	0.034
4.	Avg. length	6mm or 12mm
5.	Breaking strength	350 MPa
6.	Elasticity modulus	3500 M Pa
7.	Flash point	165°C
8.	Burning point	590°C
9.	Acid and base	Excellent
10.	dispersity	Excellent

Figure 2: Polypropylene fibre

4.2.3 Lime

Lime is a calcium containing inorganic mineral primarily Composed of oxides and hydroxide mainly CaO or $Ca(OH)_2$. it is also the name for coal-seam fires and in altered limestone xenoliths in volcanic waste. The word lime comes from burnt limestone, such as quicklime and hydrated lime.

Figure 3: Lime

4.3 Preparation of samples

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

1. Soils samples are compacted in correspondence to the SPT test at their OMC and MDD
2. Fibre content of the soil added to the soil according to the weight of soil.
3. Fibre reinforcement is added in the varied percentages 0%, 2.5%, 0.5% and 0.75% and a constant 4% lime is added for varying percentages of fibre.
4. Water is added to air dried soil depends on the OMC of the BC soil while preparing soil sample if Lime and fibre not added.
5. To get the fairly homogenous mixture, Lime and fibre should be mixed in oven dried soil mass efficiently and then water is added.

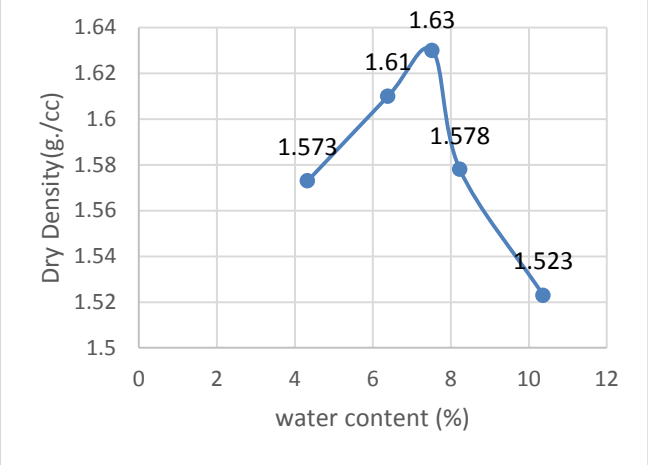
4.3 steps that to be followed in the experiments

4.4.1 Plastic limit

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

4.4.2 Standard Proctor compaction test

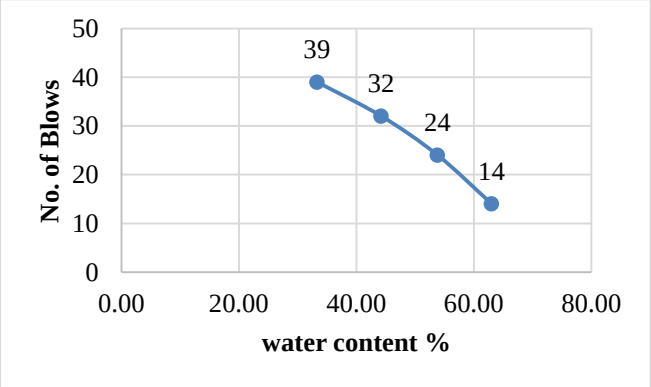
The SPT test is a the experimental determination of the OMC at which soil becomes denser and reaches its MDD. Within the same soil, fill the moisture containers and decide the moisture content. For calculation of wet or bulk mass, the weight of the soil sample is then separated by the normal volume of the mould. The dry density can be measured by using the moisture content.



4.4.3Liquid limit by Casagrande's Apparatus

The apparatus of Casagrande is a technique for determining a soil's liquid cap. In a shallow cup, a paste of soil and water is set, the paste is cut into two sections with a deep groove and the cup is then repeatedly lowered in a normal fashion until the groove has closed due to the paste flow. When combined with water, the liquid limit provides a measure of the shearing resistance that a soil has. The soil's liquid limit can be calculated by the method of Casagrande or the method of the Cone Penetrometer. With the help of semi log graph between no. of blows as abscissa and water content as ordinate, the line is drawn by adding these points states that water content is equal to 13 blows.

