International Journal of Advance Research in Science and Engineering
Volume No.07, Special Issue No. (03), January 2018
www.ijarse.com
IJARSE
ISSN: 2319-8354

INVESTIGATION ON EFFECT OF COIR FIBER IN CLAYEY SOIL

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ABSTRACT

With the rapid rate of urbanisation and need of good quality structures, there is increase in demand of good quality soil, but the soil of such standards is limited and we need to improve the soil through various ways in order to get the desired quality. Various methods are available which include chemical and mechanical methods through which soil properties can be enhanced, among these soil reinforcement by the use of natural fibres is being applied in the field as these fibres are naturally occurring and also does adds to the economics of the structure. Coir fibre which is extracted from the coconut fruit has a good tensile strength and can be utilized in the soil reinforcement. In this study, efforts are being made to use coir fibre in the soil reinforcement. Coir fibre in various percentages 0.25%, 0.50%, 0.75% and 1% is being mixed with soil and effects on soil properties have been studied through the various tests which include Standard Proctor test, Unconfined Compression test and CBR test.

Keywords:Coir Fibre, Standard Proctor Test, Unconfined Compressive Strength, CBR values.

I.INTRODUCTION

Soil stability is among most important topics in the geotechnical engineering practices. With the frequent failure of the soil whether on a slope on level ground can be costly in terms of life and property both. Because of weakness in tensile and shear strength, soil needs to be improved according to the work requirement, which varies from site to site. To overcome this problem various soil stabilization methods have been taken into consideration which includes the use of both natural as well as artificial fibre and also with the help of the chemical agents like that of lime, sodium silicate etc. Rubber, polypropylene fibres are the examples of the synthetic fibre used in the stabilization of soil since these are non-biodegradable and hence can impose a threat to the soil in the future, so use of the natural fibre which includes jute, sisal, ricehusk, coir etc. These are the best alternative for the stabilization of the soil as these are easily available throughout the different parts of India and are eco-friendly.

The use of coir fibres (coconut fibre) as soil reinforcement is a cost-effective method of soil improvement in countries like India, Philippines, Indonesia, Brazil, etc., where it is cheap and locally available. Amongst the natural materials for soil reinforcement, the coir fibres were found to have good strength characteristics and resistance to biodegradation over a long period of time. Rao and Balan (2000) reported a significant gain in strength parameters and stiffness of sand by the inclusion of coir fibres. Rao et al. (2005) found that the

behaviour of sand reinforced with coir fibres and geotextiles are similar to that observed with synthetic fibres and meshes. Babu and Vasudevan (2007) examined the adequacy of different methods for the strength prediction of coir fibre reinforced sand and also suggested an analytical approach for estimating the stiffness modulus. It is evident from previous studies that the coir in a different form (e.g., discrete fibres, mesh, etc.) is highly effective as soil reinforcing element and hence need to be fully utilised. Limited studies have been reported on the use of randomly distributed discrete coir fibres in fine-grained soils. This paper is based on an evaluation of coir fibre in improving the geotechnical properties of the clayey soil.

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II.MATERIALS USED

Soil: The soil used in the study was taken from Sitarganj region of District Udham Singh Nagar (Uttarakhand). As per IS: 1498-1970 the soil is classified as CL type i.e., the clay of low plasticity. The physical properties of soil are given in Table 1.

Coir Fibre: Coir fibre was procured from the local market in Haldwani, District Nainital (Uttarakhand). Coir used for the study was cut into 30 mm length.

III.OBJECTIVE OF STUDY

The objectives of the study are:

1. To study the various geotechnical properties of soil such as maximum dry density, optimum moisture content, California bearing ratio and unconfined compressive strength by mixing soil with different percentages of coir fibre.
2. To suggest an optimum content of coir fibre to be mixed in the soil for strength improvement in the soil.

Table 1: Physical Properties of Soil

S. No.	Properties	Value
1)	Specific Gravity of Soil	2.53
2)	**Atterberg Limits (%)**	
i.	Liquid Limit	27
ii.	Plastic Limit	12
iii.	Plasticity Index	15
3)	**Compaction Characteristics**	

i.	Optimum Moisture Content (%)		13
ii.	Maximum Dry Density (kN/m^2)		17.71
4)	**Grain Size Distribution (%)**		
i.	Gravel		0.00
ii.	Sand		7.56
iii.	Silt		80.52
iv.	Clay		11.92
5)	Differential Free Swell (%)		40
6)	IS Classification		CL
7)	Unconfined Compressive Strength (kN/m^2)	0 day	108.79
		7 day	121.83
		14 day	150.98
		28 day	151.63
8)	**California Bearing Ratio (%)**		
	Soaked		2.16
	Unsoaked		6.67

IV. RESULT AND DISCUSSIONS

Particle Size Distribution Analysis

IS 2720 (Part IV) 1985 was used to determine the grain size analysis. The particle size of soil ranges from coarse sand to silt size as shown in Fig.1. The percentage of particles passing through the 75 μ sieve was found to be 92.44%.

