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Experimental Behavior of Clayey Soil with Coir Fiber and Fly Ash

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Abstract: ***Now a day, inefficient properties of soil are a critical issue in engineering projects. In some cases, improve the characteristic of unsuitable soil is a fundamental step for making construction. In the construction of pavements sub grade, & foundations; it should provide considerable strength for the stability of the structure. There are various types of soil present in the earth depending upon the material property, size, texture, various properties. Clayey soil usually have the potential to demonstrate undesirable engineering behaviour, such as low bearing capacity, high shrinkage and swell characteristics and high moisture susceptibility. The usage of coir fibre materials in the civil engineering field has led to the development of new techniques particularly in stabilizing the soils. The experimental study deals with the use of coconut fibre and fly ash for soil stability. The study includes the properties of coir fibre and fly ash and experimental work was carried out in the laboratory. The samples were collected from R.S.Pura tehsil of Jammu district. The methods adopted for analysis is standard proctor test, California bearing ratio test and unconfined compression test. The fraction of Coir Fiber is used in this paper is 2, 2.5, 3 and 3.5 along with fixed value of Fly Ash 20%. The different percentages were determined which showed considerable enhancement in the strength of treated soil. The maximum value of C.B.R. is at 3% Coir Fiber and Fly Ash 20% additional increase in ratio of Coir Fiber the C.B.R. value decreases. The maximum value of U.C.S. is also at 3% Coir Fiber and Fly Ash 20%. Experiment results show Coir Fiber and Fly Ash enhances the strength properties of soil along with use of economical materials and also solves the environment problem.***

Keywords: Clayey Soil, Fly Ash, coir Fiber, Soil Stabilization

I. INTRODUCTION

For growth of the country along with the technological advancements, development in infrastructure field is also required and with the rapid rate of urban growth in our country it is becoming difficult to find the proper quality of soil for engineering applications. Hence, it has become a challenge for a geotechnical engineer to come up with some new ideas which would allow us to work on the even poor quality of soil without any risk of failure of the structure. With a diversification of many types of soil in our country a major category of soil which is of many problems to engineers is expansive soil which creates a lot of problems to structure formed on them. This study focuses on the expansive soils and how various geotechnical parameters can be enhanced by the use of coir Fiber and Fly Ash. The major goal of soil stabilization is to enhance the strength properties and reduce the settlement. Soil stabilization is an efficient and unfailing technique for enhancing soil strength and firmness. The material which is use to mix with soil for the soil stabilization is known as the soil stabilizer. It is illustrious that the mechanism of soil stabilization by coir Fiber and Fly Ash is a worthy method of ground improvement, which leads to increase in UCS, CBR value of clay soil, hence it increases the stability of structures, i.e. sub grade and foundation

II. LITERATURE REVIEW

Nithin et al. (2012) studied the result on silty sand mixed with fly ash and reinforced with coir Fiber and analyzed that randomly distributed coir Fiber are useful in improving the bearing capacity of the soil. The silty sand was mixed with varying content of fly ash from 5% to 20% and coir Fiber was added in the range of 0.5% to 5% with different aspect ratio.

Maliakal et al. (2013) studied the effect of randomly distributed coir Fiber on the strength of clay in shear, for this series of consolidated undrained test were performed with varying Fiber content having an aspect ratio of 50, 100 and 150 and Fiber content of 0.5, 1 and 2% was taken for study. For all percentages of coir Fiber maximum improvement in strength was obtained at the Fiber content of 2% and improvement in strength was 1.7 times in comparison to the unreinforced soil.

Mittal et al. (2014) investigated the clayey soil with varying the percentages of coir Fiber as 0.25%, 0.50%, 0.75% and 1% by weight. A series of unconfined compression test (UCS) and California bearing ratio (CBR) test were conducted in his study. From the study, it was found that there is considerable improvement in compressive strength of the soil reinforced with the coir Fiber. Soil

with no reinforcement had an unconfined strength of 2.75 kg/cm² which then on adding of Fiber increased to a value of 6.33 kg/cm² for coir content of 1% by weight of soil, this increase in value could be because of increase in the shear parameters, it was found difficult to prepare the identical sample beyond 1% of Fiber content so, only up to 1% of coir Fiber was used in his study.

