iJRASET
International Journal For Research in
Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 5 **Issue:** XI **Month of publication:** November 2017

DOI: http://doi.org/10.22214/ijraset.2017.11009

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 6.887
Volume 5 Issue XI, November 2017- Available at www.ijraset.com

Performance and Analysis of Coir Fibre as Soil Reinforcement

Bhatt Himanshu[1], Nitish Jauhari[2], Harshit Varshney[3]
[1, 2, 3]Department of Civil Engineering Rajshree Institute of Management & Technology, Bareilly

***Abstract:** The increasing tempo of construction activity has led to the requirement of good soil whose availability is less hence, there is need of improving the soil condition which can be accomplished through ground improvement methods. Among all the ground improvement techniques, soil reinforcement is emerging as an attractive alternative. The addition of natural fibre to the soil is very good soil reinforcement technique. Coir fibre extracted from the outer shell of the coconut can be effectively used to tackle much short term stability issue in geotechnical engineering. In this paper attempt is made to determine an optimum proportion mix suitable for geotechnical application by blending clayey soil with randomly distributed coir fibres. Laboratory model studies were conducted to study the effect of the amount of fibre on the strength of soil. The fibre content used were 0.25%, 0.50%, 0.75% and 1%. It can be revealed from this study that mixing of Coir fibre brings out significant improvement in geotechnical properties of soil. The unconfined compressive strength (UCS), Triaxial Shear Test and the California bearing ratio (CBR) values considerably increased with the optimum use of the coir fibre.*
***Keywords:** Coir Fibre, Unconfined Compressive Strength, Triaxial Shear Test, CBR.*

I. INTRODUCTION

Civil engineering constructions over expansive soils have to be resorted to in many cases because of the lack of availability of good bearing soil. Expansive soils are recognised by their undesirable volume changes upon exposure to moisture variations. They exhibit low strength as well as high swell and shrink characteristics. Totackle the problems due to volume changes in soil, stabilisation technique has emerged as a good solution.Reinforcing elements in the form of rods, sheets, strips, membranes, etc. are typical traditional soil improvement techniques. Use of natural materials, such as jute, coir, and bamboo, as reinforcing materials in soil is prevalent for a long time and they are abundantly used in many countries like India, Ceylon, Philippines, etc. The main advantage of these materials is that they are locally available and are very cheap. They are biodegradable and hence do not create disposal problems in the environment. Processing of these materials into usable form is an employment generation activity in rural areas in these countries. If these materials are used effectively, the rural economy can get uplift and also the cost of construction can be reduced, if the material use leads to beneficial effects in engineering construction. 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 biodegradationover a long period of time.Rao and Balan(2000) reported significant gain in strength parameters and stiffness of sand by the inclusion of coir fibres. Raoet al. (2005) found that the behaviour of sand reinforced with coir fibres and geotextiles are similar to that observed with synthetic fibres and meshes. BabuandVasudevan (2007) examined the adequacy of different methods for the strength prediction of coir fibrereinforced sand and also suggested an analytical approach for estimating the stiffness modulus. It is evident from previous studies that the coir indifferent form (e.g., discrete fibres, mesh, etc.) ishighly effective as soil reinforcing element and henceneed to be fully utilised. Limited studies have been reported on the use of randomly distributed discretecoirfibres in fine-grained soils. This paper is based onanevaluation of coir fibre in improving the geotechnical properties of the clayey soil.

A. Material Used

1) *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., theclay of low plasticity. The physical properties of soil are given in Table
2) *Coir Fibre:* Coir fibre was procured from local market in Haldwani, District Nainital (Uttarakhand). Coir used for the study was cut into 30 mm length.

B. Objectives of the Present Study

The objectives of the study are

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 6.887
Volume 5 Issue XI, November 2017- Available at www.ijraset.com

1) To study the various geotechnical properties of soil such as maximum dry density, optimum moisture content, California bearing ratio, unconfined compressive strength and shear strength parameters 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

C. Description Of Test Procedures Followed

1) *Standard Proctor Test:* For all the compaction tests to be performed, sample mixes were prepared by first mixing the dry soil and the material in the required percentage on dry weight basis. The mould of standard volume equal to 1000cc is filled up with the material to be compacted in three layers. Each layer is compacted by 25 blows of standard hammer weighing 2.45kg falling through a height of 12”.Test is repeated at different water contents. Dry density is calculated every water content so as to obtain the compaction curve between moisture content and dry unit weight. The water content corresponding to maximum dry density achieved is taken as the optimum moisture content.
2) *California Bearing Ratio (CBR) Test:*To prepare the samples for CBR test, different mixes chosen were compacted statically in standard moulds at optimum moisture content and maximum dry density. The dimension of the soil sample for CBR test is taken as 150 mm diameter and 125 mm height. Surcharge weight of was used during the testing. A metal penetration plunger of 50 mm diameter and 100 mm length was used to penetrate the samples at the rate of 1.25 mm/minute using CBR testing

