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Improving Engineering Properties of Clayey Soil with Addition of Cement and Coir Fiber

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Abstract--- In recent days, improving engineering properties of soil with various waste product such as(hair fiber, coir fiber) etc. We found that these by-products can improve and maintain the properties of soil. Soil reinforcement is most effective technique for improving soil strength. Clay is introduced for their high compressibility and poor shearing strength, it create various problems for builders. During this work the effect of moisture content, degree of compaction, synthetic fiber as a reinforcement etc. on various Geotechnical properties of cement and coir fiber are studied. A many different tests (Tri-axial, Unconfined Compression, CBR, Direct shear test) were conducted on this subject by several investigators. Here we use locally clayey soil reinforced with random distribution of coir fibers at different percentages. The bearing capacity of soil with three different proportion (0.25%, 0.5% and 0.75%) of coir fiber and two cement (3%, 6%) proportion is using for the testing of bearing capacity or settlement of clayey soil reinforced with randomly fiber. The objective of this investigation is found the optimum quantity of randomly distributed fibers & cement on the performance in term of strength of soil. It was found that fiber & cement content had significant influence on the engineering properties of fiber-cement treated soil. In this investigation, it was also found that with an increase in fiber content caused an increase both ductility & strength. The coir reinforced layer improves the bearing capacity of clayey soil and it is economical method for various types of bearing capacity improvement techniques.
Keywords-- Coir Fiber, Clayey Soil, CBR, Cement, Aspect Ratio, Compaction test.

I. INTRODUCTION

A reinforced soil foundation consists of one or more layers of a geosynthtics reinforcement and controlled fill placed below a footing to create a composite material with improved performance. Soils are good in compression and poor in tension. Geo-grid reinforcement is good in tension and poor in compression. This saves on the export and import of materials from site, embracing sustainability and reducing polluting truck movements. Use of coal ash, which is a waste material left after burning of coal in thermal power plants, is a better & cost-effective solution to construct a stable slope. Use of geosynthtics increases bond in the soil system due to the interlocking of soil particles with the reinforcement aperture as well as enhancing the bearing resistance of the transverse members of the reinforcement. Reinforced soil foundations may be used to construct shallow foundations on loose granular soils, soft fine grained soils or soft organic soils. The use of geosynthtics to improve the bearing capacity and settlement performance of shallow foundations has proven to be a cost effective foundation system. It is shown that the load-settlement behavior and ultimate bearing capacity of the footing can be considerably improved by the inclusion of a reinforcing layer at the appropriate location in the fill slope.

II. MATERIALS USED FOR THE STUDY

A. Properties Of Soil

Primary objective of the investigation is to evaluate the properties and classification of soil. According to Indian standard of soil classification, the soil was classified as clayey (CL). The other physical properties of soil as determined in the laboratory test. The properties of soil are used in this study given in table 1.

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TABLE 1

ENGINEERING PROPERTIES OF COLLECTED SOIL

S. No.	Parameter	Laboratory Value
1	Specific Gravity(G)	2.69
2	Consistency limits a) Liquid Limit (%) b) Plastic Limit (%) c) Plasticity Index (%)	51 26.37 24.63
3	Color	Blackish Brown
4	I.S Classification	CL
5	Standard Proctor Test Results: a) Maximum Dry Density (kN/m^3) b) Optimum Moisture Content (%)	17.28 18.1
6	California Bearing Ratio Value (Unsoaked) California Bearing Ratio Value (Soaked)	3.19 % 2.02 %

B. Physical Parameters of Coir Fiber

The 100% virgin fibrillated Coir fiber is manufactured in the Tashi India limited. This natural fiber presented as a medium duty fiber that has long term durability. The fibers kept dry before usage for good optimal performance.

TABLE 2: PHYSICAL PROPERTIES OF COIR FIBERS

Sr. no.	Properties	Specification
1	Color	Brown
2	Elongation (%)	15
3	Average diameter (mm)	0.25
4	Young modules (kN/m^2)	4.0×10^6
5	Average length(mm)	25
6	Density(g/cm^3)	1.45
7	Aspect ratio	100
8	Average tensile strength (N/mm^2)	405.9

C. Experimental Programmed: Compaction Test

This was first experimental program of the research. Firstly the standard compaction test was carried out and corresponding dry density and optimum moisture content values was obtained of following soil proportions.