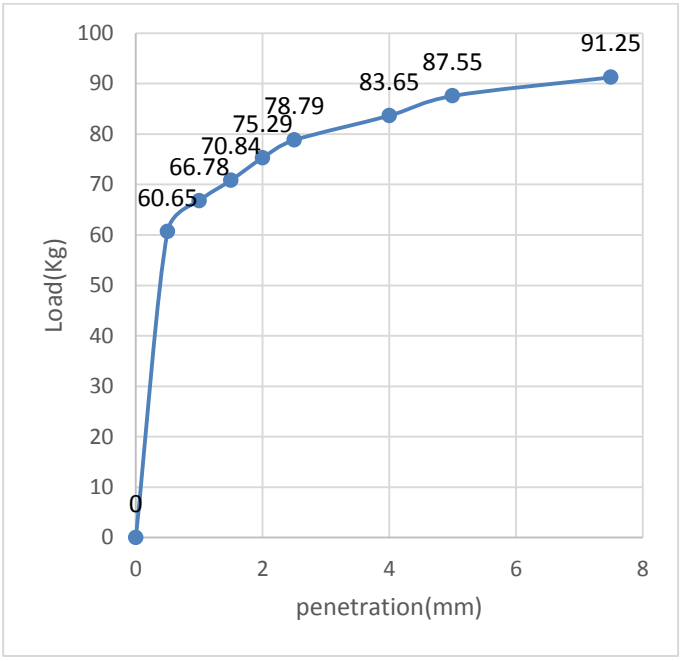
S. No.	Mix Designation	Swell index
1	Black Cotton Soil + 0% lime	60.71%
2	Black Cotton Soil + 1% lime	52.97%
3	Black Cotton Soil + 2% lime	45.18%
4	Black Cotton Soil + 3% lime	40.34%
5	Black Cotton Soil + 4% lime	35.76%
6	Black Cotton Soil + 5% lime	41.66%



4.4.4 California bearing ratio test

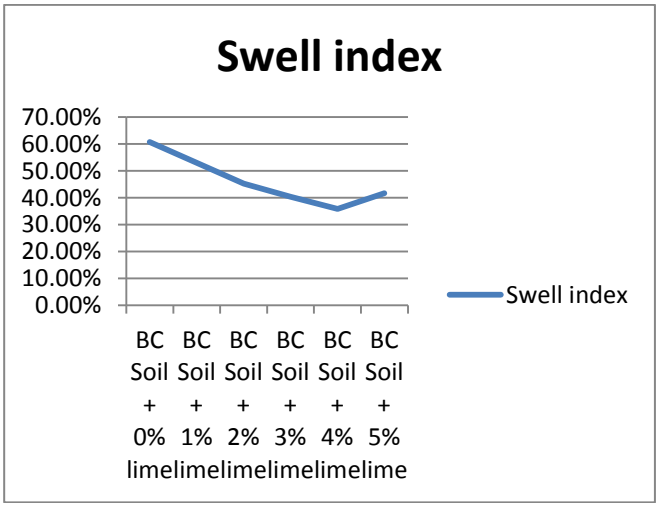
The CBR test is a penetration test required for the inspection of pavement mostly and foundation also. With the help of graph plotted between load and penetration the pavement thickness required or foundation thickness required to road or structure construction is calculated. For 2.5 mm and 5 mm penetration, the C.B.R. values are typically measured. In general, the C.B.R. value shall be greater than 5 mm at 2.5 mm and, in such a situation, the former shall be taken for design purposes as C.B.R.

C.B.R. = (PT/PS) X 100 X 100 100



4.4.5 Free Swell index test

The chance of structure damage due to swelling property of expansive soil needs to be identified. Free swell index determination of expansive soil allows us to identify the swelling potential. Soil index value should be less than 40% for structure stability



5. RESULTS AND DISCUSSION

Table 2 listed outcomes of the index properties of the black cotton soil experiments. Figures 4 to 8 indicate the difference in the optimal moisture content, maximal dry mass, unconfined compressive power, direct shear test and the effects of the California bearing ratio test.

Table-2: Summary of results

Specific gravity (G)	2.268
L.L. of soil	49.43%
P.L of soil	33.45
P.I	15.98
MDD	1.630g/cc
OMC	7.52%
CBR Value	5.6mm

6. CONCLUSION

1. For plain soil, obtained OMC and MDD values are 14.42 and 1.43g/cc.
2. With addition of lime in the soil the MDD value increases considerably reaching maximum value of 1.479 whereas OMC decreases and reaches a minimum value of 12.29%.
3. On the other hand with the addition polypropylene fibre of two different lengths i.e. 6mm and 12mm at a constant dose of 4% lime MDD increases upto 1.63 and OMC decreases to 7.53% in case of 6mm length of fibre there is a very little decrease in MDD and OMC noticed.
4. The natural BC soil has CBR value of 2.215.
5. The soaked CBR value at 3%, 4% and 5% lime are 3.41%, 4.26% and 4.42% respectively shows the percentage increase in CBR value as compare to plain soil is 53.95%, 92.32% and 99.54% respectively.
6. When polypropylene fibre of length 6mm and 12mm is added at a constant lime dose of 4% in 0.50%. The CBR value of soil sample increase up to 159.59% in case of 6mm fibre and 152.82% in case of 12mm fibre.
7. The optimum lime dose and fibre dose for CBR is 4% and 0.50%.
8. Free swell index of plain soil is 60.7.
9. Free swell index with 3%, 4% and 5% lime is 40.34%, 35.76% and 41.66% respectively.
10. Free swell index of BC soil sample with 3%, 4% and 5% increase 33.54%, 41.08% and 31.36% respectively as compared to natural Black soil.
11. When fibre is added to soil the free swell index goes very high because fibre retained very much water in it and does not have self-drained property.

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