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 6.887
Volume 5 Issue XI, November 2017- Available at www.ijraset.com

machine. Soaked CBR tests were conducted after 96 hours soaking. Soaking samples were placed in a tank maintaining constant water level throughout the period.

3) *Unconfined Compressive Strength Test*: The unconfined compressive strength tests

were conducted on the reference mixes obtained from standard compaction test. The sizes of the samples prepared were of aspect ratio 2; i.e., 38 mm diameter and 76 mm length and the strain rate of 1.25 mm/minute was used for testing. The samples were prepared by compacted sample with the help of a temping rod in three layers at optimum moisture content and maximum dry density in the UCS mould of standard dimensions.

4) *Triaxial Shear Test:*The Unconsolidated-Undrained (UU) Triaxial tests were conducted on soil mixed with coir fibre. The cylindrical specimens were prepared at their corresponding MDD and OMC according to IS: 2720 (Part – XI) 1993. The confining pressures used in this study are 0.5, 1 and 2.0 kg/cm^2.The specimen prepared is placed centrally on the pedestal of the Triaxial cell. The cell is assembled with the loading ram and the cell containing specimen is placed in the loading machine. The operating fluid is admitted to the cell and the pressure is raised to the desired value. A rate of axial compression will be selected such that failure is produced within a period of approximately 5 to 15 minutes.

II. RESULTS AND DISCUSSION

A. *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%.

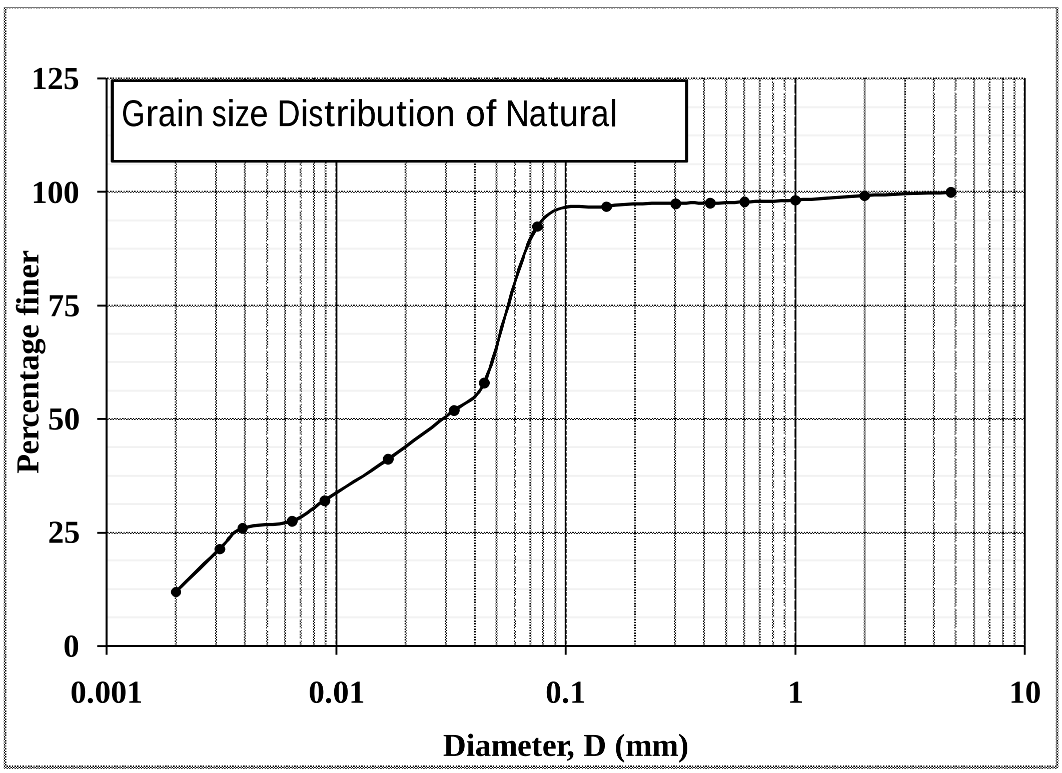
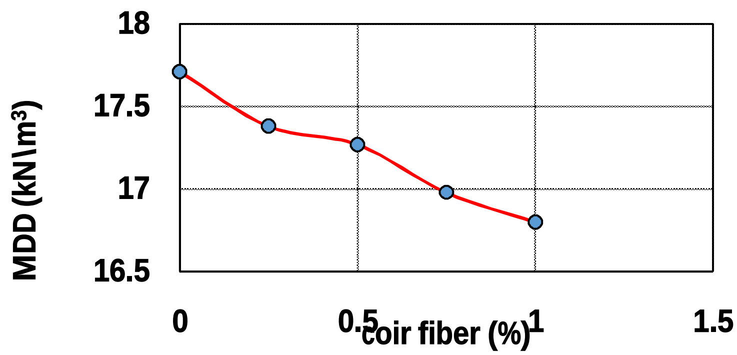


