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EXPERIMENTAL INVESTIGATION ON STRENGTH CHARACTERISTICS OF SOILS USING COIR AS STABILIZING AGENT

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Abstract
The paper presents the effect of coir fibres on compressive and shear strength behaviour of clayey soils. In the present experimental investigation coir fibres were added in clayey soil at different percentages and at varying lengths. The soil samples mixed with coir fibres were prepared at different water contents to determine the maximum dry density and optimum moisture contents of various samples. Unconfined Compressive Strength and Shear Strength tests were carried out on different soil samples which showed that the inclusion of coir fibres as reinforcement leads to appreciable increase in unconfined compressive and pronounced boost in shear strength characteristics of soil. Hence the addition of Coconut Coir Fibre into the soil leads to increase in strength characteristics of soil thereby stabilizing the soil. The results clearly support that such reinforcement in soils can be a good ground improvement technique in civil engineering projects especially on weak soils.

Keywords— *Soil Stabilisation, Coir fibres, Strength characteristics, Unconfined Compressive strength, Shear Strength*

I. INTRODUCTION

The main objective of the soil stabilisation is to improve the various characteristics of the soil at the site. Soil stabilisation is a rapidly developing field because good sites for construction are becoming sparse day by day. The geotechnical engineer plays a prominent role in the construction of foundation at those sites which would have been declared unsuitable and unacceptable by conventional artisans. At some places, the soil conditions are very poor even at greater depths and thus such sites are not suitable to construct even deep foundation. The natural soil-slope, composed of Karewa soil, undergo shear or sliding failure during heavy rainfall seasons. These soils tend to have low shear strength and tend to react rapidly with lime and losing plasticity immediately because expansive clay minerals such as montmorillonite exhibit a high cation-exchange capacity [1]. In such cases various methods of soil improvement/stabilisation techniques are adopted. One of the objectives of geotechnical expert is to improve the characteristics of soil at site thereby making the soil capable of carrying load by increasing the shear strength and decreasing compressibility of the soil so that bearing capacity of the soil is increased and the settlement of the structure built on it are reduced. The coir is a naturally occurring fibre derived from the husk of coconut fruit and it is abundantly available at low costs in India. A large number of coir products are manufactured for various geotechnical applications in the form of grids, textiles, and mats. These applications include filtration and drainage application, reinforcement, erosion control, etc. These products were found to last for four to six years within the soil environment depending on the physical and chemical properties of the soil [2-4]. The use of blended geotextiles shows an increase in the CBR value and results in even surfaces without significant subsidence or rutting [5-6].

II. MATERIAL AND METHODOLOGY

The soil samples were taken from Gallandar, Pampore , J&K, India (N 33º53´10.7´´ E 75º04´10.7´´, elevation-1626 m) and these soils are locally known as Wudur soils (Karewas). These soils are geologically classified under Lacustrine formations of recent origin and are invariably used as a potential option as fill sub-grade material in Kashmir Valley particularly in those areas where natural subgrades are having low shear strength & high compressibility. The coir fibres were collected from main market Rajouri. The fibres are normally 50–350 mm long and consist mainly of lignin, tannin, cellulose, pectin and other water soluble substances. Various tests and analysis were carried out to examine the effect of coir fibres on the Karewa-soils which include sieve analysis, water content determination, specific gravity, Atterbergs limits test, proctor test etc. Based on these tests, the optimum quantity of coir fibres required for effective stabilization of Karewa-soil was determined. The experimental work of the project was done in two phases. In the initial phase, the basic tests of plain soil sample were done as per relevant IS Codal provisions (IS-2720-1983, Part 1-5). In the initial phase, liquid limit tests were done using a mechanical liquid limit device whereas the plastic limit was obtained by the thread rolling method as per IS: 2720 (V)-1985. The optimum moisture content and dry density of soils were determined by performing the Standard Proctor Test as per IS:

2720(VII)-1980. In the 2nd phase, the same tests were repeated by varying concentrations of coir fibres and the deviations from the initial phase were noted very carefully. The Direct Shear Tests were performed as per IS 2720-13. The Unconfined compressive tests were also performed as per IS 2720-10. In the 2nd phase, the soil was mixed with 0.25% coir fibres (1cm and 2 cm length), 0.50% coir fibres (1cm and 2cm length) by dry weight of soil. The geotechnical properties of these coir treated soil samples were evaluated and compared with that of soil before stabilization. The particle size distribution cure, compaction curve and various properties of the soil pertaining to our study are shown in Fig. 1 and Fig. 2 and Table-1 respectively.

