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STABILIZATION OF BLACK COTTON SOIL BY LIME AND POLYPROPYLENE FIBRES

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Abstract:- *A large part of Central India and a portion of South India are covered with black cotton soils. These soils have high swelling and shrinkage characteristics and extremely low CBR value. Hence, there is need for improvement of these properties. The practice of using reinforced earth has been well established in soil engineering profession. The concept of reinforcing soil masses with artificial fibers is a relatively new development to improve the properties of soil. The present study is aimed at determining the behavior of black cotton soil reinforced with polypropylene fiber in a random manner.*

This project describes the compaction and strength behavior of black cotton soil (BC soil) reinforced with polypropylene fibers. In order to increase the strength of the soil-polypropylene fiber combination, optimum percentage of 2% of lime is added. The soil used is a type of black cotton soil collected from collected at a depth of 2m below the ground level from Tikota which is 25 kms away from the Bijapur city. The fibers are available in different lengths (6mm, 12mm) and mixed randomly with soil in varying percentages (0.50%, 1.0%, 1.5%, 2.0%, 2.5%, and 3%) by dry weight of soil and compacted to maximum dry density at optimum moisture content. The test results indicate a reduction in the maximum dry density and increase in the optimum moisture content of soil due to the addition of polypropylene fiber. It also indicates an improvement in the CBR value of soil due to the addition of polypropylene fibers. BC soil treated with 2% lime and reinforced with polypropylene fiber shows ductility behavior before and after failure.

Keywords: *Black Cotton Soil, Polypropylene fibers, CBR test, Optimum fibers, Ductility*

1. INTRODUCTION

During the last 20years, the reinforcement of soil by high tensile strength materials has become a widespread technique in earthwork construction. Metal strips, plastic grids and fabrics have all been used to increase the tensile strength, shear resistance and stiffness of soils. Tensile strains due to flexure occur in earth structures like embankments, dams and multilayer pavements. Tensile stresses are induced in the sub grade soil of multilayer pavements under traffic loads when the deformation modulii differ in various layers. In earth rock fill dams, tensile failure could result in cracking of the clay core. A variety of inclusions ranging from low modulus polymeric materials to relatively stiff high strength metallic inclusions have been used to reinforce soils. Fiber reinforcement is significant in both nature and engineering practice. The basic principle of reinforced earth is demonstrated in nature by the action of the tree roots. Plant roots penetrating through soil contribute to the stability of natural slopes. An earth mass stabilized with discrete randomly distributed fibers resembles traditional earth reinforcement in many of its properties. Discrete fibers are simply added and mixed with soil much in the same way as lime, cement or other additives. One of the main advantages of randomly distributed fibers is the maintenance of strength isotropy and the absence of potential planes of weakness that can develop parallel to the oriented reinforcement. The concept of strengthening soil with added rods or fibers is not new, although a systematic study of reinforced earth started only very recently. In the past, there is evidence of man trying to improve the quality of bricks by adding straw. The practice of building houses on soil reinforced with natural fibers and constructing earth walls with different types of reinforcing inclusions are age old arts to the villagers in tropical Africa and Southern Asia. Rope fibers and bamboo strips were used to strengthen rural road bases. Vertically arranged rectangle grids of bamboo strips and stalks of palm branches were used as central core for mud walls. Such walls are more resistant to crack propagation than plain unreinforced mud walls. The objectives of the present study is to determine the reinforcing effect of randomly distributed, discrete polypropylene fibers in the black cotton soil collected from collected at a depth of 2m below the ground level from Tikota which is 25kms away from the Bijapur city. The study focuses on the effect of change of length and percentage fiber content on the engineering properties of compacted soil.

1.0 OBJECTIVES OF THE STUDY

An experimental program was undertaken to investigate the effects of short polypropylene fiber on the strength and mechanical behavior lime stabilized black cotton soil, the following are the objectives of our study:

- Determination of Dry density-Water content of BCS & BCS with Varied percentages of lime (1%, 2%, 3% and 4%.)
- Determination of Dry density-Water content of BCS with optimum percentage of lime content mixed with polypropylene fibers (0.5%,1%,1.5%,2%,2.5%,3%)by weight of soil. with fibers of length 6mm and 12mm.
- Determination of Un-soaked and Soaked CBR of BCS & BCS with 2% of lime.
- Determination of Un-soaked and Soaked CBR of BCS with optimum percentage of lime content varied with polypropylene fibers (0.5%,1%,1.5%,2%,2.5%,3%)by weight of soil. with fibers of length 6mm and 12mm.

2.0. MATERIALS USED

Various materials are used in geotechnical engineering field. Properties of these materials vary from place to place. Complete characterization of these materials in terms of their basic properties will be very much useful in understanding soil response to changes in stress levels and changing environmental conditions. Also, it is a thorough understanding of material. Properties are varying much essential for developing appropriate stabilization methods.
The material properties are classified into two parts, they are:

- Index properties
- Engineering properties

The index properties are those properties of soil, which are used in their identification and classification. Those properties include determination of:

- Water content
- Specific gravity
- Consistency limits

The materials used for project are

- B.C soil
- Lime
- Polyproplene fibers

BLACK COTTON SOIL:

Black cotton soil is also called as expansive soil or swelling soil. This soil is found in extensive regions of the Deccan. The name ‘Black cotton’ has an agricultural origin. Most of the soils are black in color and are good for growing cotton. Some of these soils have reddish brown and grey color. The soils are usually found near surface, with the layers thickness varying from 0.5mts to more than 10mts. These soils cover vast area of Maharashtra, Karnataka, Andhra Pradesh and Gujarat making 20% of the total area of the country. Similarly soils are also found in Burma, Australia, South Africa, Egypt and U.S. and Russia.