Fig. 1: Grain Size Distribution of Soil

A. *Standard Proctor Test Results*

Compaction tests were carried out on different proportions of coir fibre and soil to study their moisture-densityrelationship. Fig 2.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 of coir 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 that OMC of the soil mix does increase withanincrease 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.



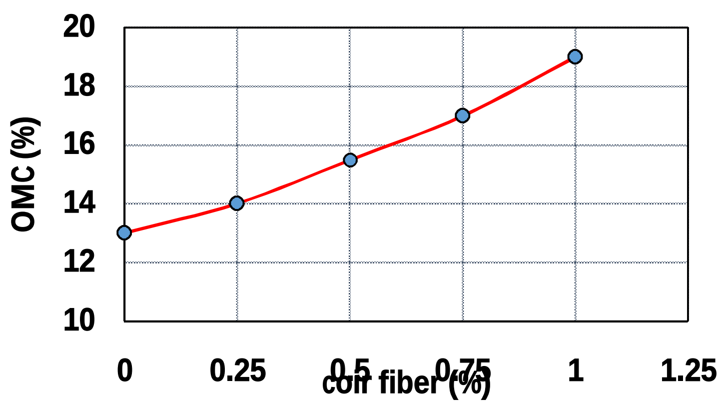


Fig. 2: variation of MDD and OMC

B. 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 intheFig. 3. 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 from6.67% to11.32% for the same optimum fibre content. This improvement in CBR values probably happened because of the better compaction and packing characteristics of the particles achieved with the introduction of additive in the clayey soil

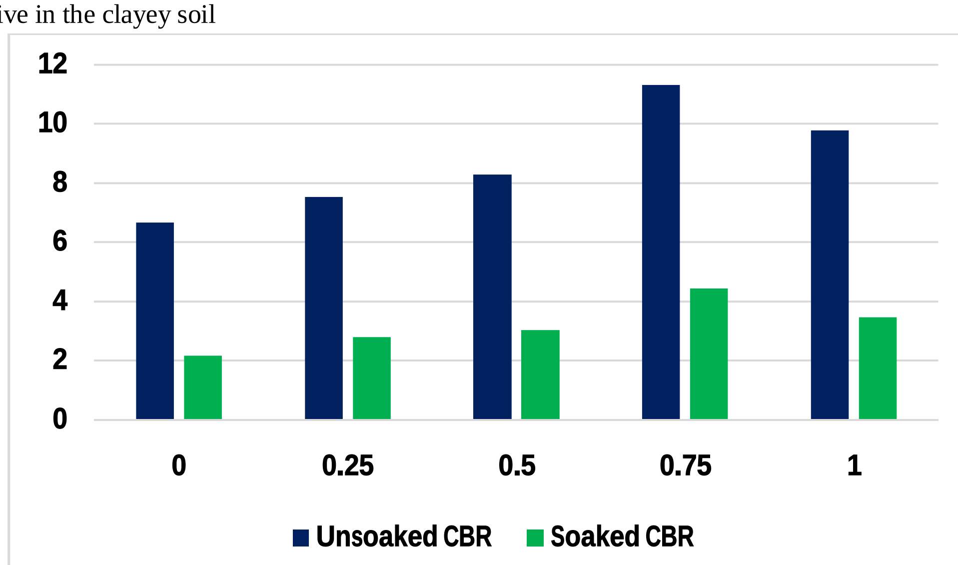


Fig. 3: Unsoaked and Soaked CBR Values

C. 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 4. Unconfined compressive strength of clay used in this study was 151.63kN/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.4.