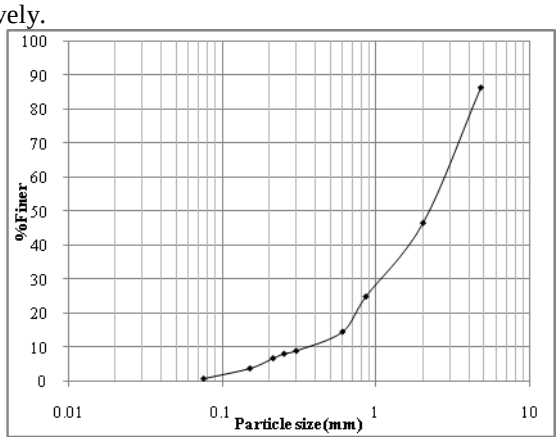

Fig.1 Particle Size Distribution Curve

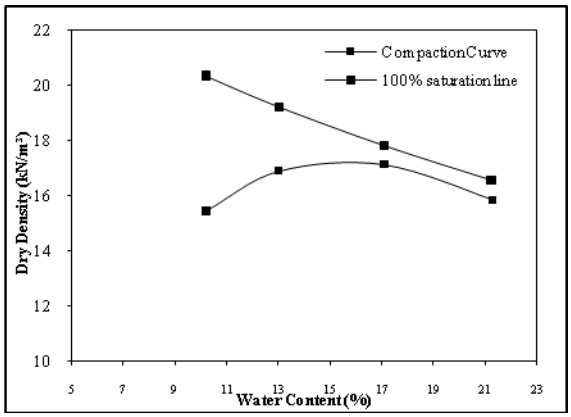

Fig.2 Compaction Curve of plain soil

Table-1: Summary of various properties of soil

Property	***Soil (without coir fibres)***
Collection site	*Pampore, J&K, (N 33º53´10.7´´ E 075º04´10.7´´)*
Colour of soil	*Brown*
Depth at which sample was taken	*1 m*
Natural moisture content (w)	*9.536%*
Specific gravity at room temperature	*2.64*
Uniformity Coefficient (C_u)	*28*
Co-efficient of curvature	*0.86*
Liquid limit	*32%*
Plastic limit	*17.49%*
Plasticity index	*14.51%*
PIA = *0.73 (Liquid Limit – 20)*	*8.76%*
Soil type based on Plastic limit and PIA	*Fine grained inorganic clay (CL)*
Maximum dry density	*1.713 gm/cc*
Optimum moisture content	*17.08%*
CBR Value at optimum moisture content	*1.88%*

III. RESULTS AND DISCUSSIONS

The experimental results presented in figure 3-4 shows that with the increase in percentage of coir fibres (up to 0.50%) with concomitant increase in the length of fibres (up to 2 cm), the unconfined compressive strength and shear strength increased continuously corresponding to change in strain. The Unconfined Compressive Strength increased from 2.63 N/cm^2 (for plain soils) to 7.66 N/cm^2 (reinforced with coir) while as Shear Strength increased from 26.68 N/cm^2 (for plain soils) to 75.568 N/cm^2 (reinforced with coir). Hence the load carrying capacity increases with the increase in percentage and length of coir fibres, which may be attributed to the fact that when coir is used as reinforcement, the coir layers can share the load with soil until its degradation thus increasing the load bearing capacity of the sub grades. The strength of soil sub-grade increases in due course of time as the soil undergoes consolidation induced by the external loads e.g., traffic loads. For such applications, where the strength of sub-grade increases with elapsed time, the natural reinforcement products are extremely suitable. The application of natural woven coir geotextiles for unpaved roads on soft sub-grade performs satisfactorily.

