Experimental Investigation on the Effect of Alkali Treated Coir Fibre on Clayey Soil

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***Abstract*— Clayey soils are usually problematic soils characterized by their low strength, consolidation settlement, time-dependent deformation and high compressibility. The use of natural reinforcing materials in the soil such as jute and coir has the advantage that they are available at a low cost. Coir has the greatest tensile strength among the natural reinforcing fibres in soil, retains its property even in wet conditions, in soil, coir has the greatest tensile strength and retains its property even in wet conditions and has been used in many non-critical civil engineering applications. In the present study, compaction characteristics of clayey soil admixed at different percentages of treated coir fibres were used to increase the durability. The present study indicated that the maximum dry density decreases with an increase in the percentage of coir fibres. When the fiber content varied from 0.2%, 0.4%, 0.6%, 0.8% and 1%. However, the treatment of coir fibre causes a significant reduction in water absorption leading to significant improvement in compaction characteristics and strength of clayey soil**.

Keywords*— *Clayey soil; coir fiber; Maximum dry density; Optimum moisture content; Compaction

I. INTRODUCTION

The stability of soil is one of the most important topics in the geotechnical engineering field. 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 poor tensile and shear strength, the soil needs to be stabilized according to the work requirement, which, varies from site to site. To solve this issue various soil stabilization methods have been taken into consideration which includes the use of both natural as well as artificial fibre. The use of coir fibre as soil reinforcement is a cost-effective method of soil improvement. When compared to other natural fibres, are increasingly becoming popular to strengthen the soil due to their high strength, stiffness, and good hydraulic properties. Because of the high lignin content in coir fibre among other natural fibres, it is durable when mixed with soil A major drawback associated with coir fibres is high water absorption the fibres, causing the deterioration of its strength in a short period. It is necessary to impart hydrophobicity to natural fibres with suitable chemical treatment, to increase their life span when introduced into soils. Surface modification of coir fibre not only decreases moisture adsorption but also improves the interfacial bond strength. Several studies had been conducted by various researchers regarding the effectiveness of treatment of natural fibres and developed methods such as alkali treatment, acetyl treatment, permanganate treatment, and heat treatment Among several methods, alkali treatment on natural fibres including coir fibres, indicated that the fibres can retain tensile strength after alkali treatment.

This study focuses on the effect of treated coir fibre to reinforce the clayey soil and it also increases the durability of coir. various experiments were carried out to find their change in properties.

II. OBJECTIVES OF STUDY

A. To find the change in properties of untreated and treated clayey soil.
B. To reinforce the soil with alkali treated coir fiber.
C. To evaluate the performance of stabilized soil in terms of strengthening.

III. MATERIALS USED

A. Clayey soil

The soil sample was collected from Neyyattinkara, Thiruvananthapuram District, Kerala at a depth of 6m from the ground surface. It was light grey in colour.

Figure 1: Clayey soil

B. Coir Fibre

The Coir fibre was collected from Mandaikkad, Kanyakumari District, Tamilnadu. The coir was randomly cut into pieces of 3cm in length. The fibers were washed with distilled water and then air dried and also treated with NaOH solution of 6% concentration for about 24 hours.

Figure 2: Coir fibre

IV. LABORATORY TESTING

Properties of clayey soil where shown in table 1.

TABLE I. PROPERTIES OF CLAYEY SOIL

Sl. No	Parameter	Property
1	Specific gravity	2.35
2	Liquid limit (%)	32.50
3	Plastic limit (%)	22.33
4	Optimum moisture content(%)	23.07
5	Maximum dry Density (kN/m^2)	15.8
6	Unconfined compressive strength (kPa)	55.99

Compaction test were conducted to determine the compaction characteristics of coir and polypropylene reinforced clay. Unconfined compressive strength test were conducted to determine the optimum percentage of coir and polypropylene fibre

TABLE II. VARIATION OF OMC OF CLAY REINFORCED WITH VARYING COIR FIBER CONTENT

Sl. No.	Coir Fibre Content (%)	OMC (%)
1	0	23.07
2	0.2	20.00
3	0.4	11.76
4	0.6	20.00
5	0.8	23.5
6	1	28.5

Compaction test were conducted with varying percentage of treated coir fibre and randomly reinforced with clay by using replacement stabilization. The percentage of coir fiber varied were 0.2%, 0.4%. 0.6%, 0.8% and 1%. From the compaction test the compaction characteristics of clay with varying percentage of coir fiber were obtained.

TABLE III. VARIATION OF MDD OF CLAY REINFORCED WITH VARYING COIR FIBER CONTENT

Sl. No.	Coir Fibre Content (%)	MDD (kN/m^2)
1	0	15.8
2	0.2	16.5
3	0.4	16.7
4	0.6	16.3
5	0.8	15.6
6	1	15.1

The percentage of coir fiber varied were 0.2%, 0.4%. 0.6%, 0.8% and 1%. The optimum percentage of Coir fiber and polypropylene fiber were obtained from unconfined compressive strength test.

