Analysis of Soil Stabilization Using Geosynthetic Material(Cane Fibers)

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Abstract- *Use of natural fibre in civil engineering for improving soil properties is advantageous because they are cheap, locally available, biodegradable and eco-friendly. The natural fiber reinforcement causes significant improvement in tensile strength, shear strength, and other engineering properties of the soil. Over the last decade the use of randomly distributed natural and synthetic fiber has recorded a tremendous increase. In this study the soil samples were prepared at its maximum dry density corresponding to its optimum moisture content in the CBR mould with and without reinforcement. The percentage of cane fiber by dry weight of soil was taken as 0.25%, 0.5%, 0.75% and 1%. The laboratory CBR values of soil and soil reinforced with cane fiber were determined. Tests result indicates that CBR value of soil increases with the increase in fiber content. Thus there is significant increase in CBR value of soil reinforced with cane fiber and this increase in CBR value will substantially reduce the thickness of pavement subgrade.*

Keywords- Cane fiber, Geosynthetic, Natural fiber.

I. INTRODUCTION

In developing countries like India the biggest challenge is to provide a complete network of road system with limited finances available, particularly in providing connectivity to remote villages. The cost of road construction using conventional construction materials and methods has been increasing by leaps and bounds year after year. Therefore there is a need to resort to one of the low cost road construction methods by effectively utilizing locally available materials and adopting soil stabilization techniques.

Stabiliasation, in a broad sense, incorporates the various methods employed for modifying the properties of a soil to improve its engineering performance. Stabilisation is being used for a variety of engineering works, the most common application being the construction of road and air-field pavements, where the main objective is to increase the strength or stability of a soil and to reduce the construction cost by making best use of locally available materials.

In present investigation, properties of Black Cotton soil and Local soil with Cane Fiber i.e percentage of Cane fiber by weight 0.25%,0.5%,0.75% & 1% were investigated.

II. EXPERIMENTAL INVESTIGATION

2.1 Materials and Method

- The Standard Proctor Test is conducted to study the density of soil and its corresponding optimum moisture content. Compaction of soil is a mechanical process by which the soil particles are constrained to be packed more closely together by reducing the air voids. Soil compaction causes decrease in air voids and consequently an increase in dry density. This may result in increase in shearing strength.
- The shear strength of the soil is determined by conducting unconfined compression test. Unconfined compression tests are carried out on cohesive soil specimen. The test may be considered as a special case of the tri axial compression test when the lateral confining pressure σ3 is equal to 0. Therefore, the cylindrical test specimen may be directly placed in a compression testing machine and the compressive load applied.
- The CBR test denotes a measure of resistance to penetration of a soil or flexible pavement material, of standard plunger under controlled test conditions. The method combines a load penetration test performed in the laboratory or in-situ with the empirical design charts to determine the thickness of pavement and of its constituent layers. This is probably the most widely used method for the design of flexible pavement.

2.2 Testing of Black Cotton Soil and Local Soil reinforced with cane fibers

After the curing period is completed, the specimens are tested for the following tests:

a) Standard Proctor Test :The Black Cotton soil and Local soil are tested for Maximum Dry Density and Optimum Moisture Content with different percentage of Cane fibers as per IS:2720(Part-20) –1992.

b) Unconfined Compression Test : The Black Cotton soil and Local soil are tested for Maximum Axial Stress with different percentage of Cane fibers as per IS:2720(Part-10) –1991.

c) California Bearing Ratio Test: The Black Cotton soil and Local soil are tested for CBR value with different percentage of Cane fibers as per IS:2720(Part-16) – 1987.

III. LITERATURE REVIEW

[1] **Tonmoy Kumar Brahmachary and Md.Rokonuzzaman** studied investigation of random inclusion of Bamboo Fiber on ordinary soil and its effect on CBR value.Various index properties of soil such as moisture content, specific gravity,Atterberg's limits, plasticity index, shrinkage ratio, grain size distribution, pH were determined. Standard Proctor Compaction tests were carried out to determine the OMC and MDD of soil sample.CBR test value for unsoaked and soaked environments were ascertained for normal soil and reinforced soil for different proportions of bamboo fiber such as 0.2, 0.4, 0.6, 0.8, 1.0, 1.2, 1.4% by waterless weight of ordinary soil. Based on the investigation and study they concluded that CBR value increases with increase in bamboo fiber length and diameter. Also CBR test beyond 1.2% of bamboo fiber dosage is not feasible and optimal proportion of bamboo fiber is found 1.2% by waterless weight of ordinary soil.

[2**] Dipika Devi and Boken Jempen**, , studied Shear Strength Behaviour of Bamboo Fiber Reinforced Soil. Their objectives were to study & compare experiment results i.e. shear strength parameters (C and φ) of soil alone and the Bamboo fiber reinforced soil. The shear strength parameter of the soil are determined by Direct Shear Test. All the samples of the soil (both unreinforced and reinforced) are tested at low strain rate so that the tests can simulate drained condition. The three different normal stresses applied for each set of tests are: 0.5 kg/cm2, 1 kg/cm2, 1.5 kg/cm2. The percentage of the bamboo fiber used for the study are 1%, 2%, 3%, 4% and 5% by weight of the soil. The water content and density of the soil was maintain as 13% and 18 kN/m2 (near to OMC and MDD). It can be drawn from the results that inclusion of the fiber content in the soil increases the values of shear strength parameters. The increase in length of fiber also increases the shear strength parameters. It is observed that shear strength parameters start falling beyond 4% of fiber content. As only two particular length of the fiber is considered in the study, to draw a conclusion of optimum percentage of fiber with an optimum length, extensive study is to be done and can be a future scope of study.

[3] **Md Asaduzzaman and Muhammad Iftiarul Islam**, studied Soil Improvement By Using Bamboo Reinforcement after determining the soil properties, the soil sample was placed for CBR test. Bamboo reinforcement having 0.5 inch diameter and 12 inch long was placed into the soil at different depth. The bamboos were horizontally spaced at 1.75 inch interval to each. Density/degree of compaction was ensured by Standard Proctor Test. This experiment was performed for different dimensions of footing with different layer system of bamboo reinforcement. The layer systems were- single layer system, two layer system, three layer system of bamboo reinforcement. And the footing sizes were- 3 inch x 3 inch, 3.5 inch x 3.5 inch, 4 inch x 4 inch. The load bearing capacity of soil increases when the bamboo reinforcement placed within the depth of failure envelope. The load bearing capacity is increased up to 1.77 times for single layer reinforced soil and 2.02 times for multiple layer reinforced soil system than the load bearing capacity of unreinforced condition of soil.

[4] **H.P.Singh and M.Bagra** studied improvement in CBR value of soil reinforced with jute fiber. The reinforcing material used in this study is natural jute fiber of diameters 1 mm and 2 mm. The length of fiber corresponding to each diameter of fiber was taken as 30mm, 60mm and 90 mm. Fiber is added by weight i.e.0.25%,0.5%,.75% and 1% of dry soil. It is clear from the test results that CBR value of soil reinforced with Jute fiber increases with the increase in fiber diameter. It is observed that CBR value of soil reinforced with same fiber content and same fiber diameter increases with increase in length of fiber. It is observed that CBR value of soil increases as the fiber content increases. This aspect can be observed for all fiber lengths (30mm, 60mm and 90mm) and fiber diameters (1mm and 2mm). It was also found that preparation of identical soil samples for CBR test beyond 1% of fiber content is not possible and optimum fiber content was found to be 1 % by dry weight of soil.