D. Triaxial Shear Tests Results

Triaxial test was conducted at 0.5, 1 and 2.0 kg/cm^2 cell pressure and the value of cohesion increased from 19.82 to 42.22 kPa at the optimum fibre content and the angle of internal friction increased with increase in coir fibre content, value increased from 16.99 to 29.95^o. The various failure envelope of different soil mix is shown in Fig.5.

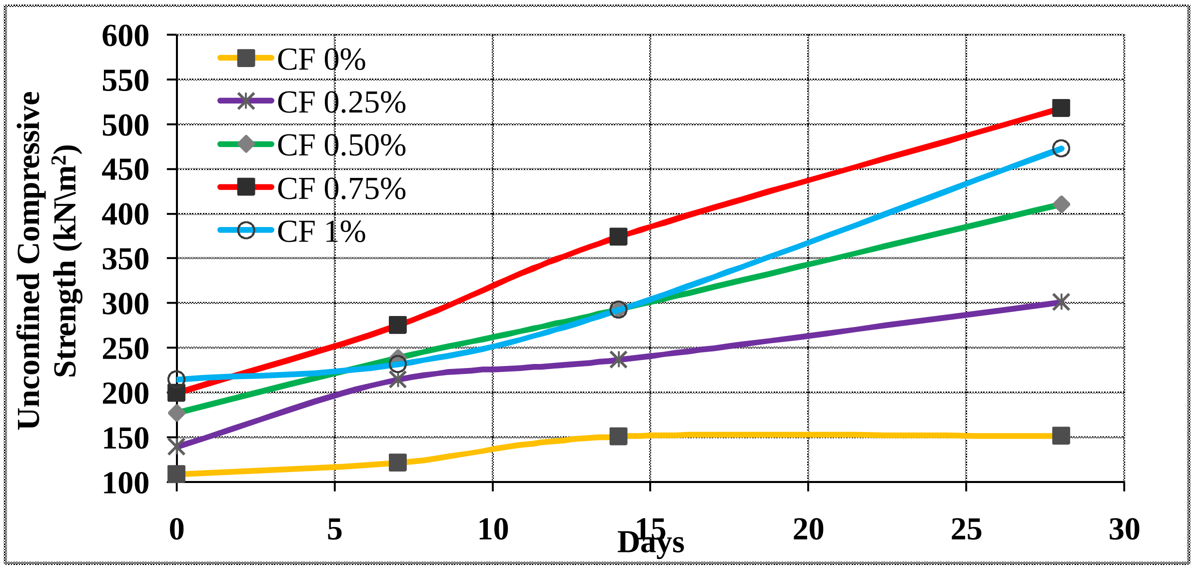


Fig.4: Variation of UCS Value with Days and Different Coir Percentages

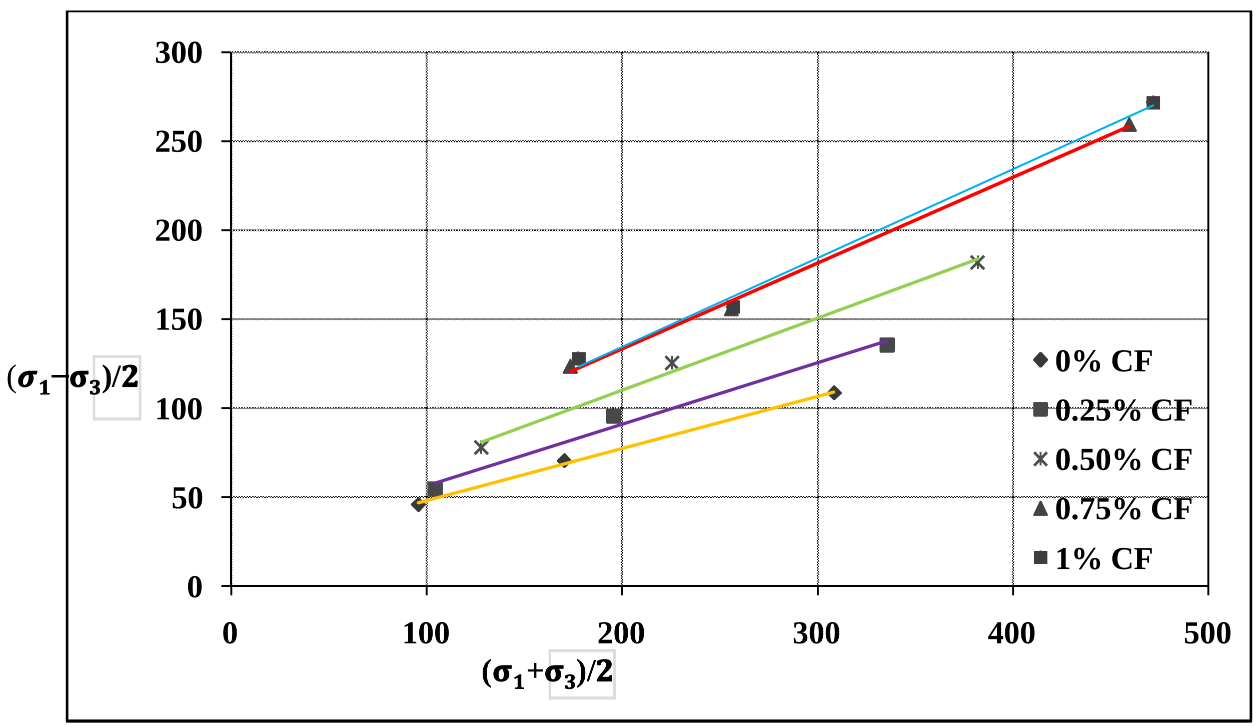
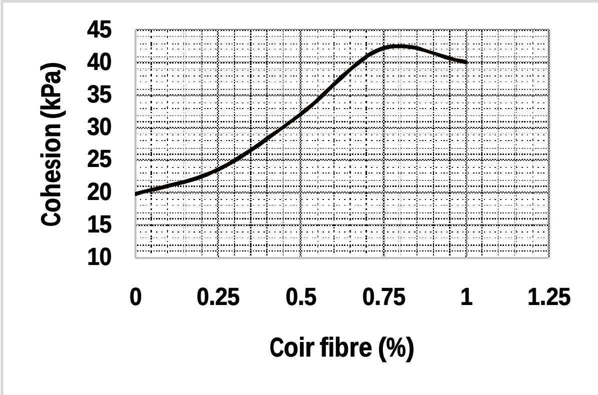


Fig.5:Failure Envelope of Soil Mix



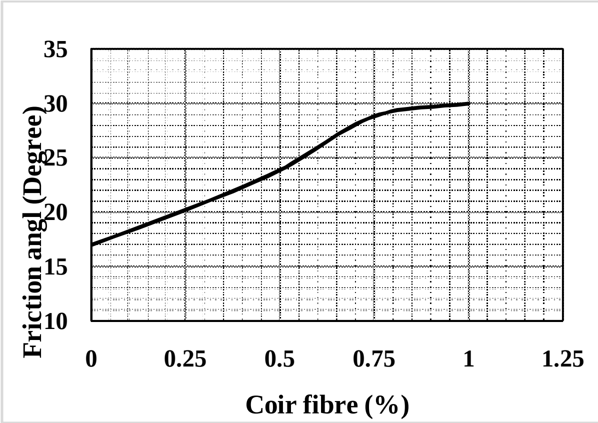


Fig.6: Variation of Cohesion and Angle of Internal Friction with Different Coir Percentage

