ISSN: 2277-9655
Impact Factor: 1.852

IJESRT

INTERNATIONAL JOURNAL OF ENGINEERING SCIENCES & RESEARCH TECHNOLOGY

Effect of Jute Fibres on Engineering characteristics of Black Cotton Soil

Harshita Bairagi[*1], R.K.Yadav[2], R.Jain[3]

[*1] M.E. Student, [2,3]Associate Professor, Civil Engineering Department, Jabalpur Engineering College, Jabalpur, India

Harshitabairagi1@gmail.com

Abstract

Light structures such as highways, railroads, runways, and other lifeline structures, constructed over black cotton soil may be severely damaged due to high swell-shrinkage behaviour of this soil owing to fluctuating water content. In India, black cotton soil cover as high as 20% of the total land area. Because it's swell-shrinkage behaviour it is also called expansive soil. Expansive soil are considered to be unsafe with reference to safety of the structure in serviceability aspects, and needs to be tackled in a well engineered manner, if it should be used as a foundation soil. Several ground improvement and ground stabilisation techniques are in use to control the swelling potential of such soil. The use of Jute geotextile is a new and innovative solution, in which a geotextile material is used in expansive soil to stabilize it. The present study attempts to understand the effectiveness of Jute fibres in controlling swelling behaviour of black cotton soil measured in the laboratory with and without use of random reinforced jute fibres in the black cotton soil. The influence of one parameters of random reinforced jute fibres, via, its amount, on the measured reduction of swelling behaviour is systematically studied, under controlled conditions. The objective of this study is to propose an alternative method to control the swelling behaviour of the expansive soil. In the present study soil samples containing 0%, 1%, 2% to 5% of jute fibre were prepared and the shrinkage limit, optimum moisture content, maximum dry density, california bearing ratio and unconfined compressive strength were conducted as per relevant IS code of practise. The test results showed significance decrease in the expansive behaviour of the black cotton soil. The shrinkage limit increase from 8.66% to 14.68%.There is a remarkable increase in California bearing ratio and unconfined compressive strength test results. The C.B.R. value increased from 1.8% to 4.1% and unconfined compressive strength values increased from 1.09kg/cm^2 to 1.35kg/cm^2. If black cotton soil is blended with jute fibres from 0% to 5% by weight of black cotton soil.

Keywords: black cotton soil; stabilization; jute fibres; swelling behaviour.

Introduction

Soil improvement is of major concern in the construction activities due to rapid growth of urbanization and industrialisation. The term soil improvement is used for the techniques which improve the index properties and other engineering characteristic of expansive soils. Expansive soils are clay of high plasticity. They content essentially the clay mineral montmorillonite. The soils have high shrinkage and swelling characteristics. The shearing strength of the soils is extremely low. The soils are highly compressible and have very low bearing capacity. It is extremely difficult to work with such soils. These soils are residual deposits formed from basalt or trap rocks. The tendency of expansive soil to increase in volume due to infiltration of water is resisted by the structure resting on the soil and as a consequence, vertical swelling pressure is exerted on the structure. Swelling pressure develop if the soil is not allow to swell freely. The magnitude of swelling pressure depends on the degree of expansion permitted. If the swelling pressure exerted by soil is not controlled, it may cause uplift and distress in structure. The present study envisages the effect of jute fibres mixed in different proportion (up to 5% by weight of dry soil) on index properties and engineering characteristics of black cotton soil.

Experimental Programme

The black cotton soil used in the present investigation was collected from Bilheri area of Jabalpur.The particle size distribution curve of the soil is shown in fig.1.

In the present study jute thread is collected from grain market Jabalpur. The length of the jute fibre used in the study was approximately 5cms with aspect ratio 15-20.

The black cotton soil was blended with different percentage of jute thread. The mix specification are as under

CF0 - Clay with 0% jute fibres.

CF1 - Clay with 1% jute fibres.

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CF2 - Clay with 2% jute fibres.
CF3 - Clay with 3% jute fibres.
CF4 - Clay with 4% jute fibres
CF5 - Clay with 5% jute fibres

The consistency limits (liquid limit, plastic limit and shrinkage limit) tests were conducted as per IS: 2720 the differential free swell tests were also conducted as per IS 2720 (Part XL) 1977.

