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Effect of Inclusion of Coir Fibers of Varying Length on Unconfined Compressive Strength of Expansive Clay

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Abstract - *Sustainability is the most widely used word in today's research. Sustainable solutions are making way for the older unsustainable methods which were already in use. The improvement in the strength property of expansive soil by the inclusion of natural fibres is widely documented. The study made an attempt to find the improvement of strength in expansive soil with addition of coir fibre in various percentages with different lengths of fibres, through a series of UCS tests. The fibres were added in terms of percentage of 0.4, 0.8, 1.2 and 1.6 by weight of dry soil. Fibres were used in 20mm and 30mm lengths. It was found that with the increase in fibre proportions there was improvement in UCS value up to an optimum percentage of added coir fibres. The optimum percentage was found out to be 1.2 percentages. It was also found that the increase in the length of fibre showed a marginal increase in the strength.*

Key Words: **Expansive soil, Coir Fibres, Coir Fibre inclusion, Fibre Length, Unconfined Compressive Strength.**

1. INTRODUCTION

The expansive soil by the property increases in volume with increase in moisture. The moisture in soil varies from season to season which causes alternative swelling and shrinkage these changes in volume creates a lot of undue stresses on foundations, buildings, roads, retaining structure etc. The addition of fibres reduces the variation in volume due to change in moisture content. The use of waste products to reinforce the soil prevents the volume changes and the effort required in disposal of waste is solved. This concept is used for the improvement of certain desired properties of soil such as bearing capacity, shear strength, compaction behavior, drainage, filtration, permeability etc. [7]. The main advantage of these materials is that they are locally available and are very economic.

Coir is a versatile natural fibre extracted from the fibrous husk that surrounds the coconut. The fibres are tough, strong and extremely resistant to fungal and bacterial decomposition. Coir cross sections are highly elliptical and non uniform with average diameter 0.25 mm. In spite of low cellulose content, coir fibre has a very close fibre structure which account for its better durability compared to other natural fibres. These fibres are normally 50–350 mm in length. It has been found that these fibre are rich mainly in cellulose, pectin, lignin other water soluble substances. (Hejazi,et. al,2012)[6].

This paper presents the experimental results of the influence of coir fibres on the compaction characteristics and strength behaviour of soil.

2. LITERATURE REVIEW

Irjet Template sample paragraph .Define abbreviations and acronyms the first time they are used in the text, even after they have been defined in the abstract. Abbreviations such as IEEE, SI, MKS, CGS, sc, dc, and rms do not have to be defined. Do not use abbreviations in the title or heads unless they are unavoidable.

Jeena Mathe, Karthika Ramesan (2016)[1], studied the effect of addition of coir fibre and polypropylene fibre on the clayey soil. In their findings it has been reported that addition of fibres improves the strength parameters.

C.Jairaj, Dr.M.T.Prathap kumar (2015)[2], studied the effect of length of coir fiber on strength of black cotton soil treated with lime. In their study it was reported that, increase in length of fiber increases peak deviator stress for a given percentage of fiber content. However when the length of fiber exceeds 20mm, there is marginal reduction in peak deviator stress.

Singh and Mittal (2014)[3], conducted an experimental study on clayey soil mixed with coir fibres in varying percentage . Tests result indicates that both unsoaked and soaked values of CBR of soil increases with the increase in fiber content.

Maliakal and Thiyyakkandi (2013)[4], discusses the shear strength of clayey soil mixed with coir fibers based on a number of consolidated undrained triaxial compression tests. The study identifies that the inclusion of discrete coir fibers in soil significantly improves the shear strength of clay.

Rakesh Kumar Dutta et al. (2012)[5], studied the use of treated coir fibres on unconfined compressive strength of clay. The obtained results indicated that fibre reinforced clay was able to bear higher strains and increase in the unconfined

compressive strength was higher when the fibres were given a suitable chemical treatment.

From this literature survey, it was clear that studies have been conducted on the characterizing the variation in properties of soil mixed with treated and untreated coir fibres. The researchers aim at finding the optimum percentage of fibres to get optimum proportion of added fibres which can be further referred for improving the different properties of soil in different situations.

3. MATERIAL USED

3.1 Soil Sample

The soil was classified as clay with low plasticity and the various parameters of the tested soil are given in Table 1

TABLE-1: Physical and Engineering Properties of Soil.