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TABLE 3

Sample no.	Composition of soil (by the weight), cement and fiber (%)
1	Virgin soil
2	3% cement
3	6% cement
4	0.25% CF
5	0.50% CF
6	0.75% CF
7	0.25%CF & 3% Cement
8	0.50%CF & 3% Cement
9	0.75%CF & 3% Cement
10	0.25%CF & 6% Cement
11	0.50%CF & 6% Cement

TABLE 4
READINGS OF PROCTOR TEST ON SOIL & CEMENT

Sr. No.	Name of Proportion (%)	M.D.D (kN/m³)	O.M.C (%)
1.	Soil (100)	17.28	21.64
2.	Soil : Cement (97: 3)	17.98	20.22
3.	Soil : Cement (94 : 6)	18.1	19.05

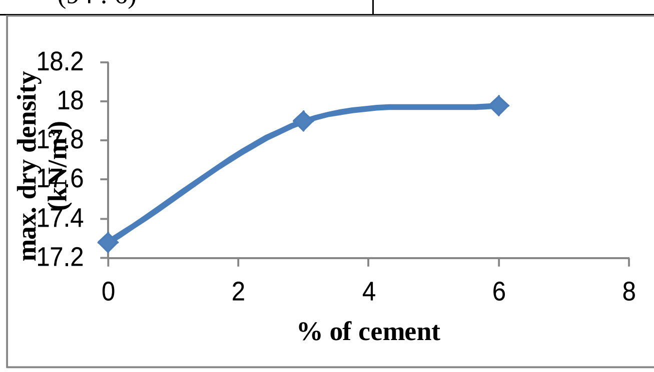

Fig. 1 Graph showing decrease in maximum dry intensity (MDD) of Soil for different proportions of cement.

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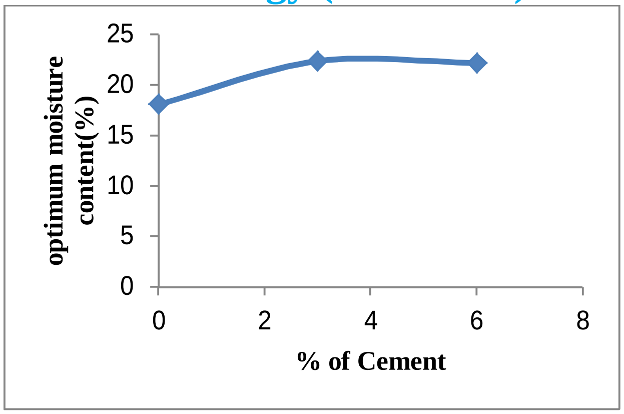

Fig. 2 Graph showing increase in optimum moisture content (O.M.C) of soil for different proportions of cement

TABLE 5

READINGS OF PROCTOR TEST ON SOIL & COIR FIBER

Sr. No.	Name of Proportion (%)	M.D.D (kN/m³)	O.M.C (%)
1.	Soil : CF (99.75 : 0.25)	16.90	19.17
2.	Soil : CF (99.50 : 0.50)	16.70	20.33
3.	Soil : CF (99.25 : 0.75)	16.67	20.53

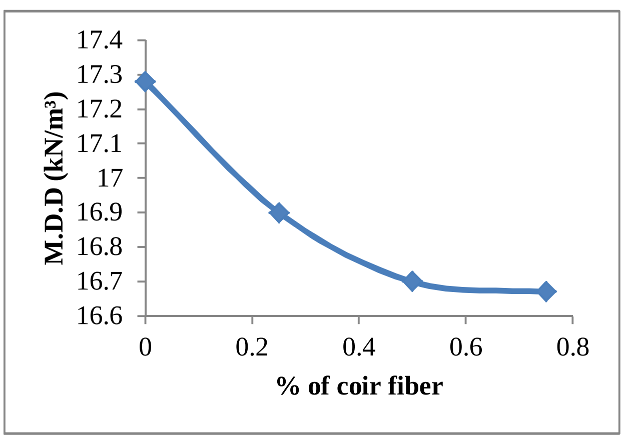

Fig. 3 Graph showing decrease in maximum dry soil for different proportions of coir fiber.