Results and Discussion

The test results are summarized in table 1.
Table 1- Test results of black cotton soil

Test Performed	**CF0**	**CF1**	**CF2**	**CF3**	**CF4**	**CF5**
1.Sieve Analysis(-75 micron size)(%)	88.732					
2.Hydrometer test	Well graded soil					
3.Liquid limit(%)	51.75					
4. Plastic limit(%)	24.85					
5. Shrinkage limit(%)	8.66	10.83	11.65	12.29	13.85	14.68
6. Differential free swell(%)	66.04					
7. Specific Gravity	2.60					
8.Optimum moisture content(%)	22.1	22.7	23.2	23.9	24.5	25.1
9.Maximum dry density(g/cc)	1.61	1.60	1.60	1.59	1.57	1.56
10.California bearing ratio(%)	1.8	2.2	2.7	3.1	3.6	4.1
11.Unconfined compressive strength(Kg/cm^2)	1.09	1.15	1.22	1.26	1.30	1.35

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Impact Factor: 1.852

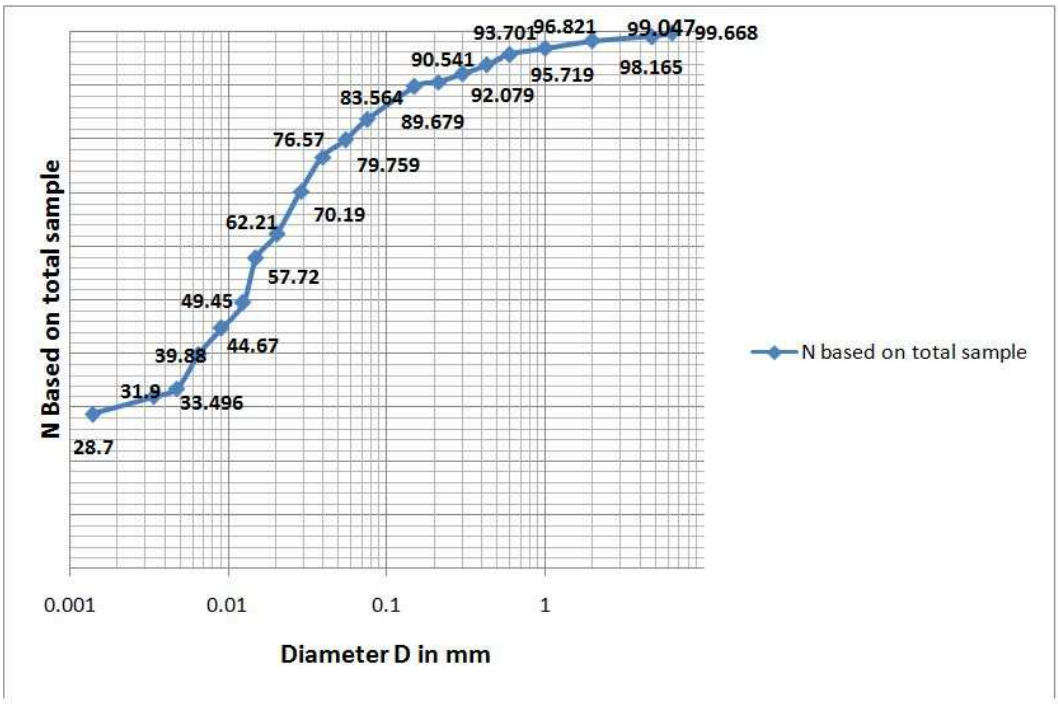

Fig.1 – Particle size distribution curve

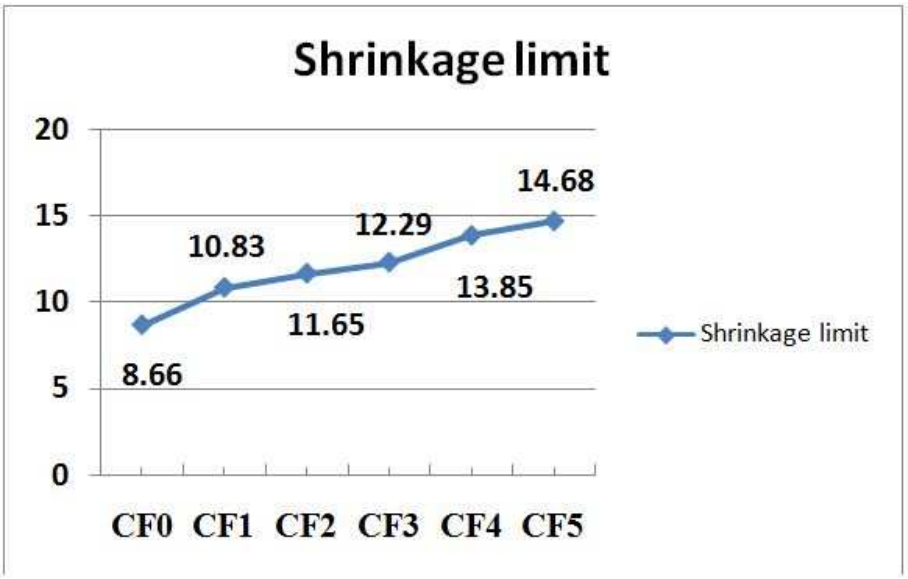

Fig. 2 – Variation in shrinkage limit

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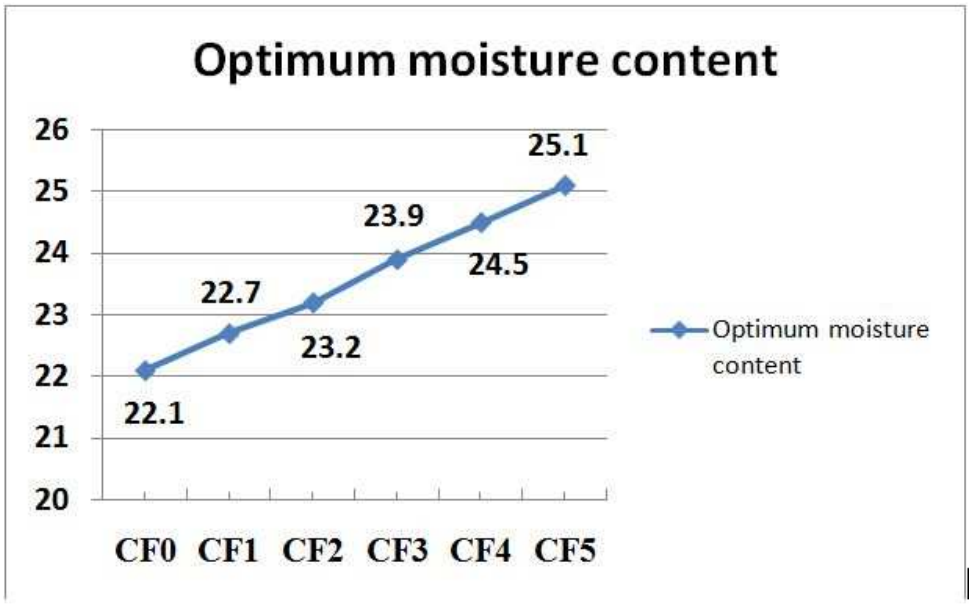