TABLE IV: VARIATION OF UCS OF CLAY REINFORCED WITH VARYING COIR FIBER CONTENT

Sl. No.	Coir Fibre Content (%)	UCS (kPa)
1	0	44.07
2	0.2	49.84
3	0.4	52.43
4	0.6	55.99
5	0.8	50.03
6	1	47.49

V. RESULT AND DISCUSSION

The results obtained from sieve analysis, Standard proctor compaction and Unconfined compressive strength.

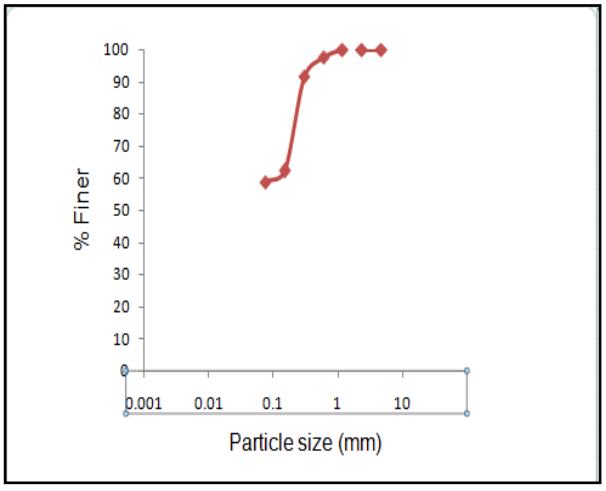


Figure 3: Particle size distribution of clayey soil

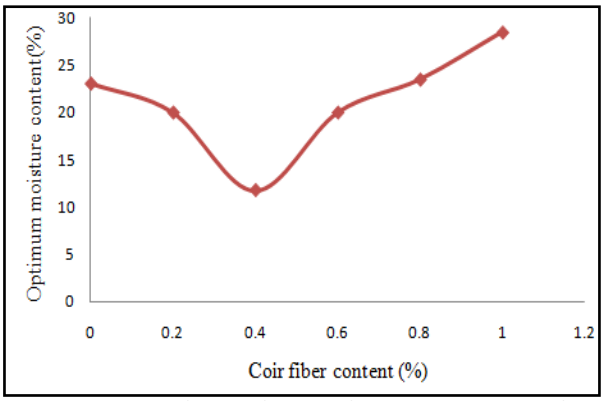


Figure 4: Variation of OMC of clay reinforced with varying coir fiber content

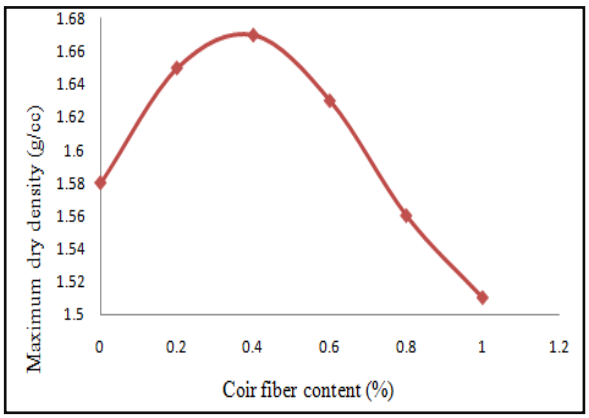
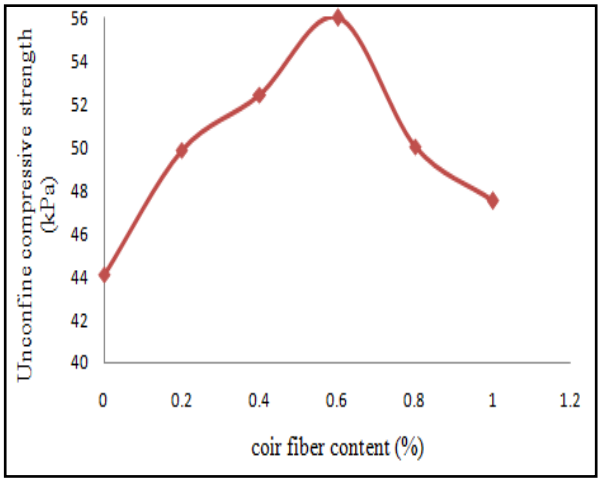


Figure 5: Variation of MDD of clay reinforced with varying coir fiber contenT

The percentage of treated coir fibre also plays a significant role in increasing MDD and decreasing OMC thereby leading to increase in strength of clayey soil admixed with treated coir fibre. The study has indicated that the results of compaction test show higher MDD and lower OMC for clayey soil admixed with treated coir fiber at 0.4%.



With the increase of fibre content the unconfined compressive strength increases from 44.07 kPa to 55.99 kPa for 0.6% of fibre. After that the gets decreases due to the lack of bonding between coir fibre and clay particles.

VI. CONCLUSION

About 58.99% of clay content where found in this soil, so it is considered as clayey soil.The liquid limit, plastic limit and plasticity index were found to be 32.50%, 22.33% and 10.17 respectively. With the inclusion of treated coir fibre the maximum dry density of soil increased from 15.8 to 16.7 kN/m^2 . The optimum moisture content decreased up to 96.17%. The optimum percentage of treated coir fibre was 0.6% and the maximum compressive strength at this percentage was 55.99 kpa. The strength increased up to 21.28% than the untreated soil.

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