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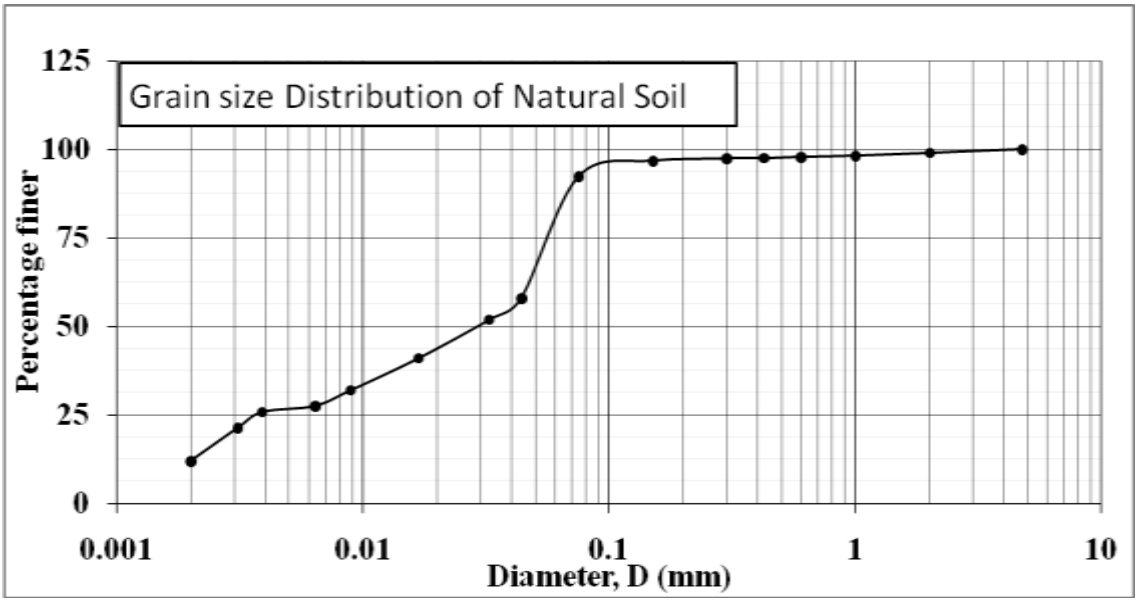

Fig.1: Grain Size Distribution Curve of the Soil

Standard Proctor Results

Compaction tests were carried out on different proportions of coir fibre and soil to study their moisture-density relationship. Fig 2 and Fig.3 Shows the variation in maximum dry density (MDD) and corresponding optimum moisture content (OMC) for different percentages of coir fibre. It can be observed from the Fig.2 that the dry density is constantly decreasing by the addition ofcoir fibre. This is because of the addition of coir fibre having low density in place of soil having comparatively high density. It can also be seen from Fig 3 that OMC of the soil mix does increase with an increase in the fibre content, the increase in optimum moisture content at high coir fibre content may be due to the greater water absorption capacity of fibres.

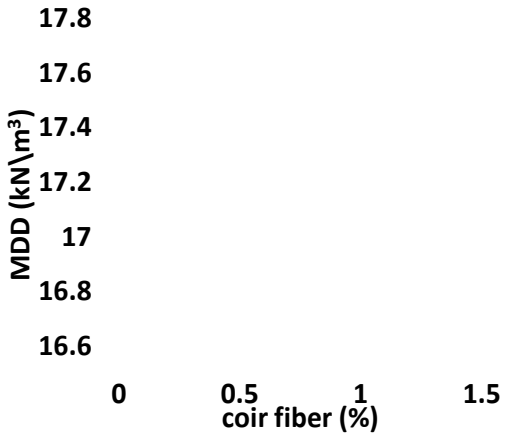

Fig. 2: Variation of MDD

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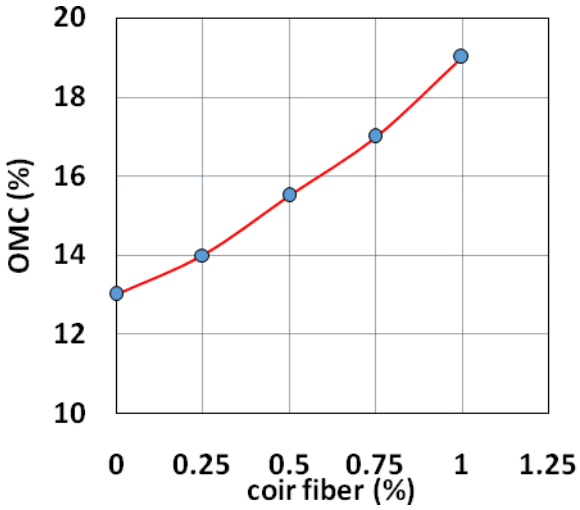

Fig. 3: Variation of OMC

California Bearing Ratio (CBR) Test Results

Soaked and Unsoaked California bearing ratio tests were carried out on all selected soil mixes to evaluate their load bearing capacity and their suitability to be used as a construction material for the sub-grade. As expected the unsoaked CBR values for all the soil mixes were higher than those of the soaked CBR values. The trend of soaked and unsoaked CBR values of all the soil mixes is shown in the Fig. 4. It was observed that soaked CBR value increased from 2.16% to 4.45% for the optimum mix of 0.75% coir fibre while the unsoaked CBR value of clayey soil increases from 6.67% to 11.32% for the same optimum fibre content. This improvement in CBRvalues probably happened because of the better compaction and packing characteristics of the particles achieved with the introduction of additive in the clayey soil.