Fig. 3 – Variation in Optimum moisture content

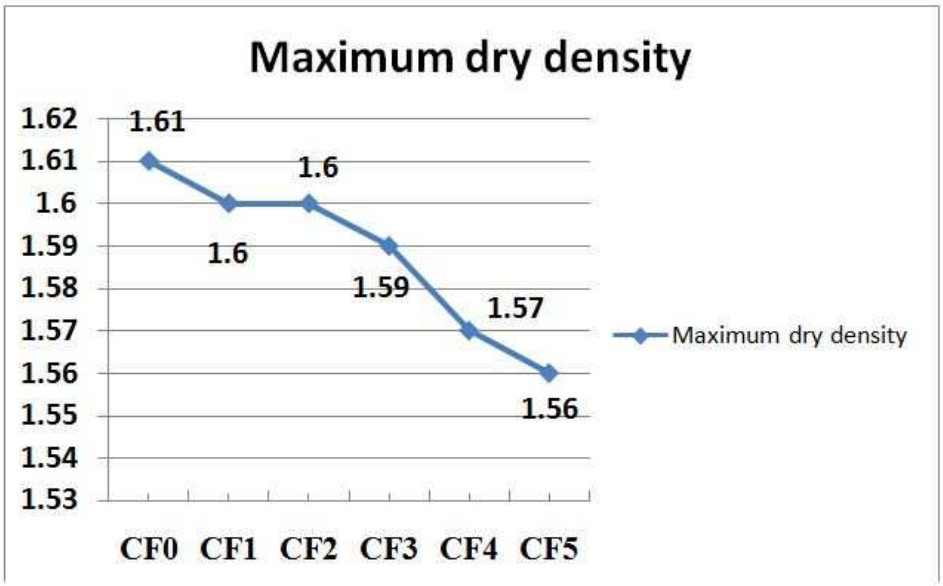

Fig. 4 – Variation of Maximum dry density

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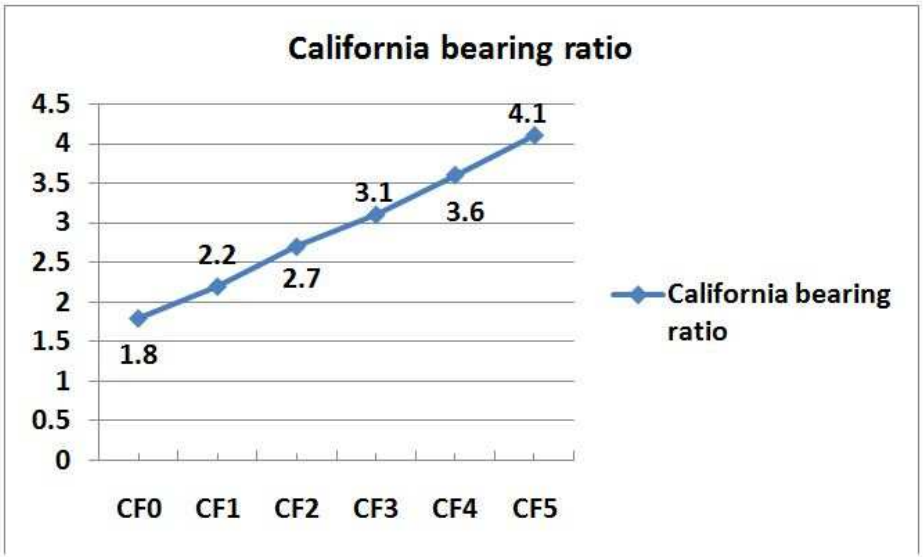

Fig. 5 – Variation in C.B.R. values

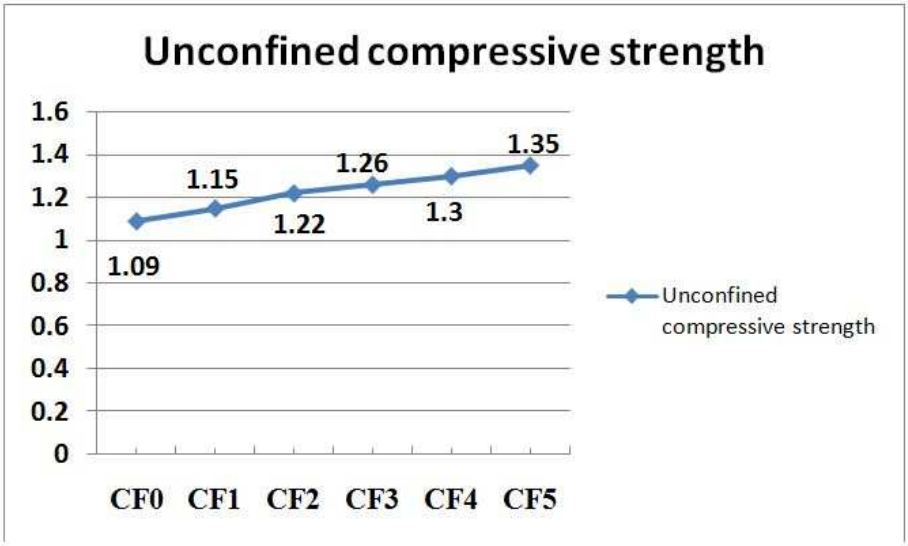

Fig. 6 – Variation in Unconfined compressive strength

Conclusions

From the series of tests conducted on Black Cotton soil mixed with lime and jute fibres, the following conclusions are drawn

1. With the increase in the jute fibres percentage the shrinkage limit values increases from 8.66% to 14.68% (fig.2)
2. The Optimum moisture content values increase from 22.1 to 25.1 and the Maximum dry density are also decreased from 1.61 to 1.56(fig.3 & fig.4).
3. There is significant increase in California bearing ratio and unconfined compressive strength values. The California bearing ratio increases from 1.8% to 4.1%and the unconfined compressive strength increases from 1.09kg/cm^2 to 1.35kg/cm^2.The variation is presented in figure 5 and 6.
4. From the test results it can be concluded that the addition of jute fibres to black cotton soil decreases its swelling behaviour and increase the C.B.R. and unconfined compressive strength properties.

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ISSN: 2277-9655
Impact Factor: 1.852

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