Sl No.	Description	Value/Characteristics
1	Colour	Brown
2	Natural Water Content	17.25%
3	Liquid Limit	34.2 %
4	Plastic Limit	14.2%
5	Plasticity Index	20%
6	Liquidity Index	0.15%
7	Consistency Index	0.84%
8	**Compaction Properties**	
	Maximum Dry Density	1.88g/cc
	O M C (%)	13.5%
9.	Specific Gravity(Gs)	2.68
10.	IS Classification	CL
11.	UCS	109 kPa

3.2 Coir Fibre

Coir fibres were collected from a small local factory in Chandigarh, Punjab. The fibres were mixed indifferent proportions of 0.4%, 0.8%, 1.2% and 1.6%. Fibres used were of two different lengths (20mm & 30 mm).

Table- 2: Characteristics of Coir Fibre

Sr. No	Description	Value
1.	Diameter of fibre	0.5mm
2.	Length of fibre used	20mm, 30mm

4. EXPERIMENTAL PROCEDURE

The study is done to ascertain the effect of addition of fibres on soil strength property. Fibres were added in different proportions to soil and samples were prepared. The samples were tested for MDD, OMC and for unconfined compressive strength. The effect of reinforcing fibres on the moisture - density relationships, standard compaction tests were conducted as per Bureau of Indian Standard specifications on controlled soil (clayey soil) and soil - fibre mixtures. Compaction was done with the help manual compaction.

UCS test specimens were prepared with soil (control specimen) and two sets of specimens of soil with fibres at different proportions (0.4%, 0.8%, 1.2% and 1.6%) were prepared with two different lengths of fibres. Nine Specimens were prepared in total. Manual compaction was done. The prepared specimen was then extruded from the mould using a sample extruder. The prepared sample is then kept in UCS machine and tested for UCS as per IS 2720, part 10.

5. RESULTS AND DISCUSSIONS

5.1 Optimum Moisture Content and Dry Density Relationship

For the control specimen MDD and OMC values obtained were 1.88g/cc and 13.49% respectively. It was found that for the soil treated with fibres of length 20mm, improvement was there in dry density of soil.

The dry density of soil increases with increase in fibre content from 0.4% to 1.2% though the increase in dry density is marginal from 1.83 g/cc to 1.88g/c and OMC required increases from 11.9% to 13.00% with 20mm length this may be attributed to addition of fibres increases the friction.

To study the influence of increase in length of fibre sample were prepared in the same manner with higher fibre length of 30mm. For this trial also the pattern of variation obtained is same as it was for the soil-fibre mix of length 20mm i.e. in this case also OMC and MDD value are increasing initially upto 1.2% fiber content and then decreasing subsequently corresponding to 1.6% of fibre content value. This variation has been shown in the Table-3.

Table-3: MDD and OMC Relationship with Fibre Length = 20mm

Sr. No.	Fibre Proportion (%)	Fibre Length =20mm		Fibre Length =30mm	
		Moisture Content (%)	*Maximum Dry Density (g/cc)*	*Moisture Content (%)*	*Maximum Dry Density (g/cc)*
1	0.4	11.9	1.83	12.12	1.9
2	0.8	12.87	1.86	13.21	1.91
3	1.2	13.0	1.88	14.1	1.96
4	1.6	11.0	1.78	14.0	1.88

Chart-1 and Chart-2 shows comparative compaction characteristics of moisture content and dry density soil-fibre mix with 20mm and 30mm fibre length. It can be observed that for the MDD and OMC values corresponding to 1.2% there is marginal increase with the increase in the length. The increase in the MDD obtained is 4.2% more compared to the plain soil. This increase in the MDD is due to inclusion of fibres. The increase in OMC is due to interfacial friction between fibre and surface of soil particle, soil matrix requires more water to achieve same density.