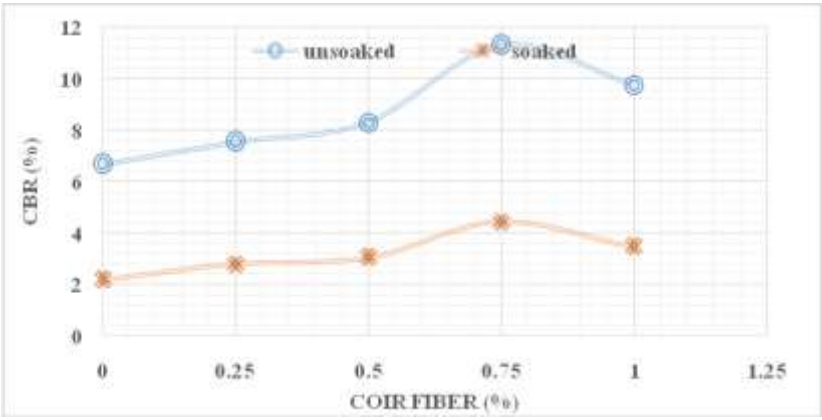

Fig. 4: Unsoaked and Soaked CBR Values

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Unconfined Compressive Strength Test Results

The unconfined compressive strength tests were conducted on the optimum mixes obtained from standard compaction. The stress-strain behaviours of different composites are shown in Fig 5. Unconfined compressive strength of clay used in this study was 151.63 kN/m^2. For all the optimum mixes, the value of unconfined compressive strength is greater than that of pure clay. The value of unconfined compressive strength for the mix of 0.75% coir fibre comes out to be maximum. The addition of coir fibre increases the strength capacity of the soil which can be seen from the Fig.5.

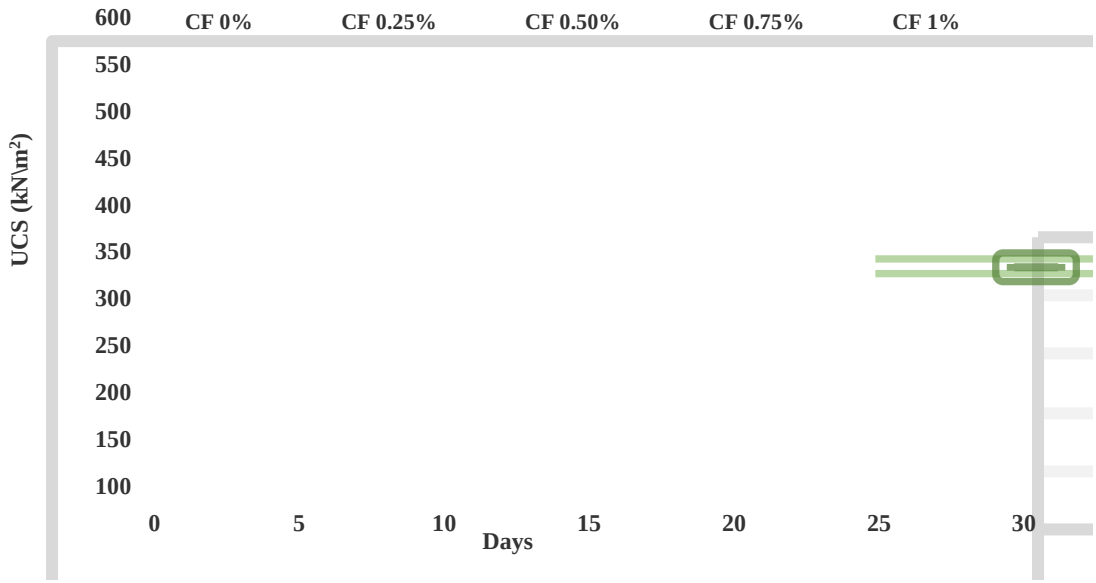

Fig.5: Variation of UCS Value with Days and Different Coir Percentages

V.CONCLUSIONS

The conclusion drawn from the study are as follows:

1. On increasing the coir fibre content the maximum dry density of the soil mix gets reduced and the value of optimum moisture content increases with the increase in fibre content.
2. Optimum fibre content was found to be 0.75% of the dry weight if the soil.
3. Soaked and unsoaked values improved considerably for the optimum mix in comparison to that of unreinforced soil.
4. The unconfined compressive strength increased with the increase in the coir fibre up to the optimum fibre content.

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