Black cotton soils are highly expansive, sticky, plastic clays formed from residual weathering of deposits derived from volcanic rocks. Most expansive soils have residual origin while some are found valleys and on river banks, apparently formed from fine grained transported deposits. These soils have great affinity towards moisture and are characterized by their high swelling and shrinkage.

On saturation these soil becomes very weak and unstable and have very low bearing capacities. Foundations loading of saturated soils develop high pore pressure owing to their imperviousness. Like other soft clays, black cotton soil has very high compressibility. If swelling of soil is prevented by confinement, high internal pressure known as swelling pressure develop. If the swelling pressure exceeds the loading pressure, instability of the structure is the result. Black cotton soils are found usually in partly saturated (dry) state near the ground surf with water content ranging from 20% to 40%. In the dry conditions, the soil appears very still and show hair cracks and fissures, as would be seen in over consolidated clays. On saturation, these soils soften to a large degree. Saturation moisture content of these soils is closer to plastic limit to liquid limit, confirming to the over consolidated character. The over consolidated may be the result of desiccation or water table fluctuation.

LIME

In the last few decades attention has increasingly been paid to promoting the use of abundantly available lime for use in geotechnical engineering. One of the main properties of lime is its pozzolanic reactivity and it is this which renders it, suitable for most of its suitability for most of its applications. The pozzolanic reactivity of lime is due to reactive silica content. Recently, techniques have been developed to optimize the amount of lime added to achieve good strength and economy.

However, the strength gain depends mainly on its reactive silica content, and the addition of lime can improve this strength only up to a certain degree. Lime has proved to be very effective and economical for stabilizing the expansive soil. The addition of lime increases the strength of stabilized expansive soil. Also with addition of this additive the compressibility and permeability characteristics also improved. The low permeability of the expansive soil is mainly due to the finer particles. Hence by the addition of lime the finer soil particles grow to larger one and voids also become larger in size leading to the greater permeability of the lime stabilized expansive soil.

POLYPROPYLENE FIBERS

Polypropylene (PP), also known as **polypropene**, is a thermoplastic polymerused in a wide variety of applications including packaging and labeling, textiles(e.g., ropes, thermal underwear and carpets), stationery, plastic parts and reusable containers of various types, laboratory equipment, loudspeakers, automotive components, and polymer banknotes. An addition polymer made from the monomer propylene, it is rugged and unusually resistant to many chemical solvents, bases and acids

Most commercial polypropylene is isotactic and has an intermediate level of crystallinity between that of low-density polyethylene (LDPE) and high-density polyethylene (HDPE). Polypropylene is normally tough and flexible, especially when copolymerized with ethylene. This allows polypropylene to be used as an engineering plastic, competing with materials such as ABS. Polypropylene is reasonably economical, and can be made translucent when uncolored but is not as readily made transparent as polystyrene, acrylic, or certain other plastics. It is often opaque or colored using pigments. Polypropylene has good resistance to fatigue. The melting point of polypropylene occurs at a range, so a melting point is determined by finding the highest temperature of a differential scanning calorimetry chart. Perfectly isotactic PP has a melting point of 171 °C (340 °F). Commercial isotactic PP has a melting point that ranges from 160 to 166 °C (320 to 331 °F), depending on atactic material and crystallinity. Syndiotactic PP with a crystallinity of 30% has a melting point of 130 °C (266 °F).[2] The melt flow rate (MFR) ormelt flow index (MFI) is a measure of molecular weight of polypropylene. The measure helps to determine how easily the molten raw material will flow during processing. Polypropylene with higher MFR will fill the plastic mold more easily during the injection or blow-molding production process. As the melt flow increases, however, some physical properties, like impact strength, will decrease. There are three general types of polypropylene: homopolymer, random copolymer, and block copolymer. The comonomer is typically used with ethylene. Ethylene-propylene rubber or EPDM added to polypropylene homopolymer increases its low temperature impact strength. Randomly polymerized ethylene monomer added to polypropylene homopolymer decreases the polymer crystallinity and makes the polymer more transparent

3.0 PENETRATION RESISTANCE OF BC SOIL WITH LIME AND FIBERS

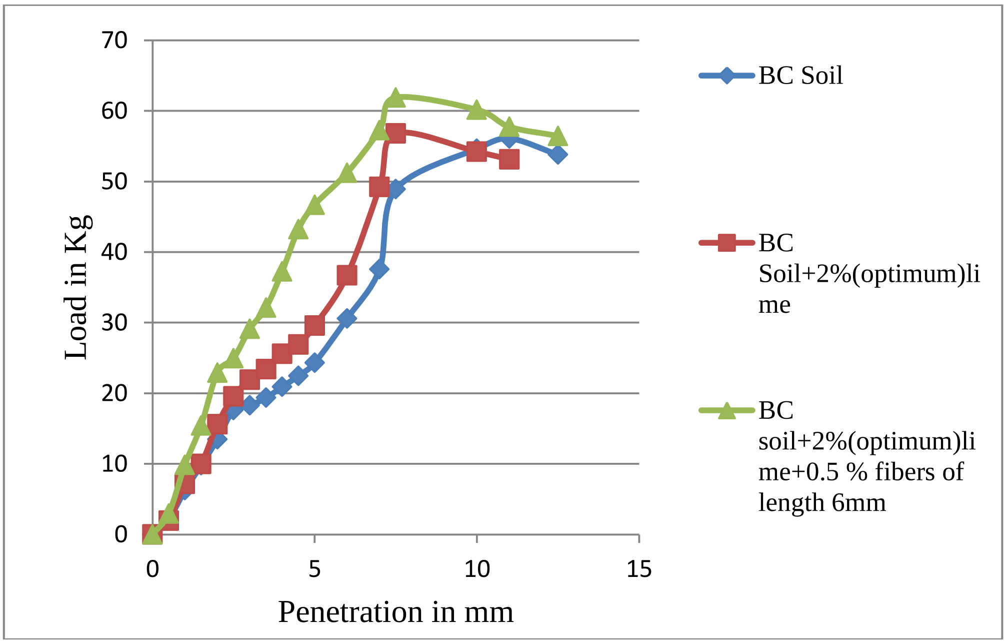
The experimental study involved performing a series of laboratory CBR tests on the unreinforced and randomly distributed fiber reinforced soil specimens with optimum percentage of lime.