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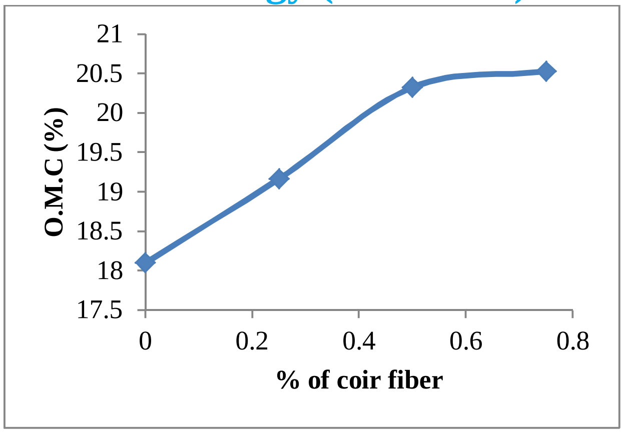

Fig. 4 Graph showing increase in optimum moisture content (O.M.C) of soil for different proportions of coir fiber.

TABLE 6

READINGS OF STANDARD PROCTOR TEST OF SOIL, 3% CEMENT & DIFFERENT PROPORTION OF COIR FIBER

Sr. No.	Name of Proportion (%)	M.D.D (kN/m³)	O.M.C (%)
1.	Soil : CF: Cement (96.75 : 0.25 : 3)	17.22	24.60
2.	Soil : CF: Cement (96.50 : 0.50 : 3)	17.21	24.68
3.	Soil : CF: Cement (96.25 : 0.75 : 3)	17.20	24.72

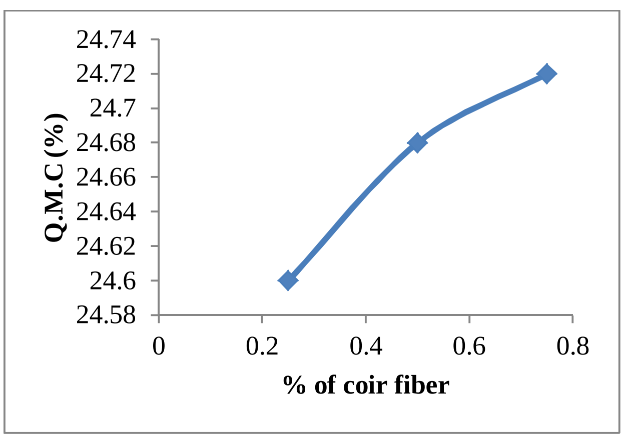

Fig. 5 Graph showing increase in optimum moisture content (O.M.C) of soil for different proportions of coir fiber with 3% cement.

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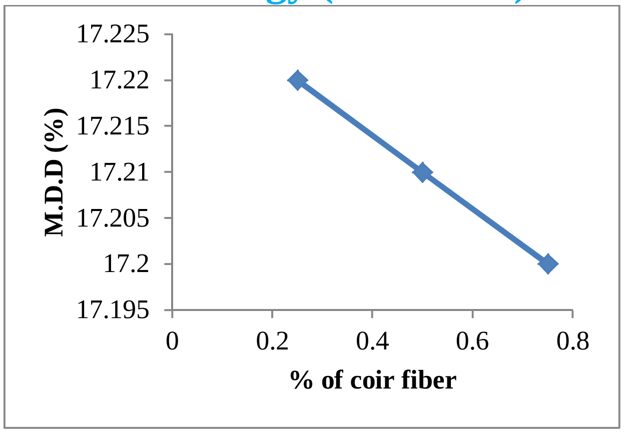

Fig. 6 Graph showing decrease in maximum dry intensity (M.D.D) of soil for different Proportions of coir fiber with 3% cement.

TABLE 7
READINGS OF STANDARD PROCTOR TEST OF SOIL, 6% CEMENT & DIFFERENT PROPORTION OF COIR FIBER

Sr. No.	Name of Proportion (%)	M.D.D (kN/m³)	O.M.C (%)
1.	Soil : CF: Cement (93.75 : 0.25 : 6)	17.36	24.80
2.	Soil : CF: Cement (93.50 : 0.50 : 6)	17.33	24.90
3.	Soil : CF: Cement (93.25 : 0.75 : 6)	17.26	25.0

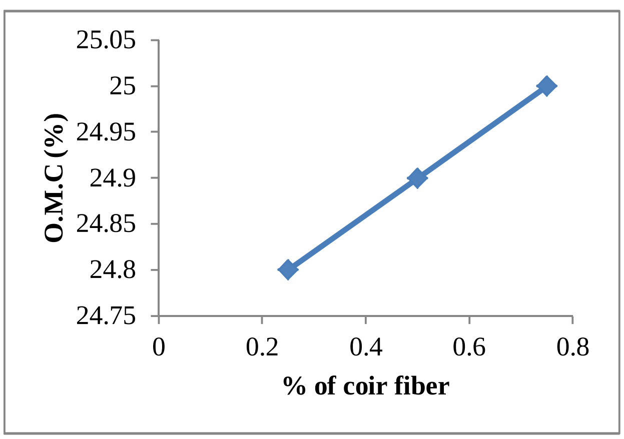

Fig. 7 Graph showing increase in optimum moisture content (O.M.C) of soil for different proportions off polypropylene fiber with 6% cement