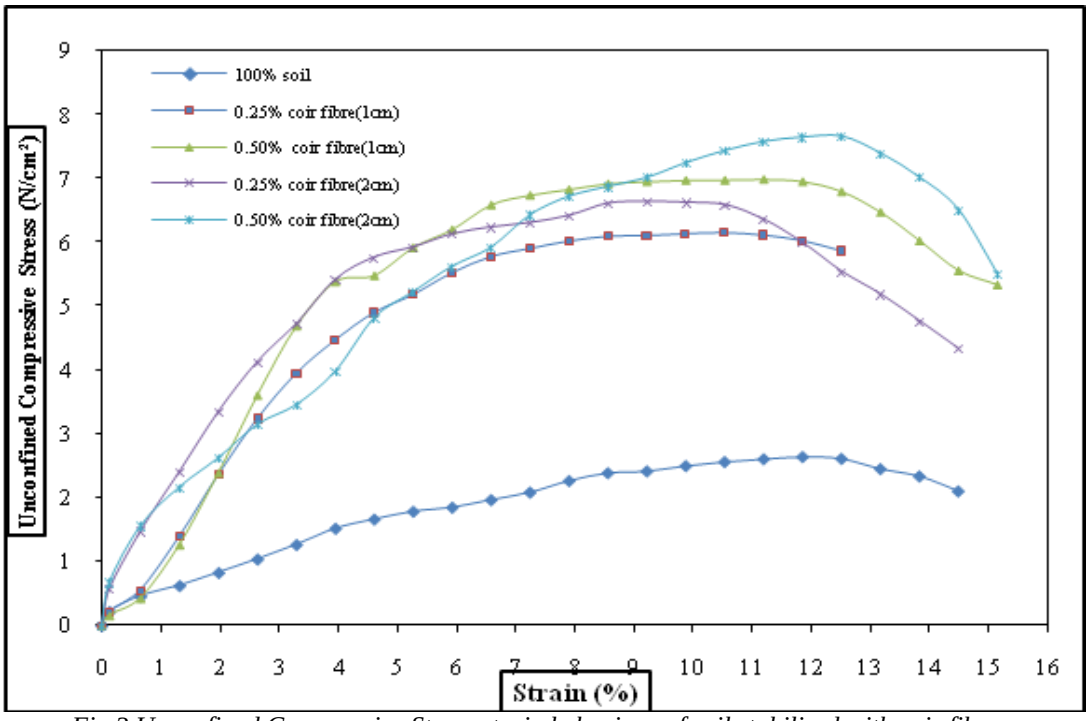

Fig.3 Unconfined Compressive Stress strain behaviour of soil stabilized with coir fibres.

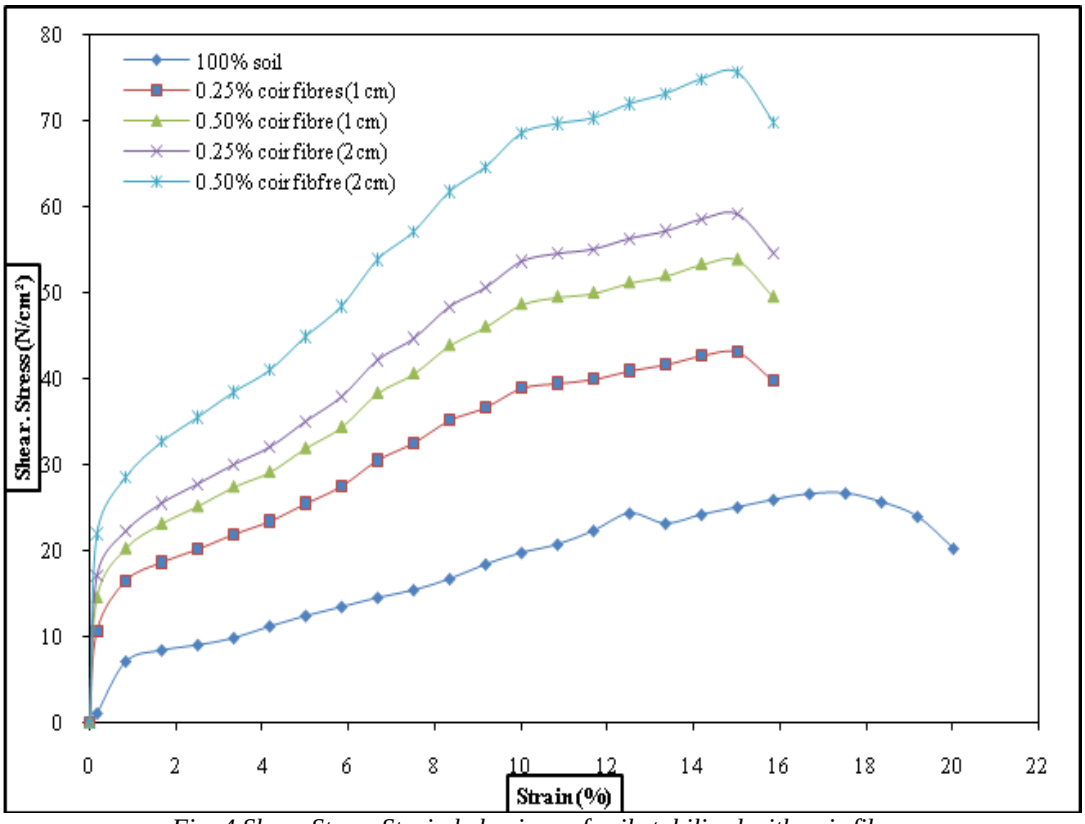

Fig. 4 Shear Stress Strain behaviour of soil stabilized with coir fibres

IV. CONCLUSION

From the experimental results of the present study, it was observed that the addition of Coir Fibres improved the properties of the soil drastically. The present experimental study can be summed up as follows:

1. The results obtained from the direct shear tests showed that shear strength increased continuously from 26.68 N/cm^2 to 75.568 N/cm^2 by the addition of coir fibres (up to 0.50%) with corresponding increase in the length of fibres (up to 2 cm).
2. The unconfined compressive strength also increased from 2.63 N/cm^2 to 7.66 N/cm^2 with the inclusion of coir fibres (up to 0.50%) and by increasing the length of fibres (up to 2 cm).
3. Reinforcing the soil with coir fibres can be considered as good ground improvement technique especially in Civil engineering projects on weak soils where it can act as a substitute to deep/raft foundations/formation for roads etc, reducing the cost of project.

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