3.1 CALIFORNIA BEARING RATIO

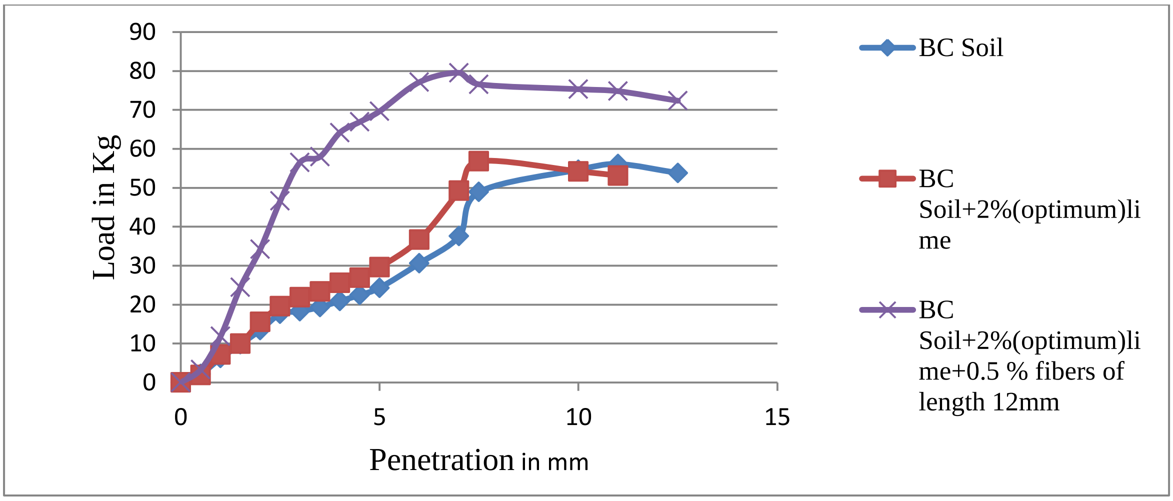
California bearing ratio test originally developed by California Division of Highways, is one of the most commonly used method to evaluate the strength of sub grade soil for design of pavement thickness. CBR value as defined by IS 2720 (Part XVI) – 1979 is the ratio of the force per unit area required to penetrate a soil mass with a circular plunger of 50 mm diameter at the rate of 1.25 mm per minute, to that required for corresponding penetration of a standard material. Standard load is that load which has been obtained from tests on a crushed stone whose CBR value is taken to be 100 %. The ratio is usually determined for penetration of 2.5 mm & 5.0 mm. The results of this test cannot be related accurately with fundamental properties of the material but are useful in the design of flexible pavements.