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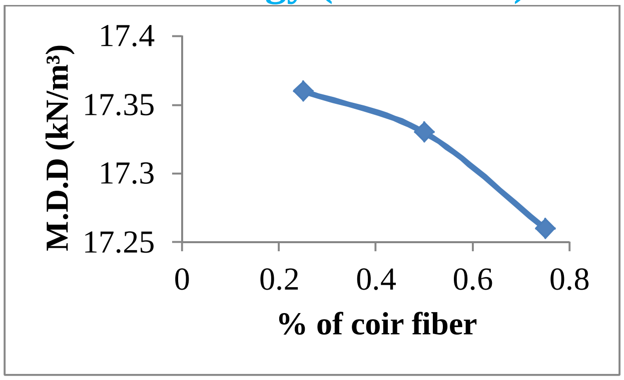

Fig. 8 Graph showing decrease in maximum dry density (M.D.D) of soil for different proportions of Coir fiber with 6% cement

D. Unsoaked C.B.R Test

Using the moisture content and dry density the amount of soil used for CBR was calculated. The sample was tested using CBR instruments and each soil sample was unsoaked CBR test was used to evaluate the sub grade strength of soil, cement, & fibers. Sample was prepared at MDD and OMC and compacted in a mould of 15cm dia, 17.5cm height. The whole arrangement with a surcharge load was kept for penetration test. For different values of penetration, load readings were recorded. Unsoaked CBR value was determined corresponding 2.5 and 5 mm penetration value. Similar test was carried out for samples at light compaction at light compaction density with varied fibre content.

E. Comparison Of CBR Values Of Different Proportions

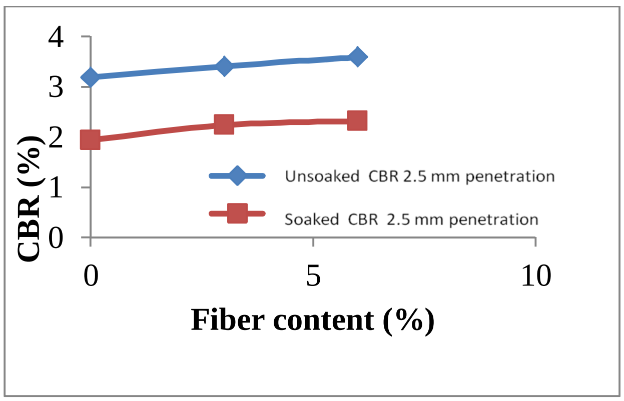

Fig. 9 Variation of CBR % with cement %

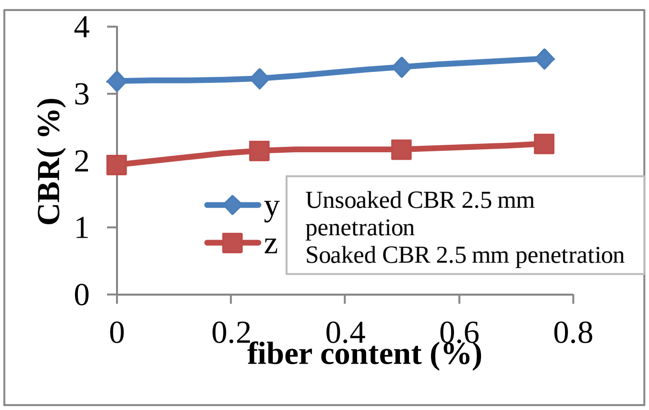

Fig. 10 Variation of CBR % with fiber %

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III. CONCLUSION

In this study the properties of soil with cement increases strength and stiffness but results in brittle failure of the soil. It was also established through literature review that the addition of certain fibers, including coir fibers, can increase the strength of soils. It was found through the laboratory results completed in this study that coir has the ability to improve all engineering characteristics of cement in clay, depending on the cement content and the fiber content. It was found that when low cement content is used with clay a high fiber percentage is the most effective at improving the clay's engineering characteristics .Triaxial tests should also be carried out to determine the effect that the fibers have on shear strength parameters. This should be done because in real circumstances the soil will have confining pressure.