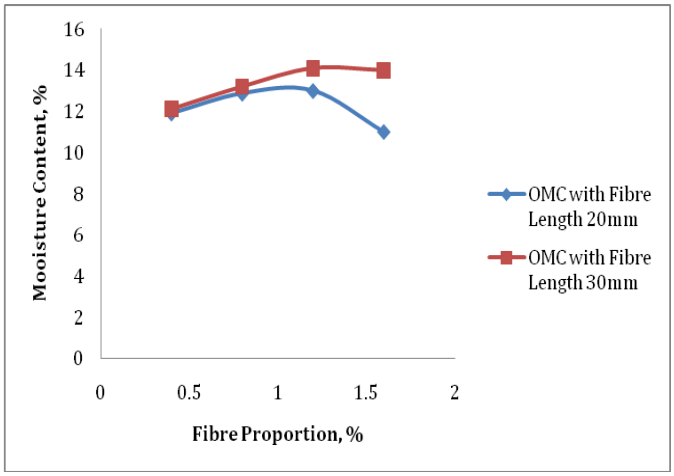

Chart-1: Variation of Moisture Content with addition of Fibres

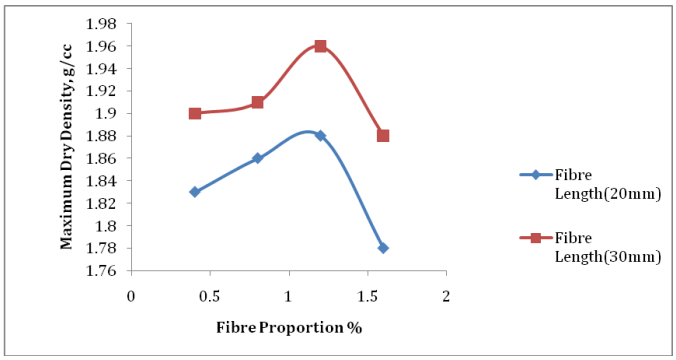

Chart- 2: Variation of Dry Density with addition of Fibre

5.2 Unconfined Compressive Strength

Fibres were cut in the length of 20mm and mixed thoroughly with soil at respective OMC and MDD for the preparation of the sample. The results are shown in Table-4**.** It was observed that at fibre proportion of 1.2% UCS result has been improved. The net increase gained at this value is 13.8% in comparison to the plain soil.

In order to study the effect of length samples were prepared with fibre length of 30mm and were mixed with the soil. The results are shown below in Table 5. At 1.2% the UCS value has been improved from 109 kPa to 130 kPa i.e. result was improved by 19.2%.

Table-4: UCS Value of Soil Mixed with Coir Fibers of Length = 20mm

Sl. No.	Fibre proportion added	UCS Value (kPa)
1	0.4%	89
2	0.8%	97
3	1.2%	124
4	1.6%	109

Table -5: UCS Values of Soil Mixed with Coir Fibers of Length = 30mm

Sl. No.	Fibre proportion added	UCS Value(kPa)
1	0.4%	102
2	0.8%	126
3	1.2%	130
4	1.6%	112

The variation of UCS values due to change in the length of fibres is represented graphically in Chart-3.Thus it has been found that 1.2% of coir fibre content is the optimum proportion for maximum improvement in the compressive strength behavior of clayey soil.

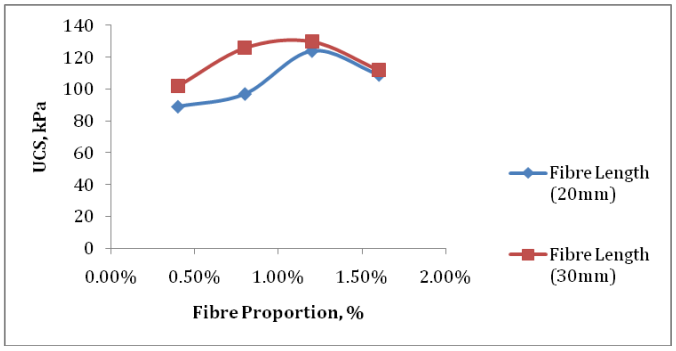

Chart- 3: Variation of UCS with addition of Fibre

6. CONCLUSIONS

Based on the study the following conclusions were drawn:

- With increase in fibre length there is marginal increase in dry density.
- It was found that with improvement in MDD and UCS with increase in fibre content the soil required higher water content for achieving MDD in comparison to control specimen, which may be attributed to the interfacial friction between fibre and soil.
- The study reveals that with increase in fibre length UCS value increases
- Maximum improvement in UCS values is observed when 1.2% of coir is mixed with the soil.
- UCS increases by 13.8% when treated with 20mm fibres and by 19.2% with addition of 30mm fibres in comparison to the plain soil.

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