LOAD PENETRATION CURVES

CBR UNSOAKED

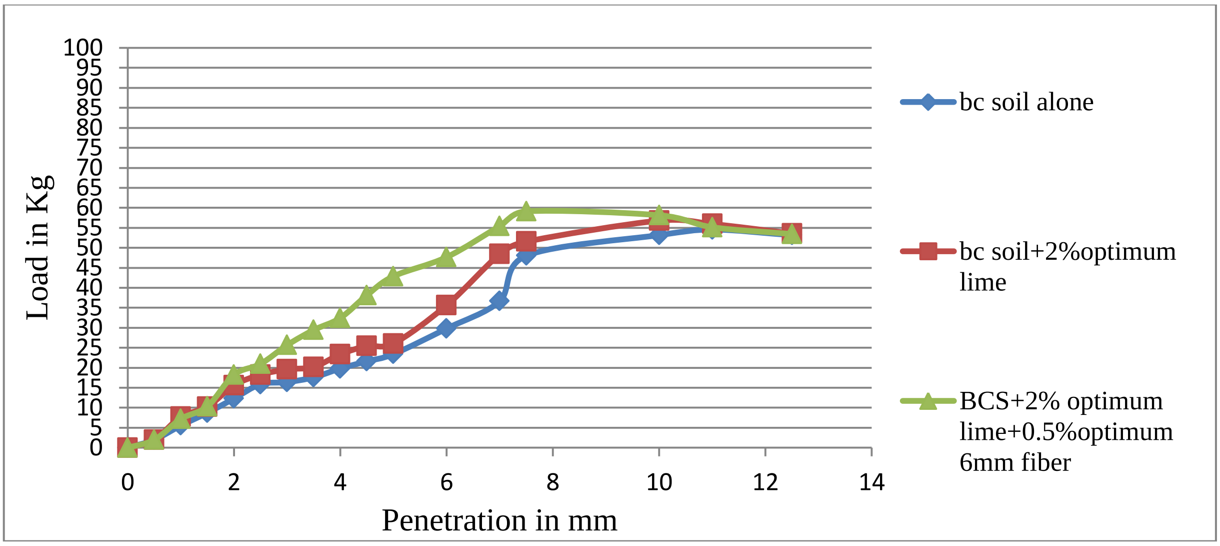


3.1 Load-penetration curves (unsoaked) for BCS + 2% optimum Lime + 0.5 % fibers of length 6mm.

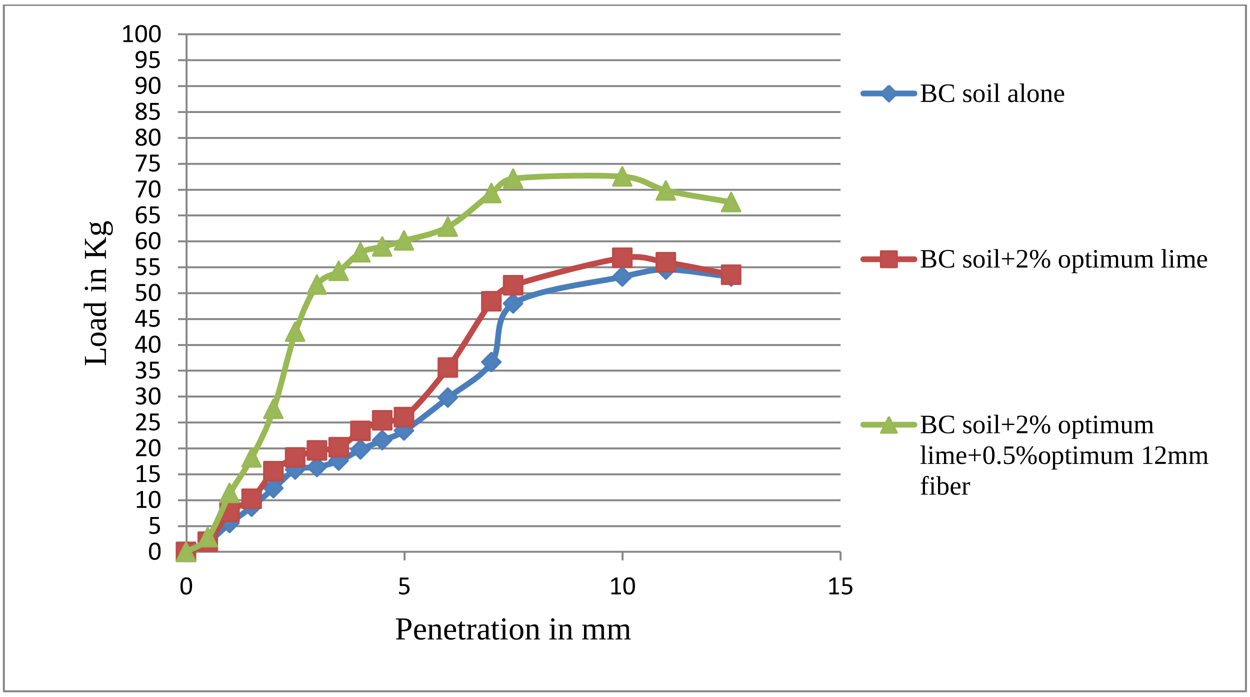


3.2 penetration curves (unsoaked) for BCS + 2% optimum Lime + 0.5 % fibers of length 12mm.