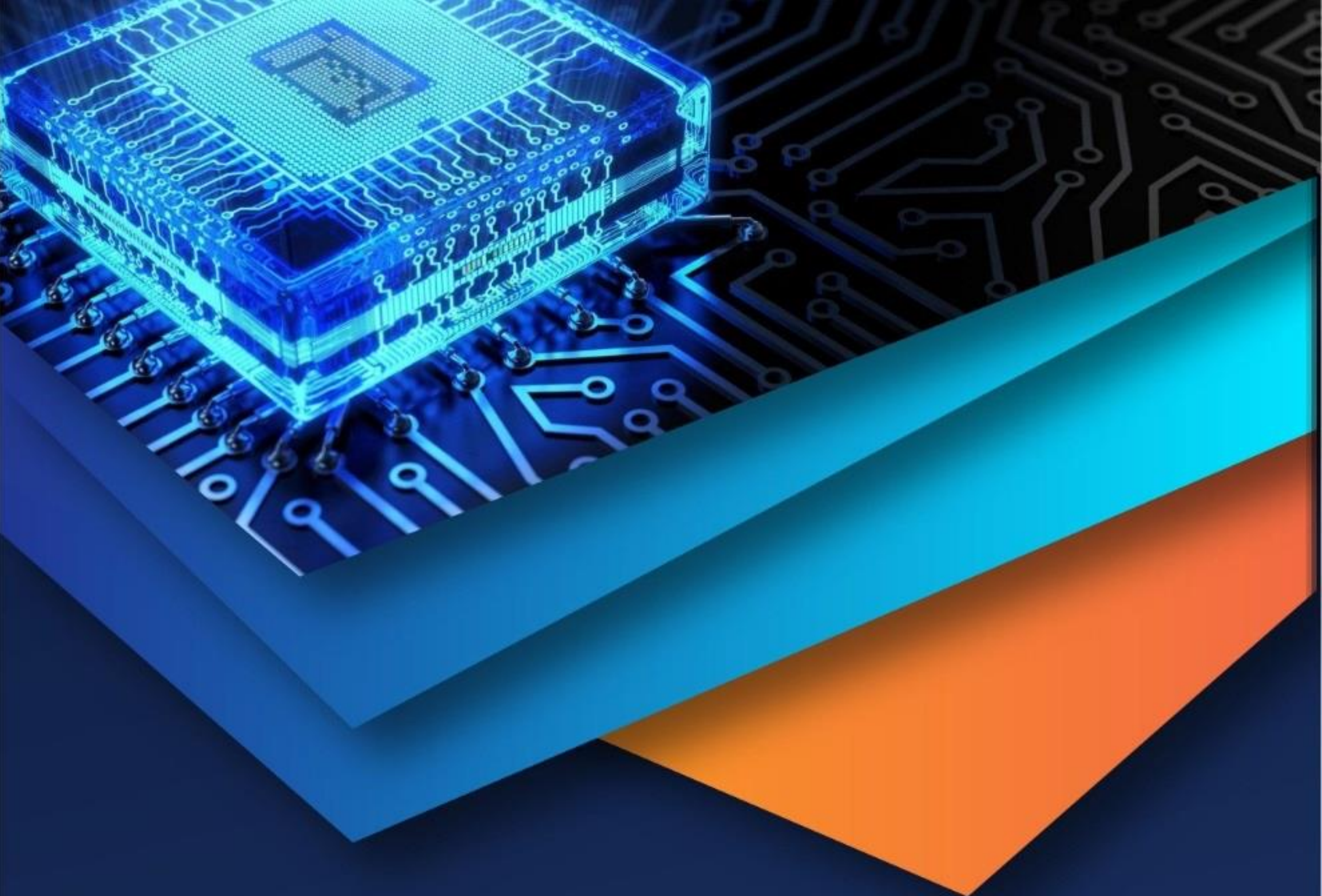
III. CONCLUSIONS

A. 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.
5) The value of cohesion also increases up to the optimum fibre content but the value of angle of internal friction increases with the increase in the fibre content.

REFERENCES

[1] Babu G.S. and Vasudevan A.K.(2007).Evaluation of strength and stiffness response of coir-fibre-reinforced soil. Proceedings of the Institution of Civil Engineers-Ground Improvement, 11(3), pp.111-116.
[2] Banerjee P.K.,Chattopadhyay R. and Guha, A. (2002). Investigations into homogeneity of coir fibres.Indian journal of fibre and textile research vol. 27, June 2002, pp. 111-116.
[3] Chauhan M.S., Mittal S. and Mohanty B.(2008):Performance evaluation of silty sand subgrade reinforced with fly ash and fibre. Geotextiles and Geomembranes, 26(5), pp.429-435.
[4] DasakaS.M. and Sumesh K.S.(2011):Effect of coir fibre on the stress–strain behavior of a reconstituted fine-grained soil. Journal of Natural Fibres, 8(3), pp.189-204.
[5] Peter L., Jayasree P.K., Balan K. and Raj S.A.(2016):Laboratory Investigation in the Improvement of Subgrade Characteristics of Expansive Soil Stabilised with Coir Waste. Transportation Research Procedia, 17, pp.558-566.
[6] Rao G.V. and Balan K.(2000): Coir geotextiles—Emerging trends. Kerala State Coir Corporation Limited, Alappuzha, Kerala.
[7] Rao V.G., Dutta R.K. and Ujwala D. (2005):Strength characteristics of sand reinforced with coir fibres and coir geotextiles. Electronic Journal of Geotechnical Engineering, 10(Bundle G).
[8] Singh H.P.(2013).Effects of coir fibre on cbr value of Itnagar soil. International Journal of Current Engineering and Technology (August 2013).



10.22214/IJRASET

INDEX COPERNICUS 45.98

IMPACT FACTOR: 7.129

TOGETHER WE REACH THE GOAL

IMPACT FACTOR: 7.429

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY