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EFFECT OF RANDOM MIXING OF NATURAL FIBERS WITH CLAYEY SOIL

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Abstract – *For the infrastructure development in India large-scale constructional activities of roads are becoming very essential. To meet this demand of construction of sub-grade in flexible road, the requirement of fill material is enormous but in many situations available soils near construction sites are found to be weak in strength and of high compressibility. Such soils need addition of some strengthening elements to increase the strength and to reduce the compressibility of clayey soil. Natural fibers like sugarcane, hemp, sabai grass etc. can be used as additive material mix with soil to fit for use as required strength of sub grade. The fibers added randomly with clayey soil in the construction of subgrade are expected to provide better compact interlocking system between the natural fibers and the soil system. The main advantage of mixing such fibers is that these are natural, eco-friendly, cheap and are in abundance in India. A series of standard Proctor test and unsoaked California Bearing Ratio (CBR) tests are done for locally available clayey soil mixed with various length and proportion of natural sugarcane, hemp, sabai grass fibers with the aim of identifying the percentages (by dry weight of soil) and length of the natural fibers causing optimum improvisation of soil-fiber mix composite used. This paper highlights the improvement of compaction and strength characteristics of clayey soils with inclusion of randomly distributed different types of natural fibers.*

Key Words: **Natural fibers[1], Eco-friendly[2], sub-grade[3], California Bearing Ratio[4] and interlocking system[5].**

1. INTRODUCTION

In present era, huge amount of roads are constructed in many parts of world. If the soil near the construction site is very poor, this cannot meet the cost effective road construction. For that proper stabilization is required to attain desired strength for the construction of the subgrade. Again to cope with increasing transportation need, the traffic load and speed have been increasing simultaneously resulting in deterioration of several existing roads which are structurally insufficient to bear heavy traffic loads. For accommodating such demands subgrade require proper improvement. In India fill material's requirement is ample and availability of soil near construction sites may be in low supply or strength of the soil is weak and compressibility is also high, also after properly compaction. For accommodating such demands subgrade require proper improvement. In India fill material's requirement is enormous and availability of soil near construction sites may be in low supply or strength of the soil is weak and compressibility is also high, also after properly compaction. These soils need some additional enhancing elements which will reduce the compressibility as well as the strength will also increases. Different materials for fiber being used for study are Nylon fiber, Polypropylene fiber, Polyester fiber etc. However, the inclusion of synthetic fibers is generally very expensive in India. Also non-biodegradable properties of synthetic fibers yield doubtful environmental effects. This problem can be solved by using locally available natural fibers as reinforcing material for low traffic unpaved roads. Large quantity of natural fibers like Sugarcane Fiber, Hemp Fiber and Date Fiber etc. are mostly available in third world countries like India at low cost and their supply is ensured from agriculture. Due to the use of these materials the cost of the construction will be minimized by introducing marginal thickness of the pavement. The introducing of the fibers in constructions are the result of more desirable compact which ensure the good interlocking system among the soil and fiber and. In this work to find its suitability for used as material for the construction of sub-grade the behavior of fiber reinforced cohesive soil is studied.

2. REVIEW OF PAST WORKS

The mixing of randomly distributed fibers to improve the engineering properties of soil is now well accepted practice in different civil engineering construction, probably started from the beginning of construction of mud shelter houses in early days of civilization at many places of the world. Inclusion of randomly distributed synthetic fibres in compacted fine grained soils is reported to cause generation of greater strength and toughness (Freitag, 1986). Various failure mechanisms of fibre-reinforced soils have been proposed (Gopal Ranjan et al, 1996). Even in sand, fiber stabilization technique has been introduced for air field and road construction. Laboratory and field studies to quantify the effects of numerous variables on the performance of fiber stabilized sand layers where sand was mixed with fibres randomly, had shown improvement in load carrying capacity, and improvement is shown to depend on material of fiber, aspect ratio of the fiber included etc. (Santoni et al 2001). Kumar and Singh (2008) reported on the basis of large number of tests, that there is manifold increase in CBR value when randomly distributed polypropelene fibres are used in compacted flyash or compacted soil mixed with fly ash. Sreedhar et al (2009) reported experimental study on effect of including geotextile fibres in dry sand as random distributed. They observed phenomenal improvement on CBR value of sand when mixed randomly with such fiber of all length of different aspect ratios.

In the present investigation, efficacies of using different types of natural fiber i.e. sugarcane, hemp, sabai grass fiber in locally available soil have been made.

3. METHODOLOGY

3.1 MATERIALS USED

A. SOIL: Locally available clayey soil collected from Nazirabad near Kolkata, West Bengal, was used in this experimental study. As per I.S. Classification (IS 1498, 1970), the soil is classified as "CI". The physical properties of clay as determined in the laboratory are given in Table 1

Table 1: Physical properties of soil

Properties	Values
Specific Gravity(%)	2.45
IS Classification	CI
Liquid Limit(%)	35.5
Plastic limit(%)	23.5
Plasticity Index	12.0
Maximum Dry Density(gm/cc)	1.715
Optimum moisture content (%)	15.5
Unsoaked CBR (%) at OMC	3.9

B. NATRUAL FIBERS:

1) **Sugarcane Fiber:** Natural sugarcane fiber was collected from local market and processed by cutting into small pieces of length 0.5cm, 1cm and 2cm for use as fiber material.

2) **Hemp fibre:** Hemp fibre were collected from local market and processed in the laboratory by cutting into small pieces of various lengths of 0.5cm, 1cm and 2cm.

3) **Sabai grass fibre:** Sabai grass fibers were processed in the laboratory purchasing raw Sabai grass from Midnapur district. The fibers were then dried in sun for several days. After that the Sabai grass fibers were cut into small pieces of length 0.5cm, 1cm and 2cm for use as fiber material.

3.2 TEST PROGRAMME:

In this study to investigate the effect of inclusion of randomly distributed natural sugarcane, hemp, sabai grass fibers on compaction and strength characteristics of cohesive soil, standard Proctor and unsoaked CBR tests have been conducted for cohesive soil mixed with varying percentages and lengths of natural fibers. The natural sugarcane, hemp, sabai grass fibers are cut into three different lengths of 0.5cm, 1cm and 2cm, and mixed in different proportion of 0.5, 1.0, 1.5, & 2.0 %.

All the tests were conducted as per relevant I.S. codal provision.

4. RESULT AND DISCUSSION

To study the reinforcing effects of randomly mixed natural sugarcane, hemp, sabai grass fibers on clayey soil, a series of standard Proctor and unsoaked CBR tests have been conducted. The experimental test results of these tests are summarized in table 2.

Table 2 Experimental Test Results

Fiber length	% OF Fiber	Clayey soil		
		MDD	OMC	CBR Unsoaked
No fiber	0.0%	1.715	15.5	3.9
Sugarcane fiber 0.5cm	0.5%	1.708	15.9	5.2
	1.0%	1.693	16.3	5.8
	1.5%	1.685	17.8	**6.3**
	2.0%	1.675	18.5	5.7
Sugarcane fiber 1.0cm	0.5%	1.7	16	5.4
	1.0%	1.69	16.5	6.3
	1.5%	1.682	17.9	**6.9**
	2.0%	1.672	18.7	6.2
Sugarcane fiber 2.0cm	0.5%	1.68	16.2	5.4
	1.0%	1.674	16.8	6.2
	1.5%	1.668	18.1	6.7
	2.0%	1.665	18.9	6.1
Hemp fiber 0.5cm	0.5%	1.701	15.8	5.4
	1.0%	1.69	16.4	6
	1.5%	1.682	17.3	**6.5**
	2.0%	1.672	17.8	5.9
Hemp fiber 1.0cm	0.5%	1.695	16	5.7
	1.0%	1.686	16.6	6.5
	1.5%	1.678	17.5	**7.1**
	2.0%	1.668	18	6.4
Hemp fiber 2.0cm	0.5%	1.676	16.3	5.6
	1.0%	1.665	16.7	6.3
	1.5%	1.662	17.8	**7**
	2.0%	1.657	18.2	6.3
Sabai grass 0.5cm	0.5%	1.692	16.3	4.8
	1.0%	1.685	16.9	5.3
	1.5%	1.676	18.1	**6.1**
	2.0%	1.668	19.2	5.4
Sabai grass 1.0cm	0.5%	1.686	16.4	5.1
	1.0%	1.675	17.1	5.7
	1.5%	1.668	18.5	**6.8**
	2.0%	1.656	19.4	5.8
Sabai grass 2.0cm	0.5%	1.665	16.6	5
	1.0%	1.658	17.5	5.5
	1.5%	1.648	18.8	**6.6**
	2.0%	1.641	19.7	5.6

4.1 Standard Proctor Test:

The Standard Proctor test has been conducted as per IS 2720 (Part-VII) on cohesive soil- natural fibers mix composites to determine optimum moisture content (OMC) and maximum dry density (MDD). The cohesive soil is mixed with randomly distributed natural sugarcane, hemp, sabai grass fibers of varying percentages (0.5, 1.0, 1.5, & 2.0 %) and lengths (0.5cm, 1cm and 2cm). Standard proctor test has been conducted on cohesive soil- natural fibers mixtures. The OMC and MDD values obtained from the standard Proctor test are given in table 2 and variation of MDD and OMC with percentage of natural fibers are shown in fig. 1 and 2 respectively.

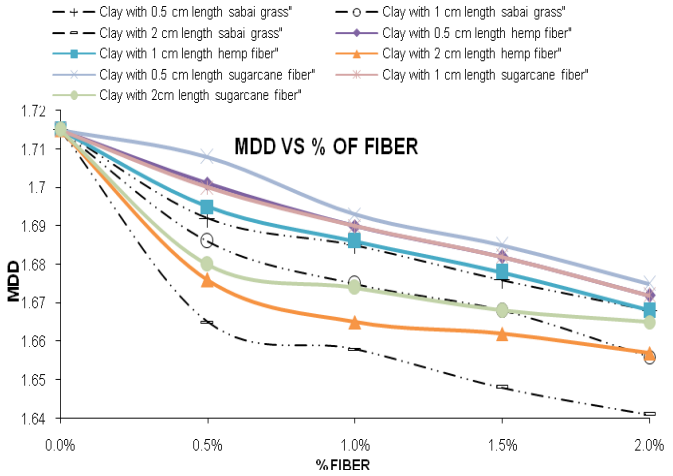

Fig 1: Variation of MDD with percentage of natural fibers

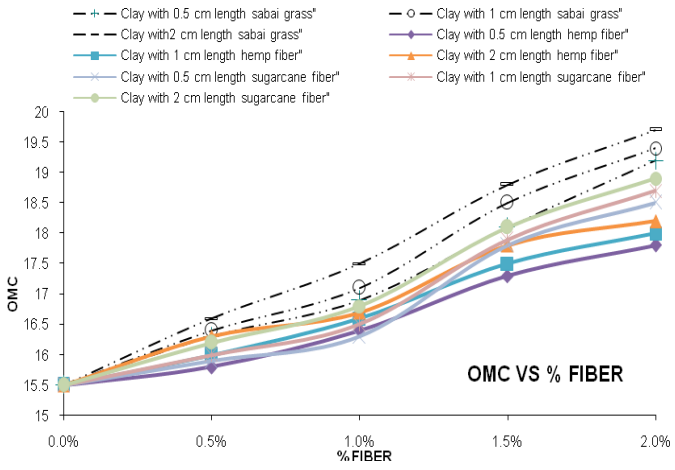

Fig 2: Variation of OMC with percentage of natural fibers

From the fig. 1, it has been observed that the maximum dry density of natural fibers mix soil increases with increase of percent of natural fibers upto a certain percentage, whereas, the Optimum Moisture Content of natural fibers mix soil decreases with increase in natural fibers content in soil as shown in fig. 2.

4.2 California Bearing Ratio (CBR) Test:-

Laboratory unsoaked CBR test has been carried out on cohesive soil- natural fibers mix composites as per IS-2720(PART-16),1979. The cohesive soil is mixed with randomly distributed natural sugarcane, hemp, sabai grass fibers of varying percentages (0.5, 1.0, 1.5, & 2.0 %) and lengths (0.5cm, 1cm and 2cm). Unsoaked CBR test has been conducted on cohesive soil- natural fibers mixtures. The CBR values obtained from Laboratory unsoaked CBR test are given in table 2 and variation of CBR with percentage of natural fibers are shown in fig. 3.

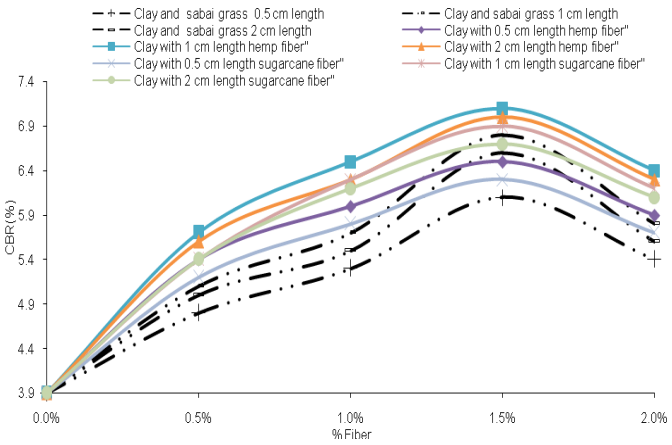

Fig 3: Variation of CBR with percentage of natural fibers

From the figure, it has been observed that the value California Bearing Ratio increases with increase of natural fibers content up to a certain limit, after that it is decreases and it is maximum at 1.5% of the dry weight of soil. The optimum length of fiber inclusion is 1 cm.

3. CONCLUSIONS

On the basis of the results of experimental study made, following conclusion may be drawn-

1) With the increase of randomly mixing natural sugarcane, hemp, sabai grass fiber contents, the value of MDD decreases whereas the value of OMC increases.

2) There is a considerable increase in the CBR value for clayey soil when mixing with randomly distributed discrete natural sugarcane, hemp, sabai grass fibers.

3) The maximum CBR value obtained when natural fibers of 1cm long, are added with 1.5% of the dry weight of soil. Hence, optimum percentage inclusion may be considered as 1.5% of the dry weight of soil and optimum length of fiber inclusion is 1 cm.

REFERENCES

[1] Freitag, D. R. 1986. "Soil randomly reinforced with fibers". J. Geotech. Engrg., ASCE, vol. 112, no 8, pp. 823-826.

[2] IS: 2720 (Part VII) – 1980, Methods of tests for soil :Determination of water content- dry density relation using light compaction, Bureau of Indian Standards, New Delhi.

[3] IS: 2720 (Part XVI) – 1987, Methods of tests for soil: Laboratory Determination of CBR value, Bureau of Indian Standards, New Delhi.

[4] Kumar, P and Singh, S.P.(2008) "Fiber-reinforced Flyash subbase in rural roads." Journal of Transportation Engineering (ASCE), vol 134 no 4 p-171-180.

[5] Ranjan, G., Vasan, R. M. and Charan, H. D. 1996. "Probabilistic analysis of randomly distributed fiber reinforced soil". Journal of Geo-technical and Geo-environmental Engineering (ASCE), vol. 122, no. 6, pp. 419 -426.

[6] Santoni, R.L. and Webster, S.L. (2001) "Engineering Properties of sand-fiber mixture for Road Construction" Journal of Geo-technical and Geo-environmental Engineering (ASCE), vol. 127, no. 3, pp. 258-268.

[7] Sreedhar. M.V.S, Sathish, T., Kumar, K.K. and Pravallika,P.K. (2009) "Investigations on effect of reinforcement in planar and fiber forms on CBR value of sand" Proc. Indian Geotechnical conference, Guntur, Vol – 1, page 194 – 197.

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