IV. FUTURE SCOPE

Further test should be carried out to determine what affect other parameters such as temperature, moisture content; curing time and compaction have on the cement & clay mixtures. Fatigue analysis should also be carried out to determine if fibers would be an effective additive for road sub grades. The product of other polymer fibers should also be tested and compared with polypropylene fibers.

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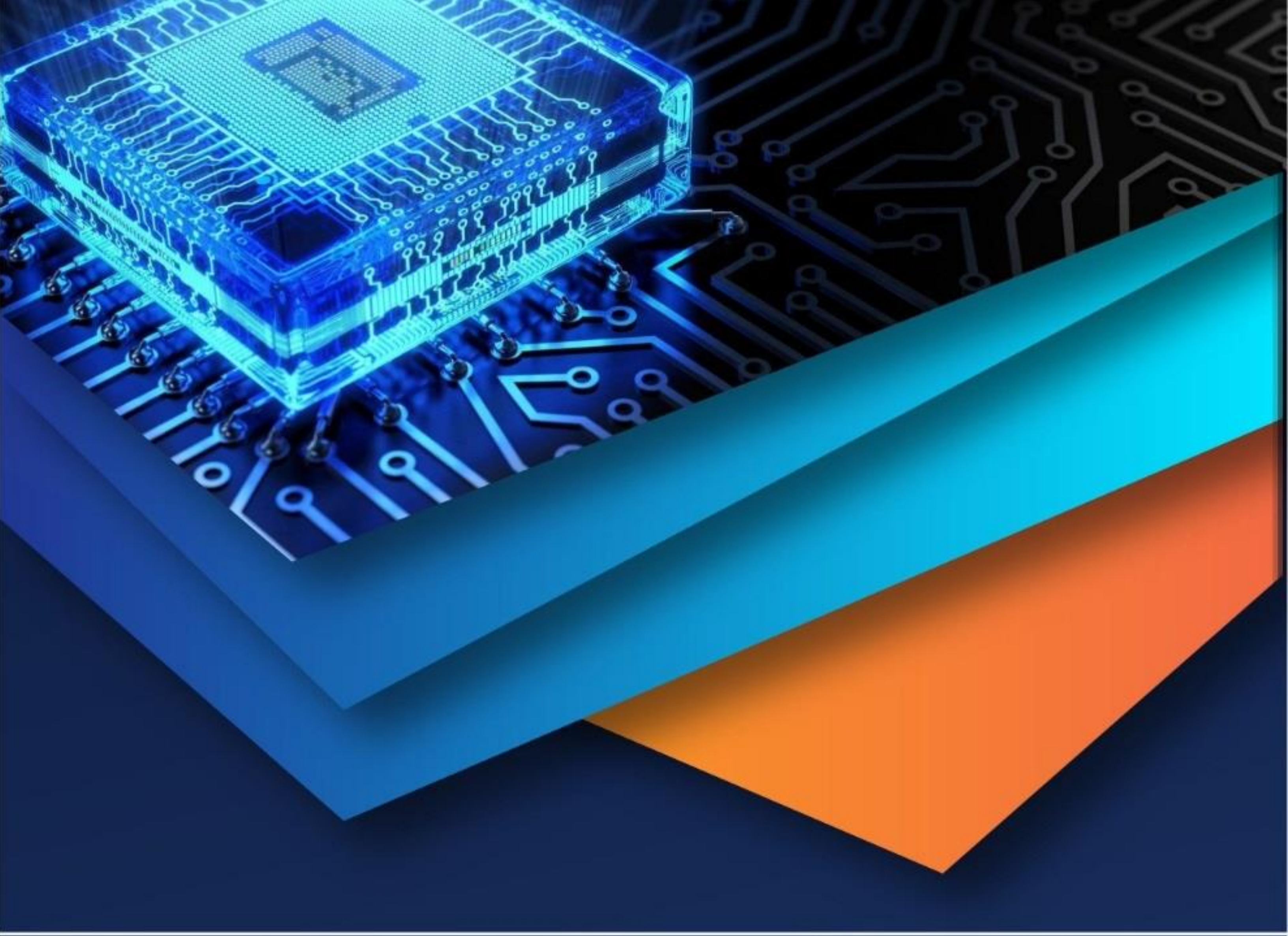

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