CBR SOAKED

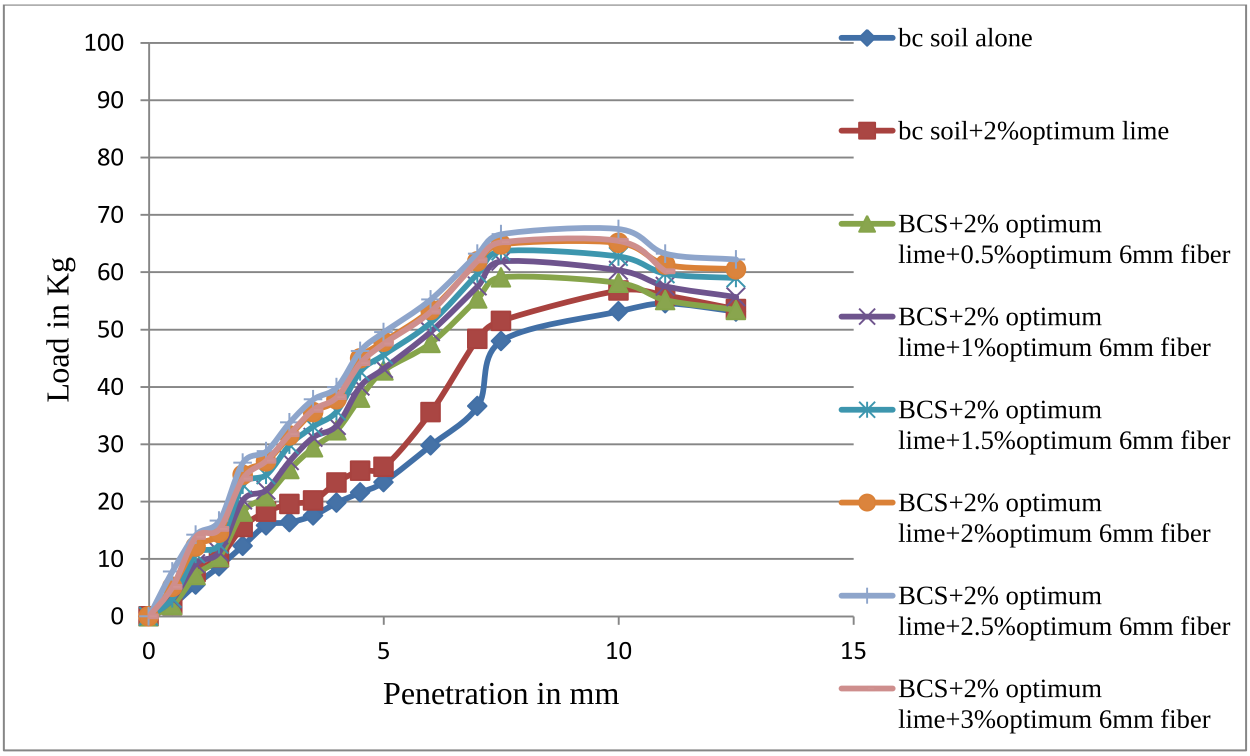


3.3 Load-penetration curves (soaked) for BCS + 2% optimum Lime + 0.5 % fibers of length 6mm.

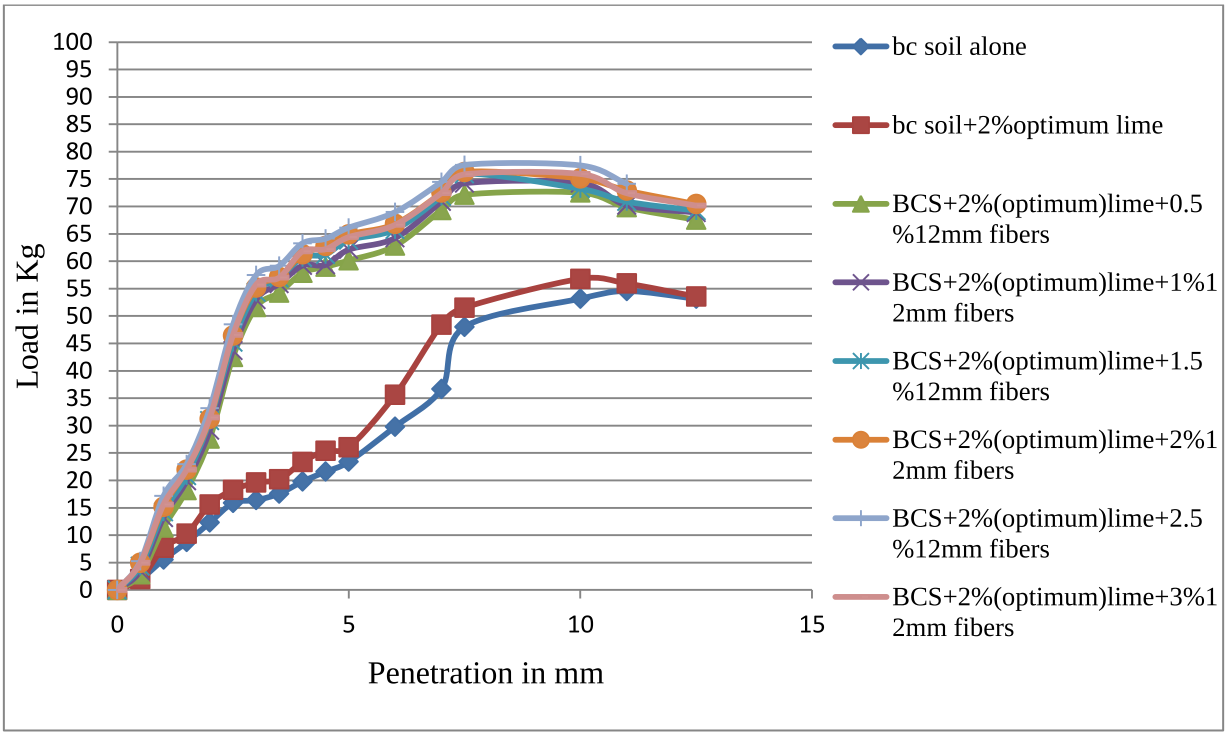


3.4 Load-penetration curves (soaked) for BCS + 2% optimum Lime + 0.5 % fibers of length 12mm.

CBR SOAKED



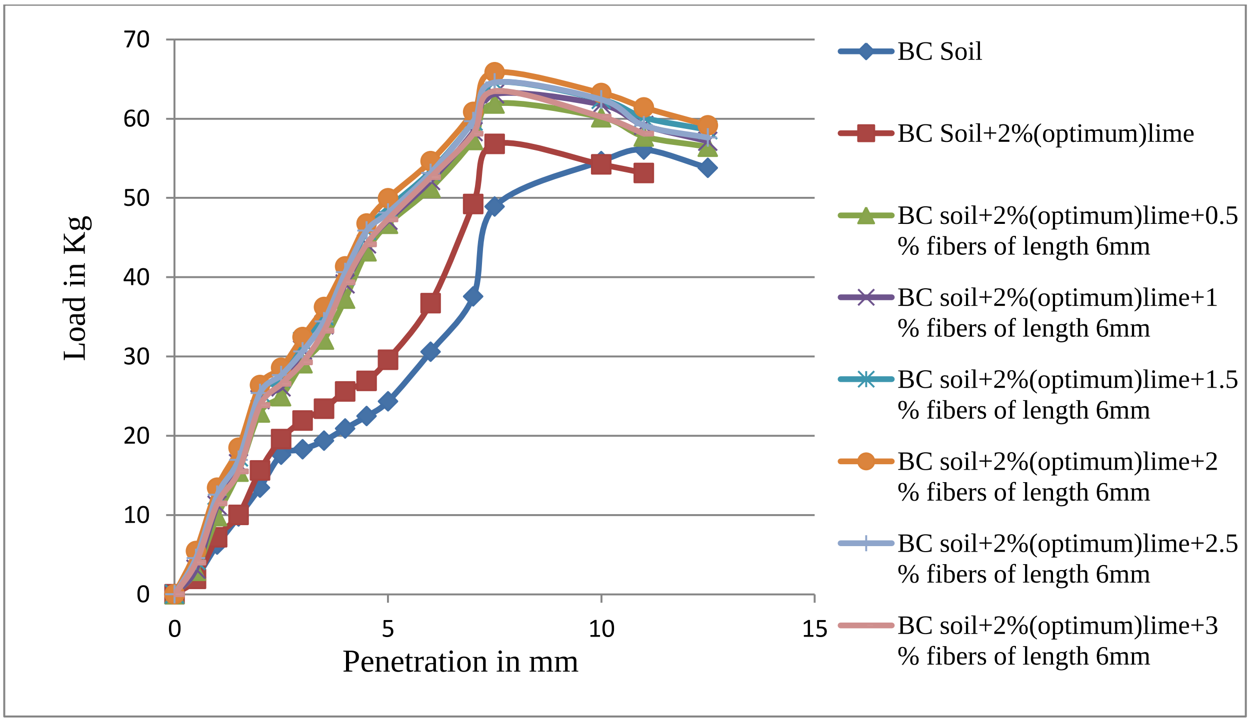
3.5 Load-penetration curves (soaked) for BCS + 2% optimum Lime + varied percentage fibers of length 6mm.