[5] **J.N.Jha, A.K.Choudhary and K.S.Gill** studied bearing capacity improvement using bamboo micropiles. Three dimensional model-footing tests were performed in a well stiffened square wooden box 1000 mm x 1000 mm x 1000 mm. The sides of the box were braced with stiffeners to avoid lateral yielding during soil placement and loading of the model foundation. The loading system is mounted by a horizontal I steel beam supported on two columns which consist of hand operated hydraulic jack and precalibrated load ring. The specific gravity of soil was determined by pycnometer method which was 2.671. The maximum and minimum dry density of

sand were found to be 19.87 and 16.26 KN/m^3 and the corresponding values of minimum and maximum void ratios are 0.344 and 0.641 respectively. Plots between pressure and settlement were drawn for different cases and ultimate loads at failure were determined using double tangent method. It can be observed from the curves that bearing capacity ratio decreases with increase in spacing of reinforcing elements and vice versa. The increase in bearing capacity of footing is due to the interruption of the reinforcing elements to the failure planes. Increasing the length of reinforcing element results in increasing the embedded part of reinforcements in the stable underlying soil, leading to greater resistance to the lateral movement of soil under footing. In cases where structures are very sensitive to settlements, soil confinements by vertical reinforcements laterally around the footing can be used to obtain the same allowable bearing pressure at a much lower settlement.

IV. RESULT

Unconfined Compression test, Standard proctor test and CBR tests were conducted with different percentage of cane fibers. The results obtained are shown below

Table 1: Unconfined compression test, Standard Proctor test and California Bearing Ratio test result for Black Cotton Soil.

Type of Soil	Percentage of Cane Fiber(By weight)	Unconfined Compression Test(Mpa)	Standard Proctor Test	California Bearing Ratio Test
Black Cotton Soil	0	0.735	OMC=17.64% MDD=1.47g/cc	2.5 mm penetration=2.48% 5 mm penetration=2.33%
Black Cotton Soil	0.25	0.0621	OMC=15.18% MDD=1.45g/cc	2.5 mm penetration=3.43% 5 mm penetration=2.99%
Black Cotton Soil	0.50	0.0985	OMC=17.18% MDD=1.44g/cc	2.5 mm penetration=3.97% 5 mm penetration=3.73%
Black Cotton Soil	0.75	0.0680	OMC=18.99% MDD=1.54g/cc	2.5 mm penetration=5.65% 5 mm penetration=5.08%
Black Cotton Soil	1.0	0.0650	OMC=16.94% MDD=1.37g/cc	2.5 mm penetration=4% 5 mm penetration=3.90%
Local Soil	0	0.0567	OMC=17.64% MDD=1.47g/cc	2.5 mm penetration=4% 5 mm penetration=3.90%
Local Soil	0.25	0.0720	OMC=17.64% MDD=1.47g/cc	2.5 mm penetration=4% 5 mm penetration=3.90%
Local Soil	0.5	0.0938	OMC=17.64% MDD=1.47g/cc	2.5 mm penetration=4% 5 mm penetration=3.90%
Local Soil	0.75	0.0961	OMC=17.64% MDD=1.47g/cc	2.5 mm penetration=4% 5 mm penetration=3.90%
Local Soil	1.0	0.1037	OMC=17.64% MDD=1.47g/cc	2.5 mm penetration=4% 5 mm penetration=3.90%

V. CONCLUSION

1. There is substantial increase in MDD with increase in addition of fibers up to 0.75% by weight beyond which it decreased.
2. There is substantial decrease in OMC with increase in addition of fibers.
3. In unconfined compression test it was observed that the shear strength of the soil has increased with the increase in percentage of cane fibers, when compared to that of shear strength of soil tested without fiber.
4. The shear strength of the soil is maximum when 1%(by weight of soil) of cane fibers is added to it. Hence in order to obtain higher shear resistance 1% of fibers (by weight of soil) can be considered as the optimum fiber content.
5. The California bearing ratio (CBR) of the soil alone is obtained as 1.82% and it increased to 5.41% after stabilizing it with optimum percentage of cane fibers.
6. The percentage increase in CBR value after stabilizing it with optimum percentage of fibers is 197.25%.
7. In the case of local soil there is substantial increase in MDD with increase in addition of fibers.
8. .In unconfined compression test it was observed that the shear strength of the soil has decreased with the increase in percentage of cane fibers, when compared to that of shear strength of soil tested without fiber.
9. The California bearing ratio (CBR) of the soil alone is obtained as 4.28% and there substantial increase in CBR value with addition of fibers.

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