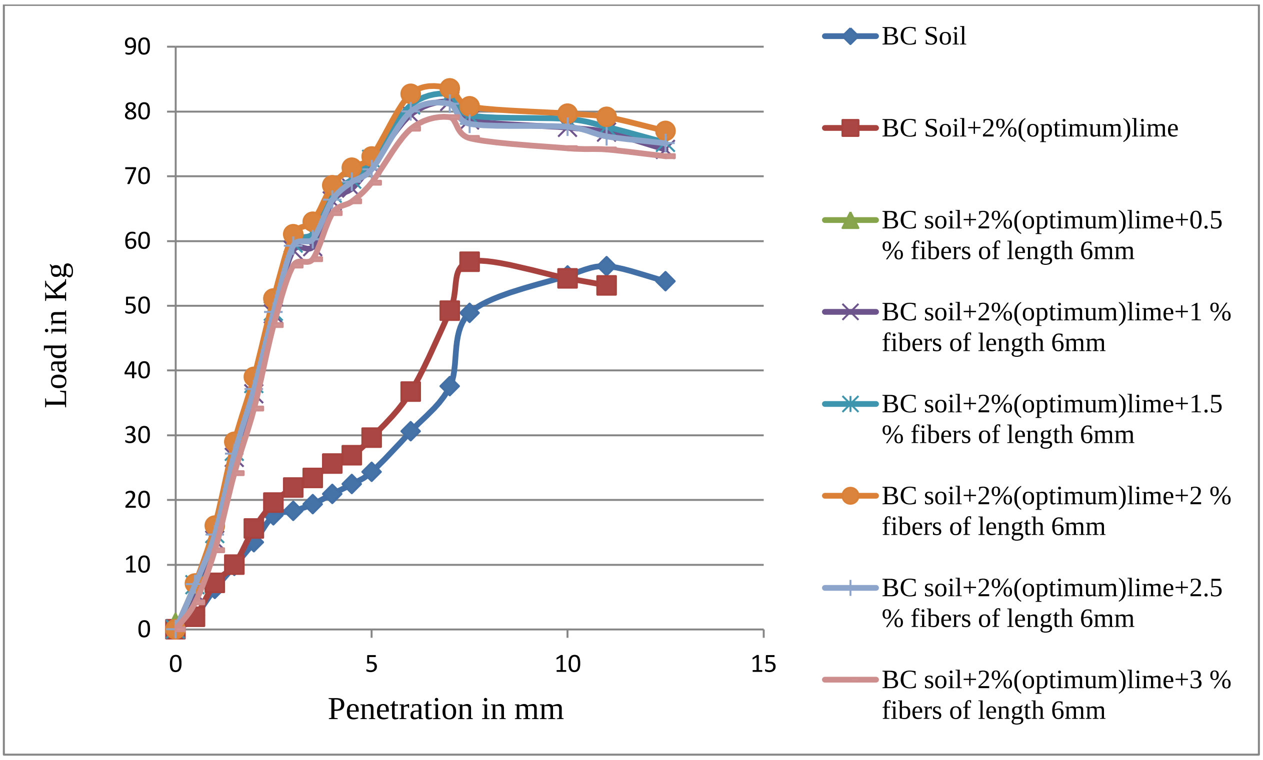
3.6 Load-penetration curves (soaked) for BCS + 2% optimum Lime + varied percentage fibers of length 12mm.

The figure 3.5 and 3.6 shows that load increases with addition of 2% optimum lime and different percentage of fiber of 6mm and 12mm length upto certain limit beyond that load decreases.with corresponding penetration value also increases upto certain limit beyond that penetration value decreases.

CBR UNSOAKED



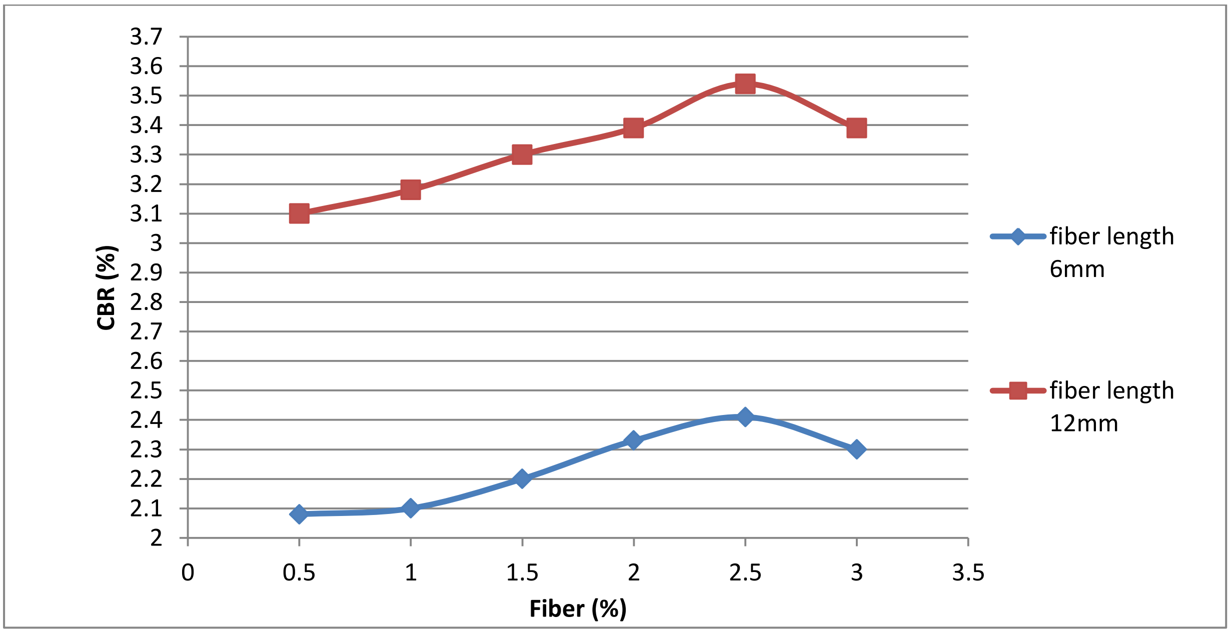
3.7 Load-penetration curves (unsoaked) for BCS + 2% optimum Lime + varied percentage fibers of length 6mm.



3.8 Load-penetration curves (unsoaked) for BCS + 2% optimum Lime + varied percentage fibers of length 12mm.

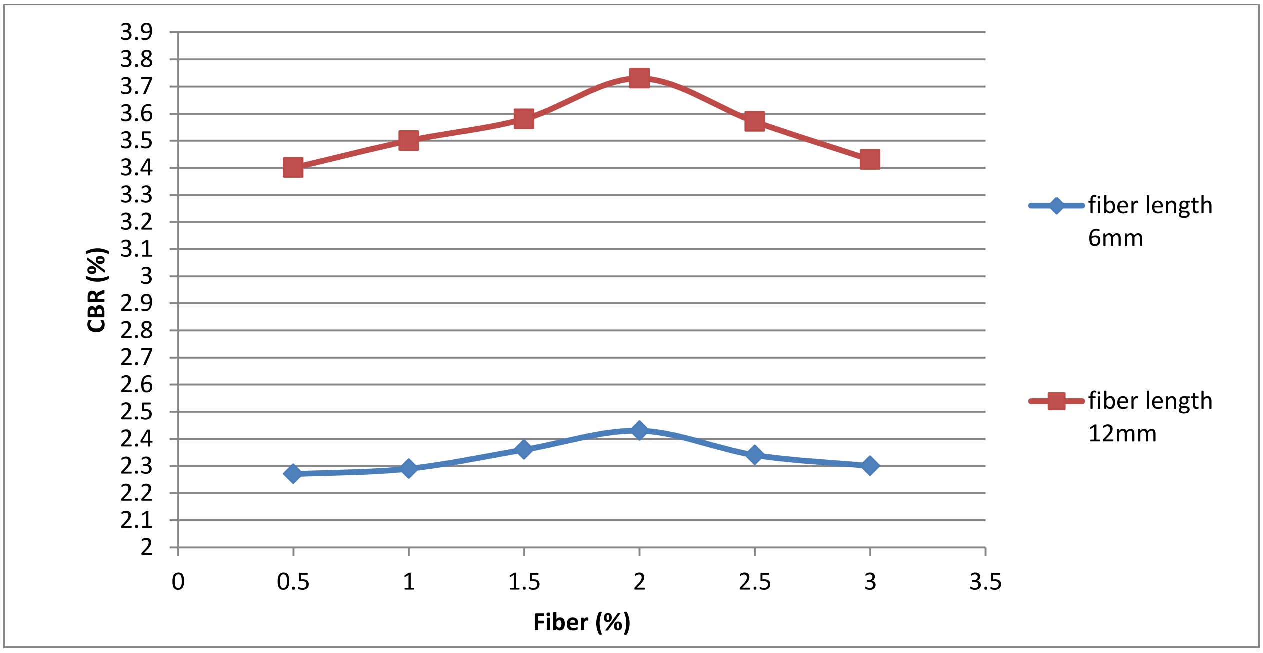
The figure 3.7 and 3.8 shows that load increases with addition of 2% optimum lime and different percentage of fiber of 6mm and 12mm length upto certain limit beyond that load decreases.with corresponding penetration value also increases upto certain limit beyond that penetration value decreases

CBR Soaked



3.9 Influence of Fiber content on CBR value of reinforced BC soil

CBR Soaked



3.10 Influence of Fiber content on CBR value of reinforced BC soil

RESULTS

Expansive Soil @ 2.5mm penetration

Table 3.4

Expansive soil	Soaked(4 days)	Un-soaked
CBR in %	1.15	1.28

Expansive Soil using lime @ 2.5mm penetration.

EXPANSIVE SOIL+ 2% LIME	CBR in %	
	Soaked (4 DAYS)	Un soaked
CBR in %	1.33	1.42

Table 3.5

Black cotton Soil using lime and fiber @ 5mm penetration.

Table 3.6

Black cotton soil using 2% lime and varied percentage fiber	CBR Value in %			
	Soaked (4 days) 6mm length of fiber	Soaked (4days)12mm length of fiber	Unsoaked (4 days) 6mm length of fiber	Unsoaked (4days)12mm length of fiber
0.5%	2.08	3.10	2.27	3.40
1.0%	2.10	3.18	2.29	3.50
1.5%	2.20	3.30	2.36	3.58
2.0%	2.33	3.39	2.43	3.73
2.5%	2.41	3.54	2.34	3.57
3.0%	2.30	3.39	2.30	3.43

CONCLUSIONS

Based on the results presented above, the following conclusions are drawn:

1. The MDD of BC soil increases with the addition of lime with corresponding increase in OMC. The addition between the water and soil particles increases with the increase in lime content up to 2%. With the further addition of lime beyond 2% MDD reduces and OMC increases.
2. Addition of optimum percentage of lime to BC soil increases the strength and the sample become brittle with curing. Addition of 0.5% of fiber of 6mm length and 0.5% fiber of 12mm length increases the dry density of B.C soil compared with other varied percentage of fiber combinations.
3. The addition of randomly distributed polypropylene fiber to B.C soil with different percentages and different length reduces MDD and increases OMC up to some extent. The B.C soil mixed with optimum percentage of lime and 0.5% of fiber of 6mm and 12mm length shows maximum value of MDD
4. The soil mixed with 2% (optimum) and 0.5% of fiber of length 6mm shows higher maximum dry density as compared to soil mixed with lime 2%(optimum)and 0.5% of fiber of length 12mm
5. The bearing resistance of specimens is found to increase with the fiber content. however the rate of increase of strength with fiber content is not uniform. At low strain levels the bearing resistance is found to remain almost constant with fiber content.
6. Randomly oriented discrete inclusions incorporated into granular materials improve its load deformation behavior by interacting with the soil particles mechanically through surface friction and also by interlocking.
7. The soil mixed with 2%(optimum) and fiber of length 6mm & 12mm shows higher CBR value compare to the BC soil with 2% (optimum) lime CBR value.
8. The addition of varied percentage of fibers with optimum lime content to BC soil showed that for 6mm & 12mm length fiber the 2.5% fibers added fibers gave higher CBR value for soaked CBR test and 2% fibers added fibers gave higher CBR value for unsoaked CBR test.

9.soil mixed with 2% optimum lime and fiber of length 12mm shows higher CBR value as compare to 6mm fibers.

REFERENCES

1. Arvind Kumar; Baljit Singh Walia; and Asheet Bajaj (March-2007) “Influence of Fly Ash, Lime, and Polyester Fibers on Compaction and Strength Properties of Expansive Soil”-ASCE,242-248.
2. G. L. Sivakumar Babu and A. K. Vasudevan “Strength and Stiffness Response of Polypropylene Fiber-Reinforced Tropical Soil” Journal Of Materials In Civil Engineering -ASCE / September 2008 / 571-577. .
3. Broms, B.B. (1984), “Lime columns, a new foundation methods”, Geotech. Eng. J. - ASCE, 105, 535-534.
4. BIS 2720 (Part VII) (1980), Method of tests for Soils-Part 7, “Determination of water content-dry density relation using light compaction”, Second Revision, New Delhi.
5. Gosavi, M., Patil, K.A., Mittal, S. and Saran, S. (2004), “Improvement of properties of black cotton soil subgrade through synthetic reinforcement”, IE(I) J, 84, 257-262.
6. Punmia B.C. 2007, “Soil Mechanics & Foundations” Laxmi Publications
7. IS 2720(III/SEC-I): 1980 Methods of Test for Soils, Determination of specific gravity.
8. IS 2720(VII):1980 Methods of Test for Soils, Determination of water content dry density relation using light compaction.
9. IS: 2720(Part 2), 1973 Methods of Test for Soils, Determination of water content.
10. Ground Improvement Techniques, December 18, 2008 [online] Available at: < http://www.engineeringcivil.com >
11. Anitha,S.,(1995), “A Study on Effective Strength Parameters of Fibre Reinforced Compacted Soil”, M Tech Thesis, University of Kerala,Trivandrum.
12. Dean,R.F.,(1986), “Soil Randomly Reinforced with Fibres”, *Journal of Geotechnical Engineering*, ASCE, Vol. 112, No. 8, pp. 823-826.
13. Gopal,R.,Charan,H.D.,(1998), “Randomly Distributed Fibre Reinforced Soil-A State of the Art Technology”, *Journal of Institute of Engineering*, Vol. 74, pp. 91-94.
14. Roy,M.,(1999), “A Study on the Penetration Resistance of Fibre Reinforced Compacted Soils”, M.Tech.Thesis, University of Kerala, Trivandrum.