Jayasree et al. (2015) used coir waste which consists of coir pith and short coir Fibers to study the change in the behavior of soil. For the experimental study, six different percentages of coir pith ranging from 0.5 to 3% were used and short FIBER ranged from 0.2 to 1%. After the various tests, it was concluded that swell index reduced by 95% and 92% with the addition of coir pith and coir FIBER respectively also the compression index was reduced by 68 and 94% respectively.

Dr. Sharma et al. (2015) concluded that randomly distributed fibre reinforced soil have recently attracted increasing attention in geotechnical engineering. The main aim of this paper, therefore, is to review the, benefits, properties and applications of coir fibre in soil reinforcement through reference to published scientific.

Peter et al. (2016) investigated the behavior of soil which was stabilized with coir FIBER and also the use of Coir pith was done in the study. Coir FIBER was varied in content of 0.2%, 0.4%, 0.6%, 0.8% and 1% whereas the coir pith was varied from 0% to 3%. It was observed that with the inclusion of both coir pith and coir pith, the maximum dry density decreases and for OMC in the case of coir FIBER was found decreasing initially which could be due to flocculation of clay particle when coir was added to them and again there was increase in an OMC with the further addition of coir FIBER.

Pooja et al. (2017) Tested the behaviour of soil reinforced with Coir FIBER with varying percentage form 0.5% to 1.5% by mass, it was observed that results from the UCS test for soil sample with Fiber content of 0.5%, 1.0% and 1.5% unconfined compressive strength increased from the value starting from 11.68%, 1.26% and 0.62% respectively and concluded that reinforcing soil with Fibers can be considered as good ground improvement technique especially in engineering projects on weak soil where it can act as a substitute to deep or raft foundation, reducing the total cost of project.

III. MATERIALS AND METHODS

A. Soil

350kg sample of soil used in the mix was collected from the fields of RS PURA (JAMMU DISTRICT), J&K. It will be combined with soil and Fiber in different proportions for further analysis. As per IS classification of soil, the soil used is low compressibility silt. The soil properties are given in the table as under:

PROPERTIES	Value
Specific gravity	2.86
Liquid Limit LL (%)	37.5
Plastic Limit PL (%)	21.5
Plasticity Index PL (%)	16
Optimum Moisture Content (%)	13.95%
Maximum Dry Density (KN/M^2)	18.61
C.B.R	3.3(%)
U.C.S	86.57KN/M^2
Indian Soil Classification	CI

B. Fly Ash

Fly ash used in this research work was collected from Varinder Fly Ash Products Yard no. 52, Bari Brahmana, Near Sidco Industrial Lain in District Jammu (Jammu and Kashmir). The fly ash was dried in oven and then it was sieved for the removal of foreign particles. Properties and composition of fly ash as obtained from the plant shown in table

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C. Coir Fiber

The coir fiber used in this study was obtained from Anand mattress manufacturing company GANGYAL (JAMMU DISTRICT), J&K. Coir is a natural fiber having greater tensile strength and can be used as an effective reinforcing material in soil stabilization. The properties and composition of coir fiber are discussed in table.

Chemical properties	Composition
Lignin	45.84 %
Cellulose	43.44 %
Hemi-Cellulose	00.25 %
Pectin's and related compounds	03.00 %
Water soluble	05.25 %
Ash	02.22 %

Physical properties	Value
Length in inches	6-8
Density (g/cc)	1.40
Tenacity (g/Tex)	10.0
Breaking elongation %	30
Diameter in mm	0.1 to 1.5
Rigidity of modulus (dyne/cm^2)	1.8924
Swelling in water (Diameter)	5%
Moisture at 65% RH	10.50

IV. EXPERIMENTAL PROGRAM

The experimental programme for this study includes the processing of materials and their mix proportion to be used for finding various engineering properties of soil- fly ash- coir fiber mix. The procedure for conducting tests i.e. standard proctor test, California bearing ratio test, unconfined bearing ratio is discussed in this chapter. All the tests were conducted according to IS code After the soil was oven dried, following basic tests were performed on it:

A. Atterberg's limit analysis (IS: 2720 Part V-1985)
B. Specific Gravity Test (Pycnometer test) (IS: 2720 Part III-Section I/II-1980)
C. Standard proctor test (IS: 2720 Part VII-1980)
D. California bearing ratio test (IS: 2720 Part XVI-1987)
E. Unconfined compressive strength test (IS: 2720 Part X-1991)

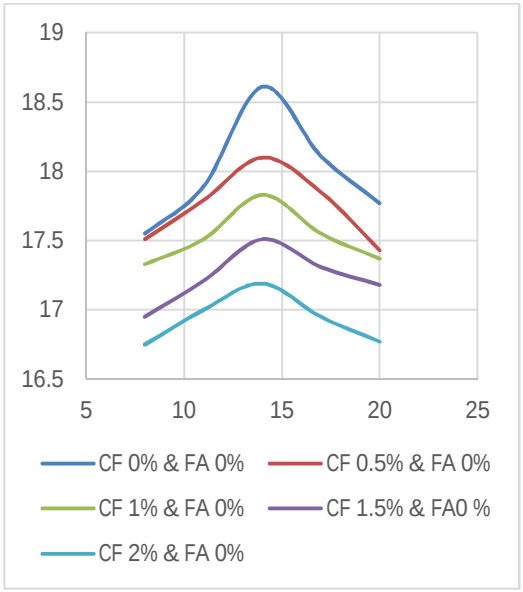
V. RESULTS AND DISCUSSION

A. Standard Proctor Test

Standard proctor's compaction tests using light compaction have been carried out in accordance with IS standard, to determine the MDD and OMC for the selected soil.

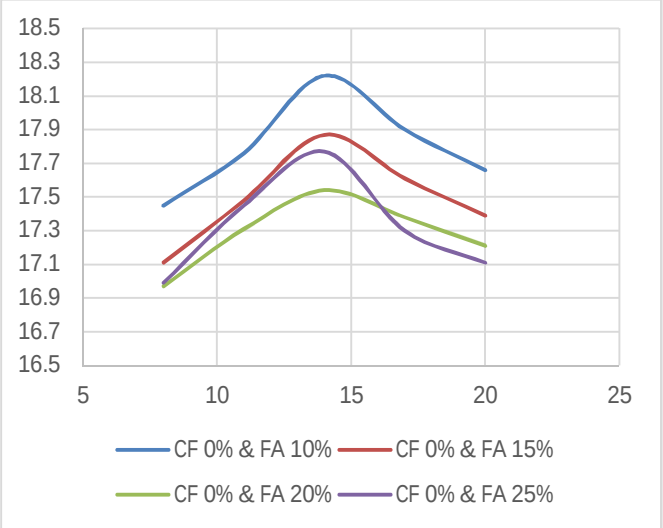
1) Variation of OMC and MDD on Addition of Coir Fiber: The OMC of the soil keep on increasing and MDD keep on decreasing for addition of coir fiber. This is because of the water absorbing capacity of the natural fiber.

S : C	MDD(Kn/m^2)	OMC(%)
100 : 0	18.61	13.95
99.5 : 0.5	18.10	14.13
99 : 1	17.83	14.47
98.5 : 1.5	17.51	14.75
98 : 2	17.19	14.98



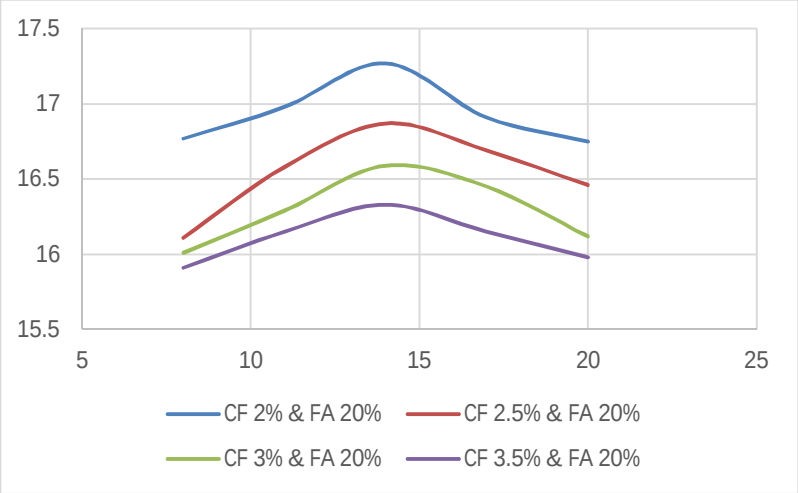
2) *Variation of OMC and MDD on Addition of fly Ash:* The OMC of the soil keep on increasing and MDD keep on decreasing on addition of fly ash.

S : FA	MDD(Kn/m^2)	OMC(%)
90 : 10	18.22	14.25
85 : 15	17.87	14.51
80 : 20	17.54	14.71
75 : 25	17.21	14.85



3) *Variation of OMC and MDD on addition of coir fiber and fly ash*

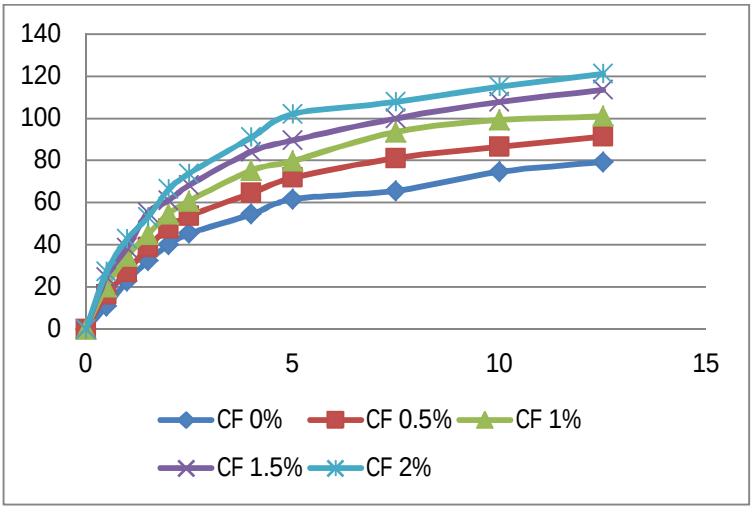
S : FA : CA	MDD(Kn/m^2)	OMC (%)
78 : 20 : 2	17.27	14.71
77.5 : 20 : 2.5	16.87	14.98
77 : 20 : 3	16.59	15.32
76.5 : 20 : 3.5	16.33	15.51



B. California Bearing Ratio Test

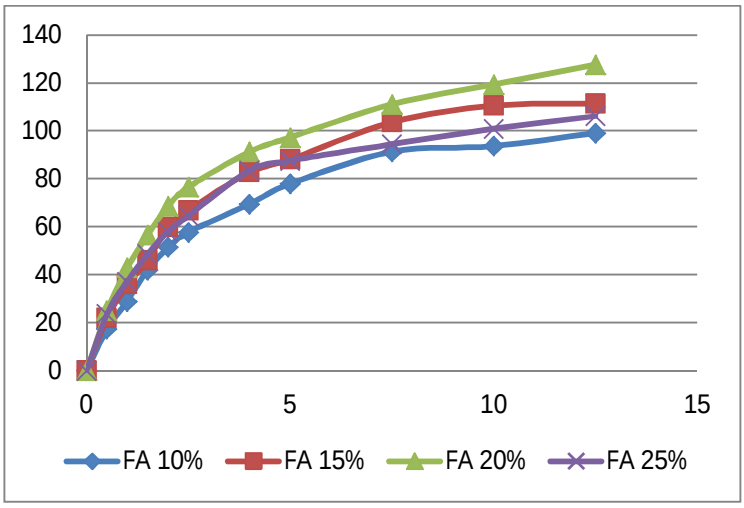
1) Variation of CBR on Addition of Coir Fiber

S : CA	CBR (%)
100 : 0	3.31
99.5 : 0.5	3.92
99 : 1	4.44
98.5 : 1.5	4.98
98 : 2	5.39



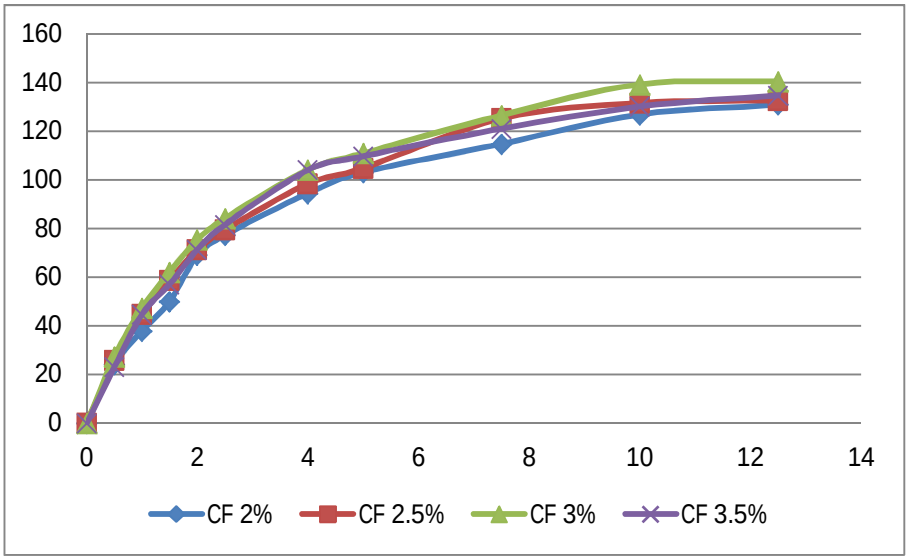
2) Variation of CBR on Addition of fly Ash

S : FA	CBR (%)
90 : 10	4.21
85 : 15	4.88
80 : 20	5.59
75 : 25	4.71



3) Variation of CBR on Addition of Coir Fiber and Fly Ash

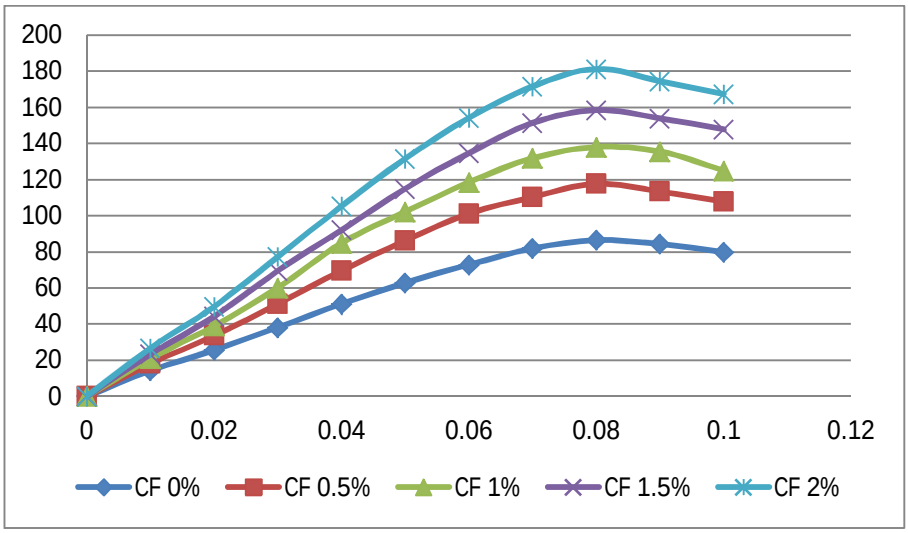
S : CA : FA	CBR (%)
78 : 2 : 20	5.65
77.5 : 2.5 : 20	5.81
77 : 3 : 20	6.15
76.5 : 3.5 : 20	5.96



C. Unconfined Compression Strength Test

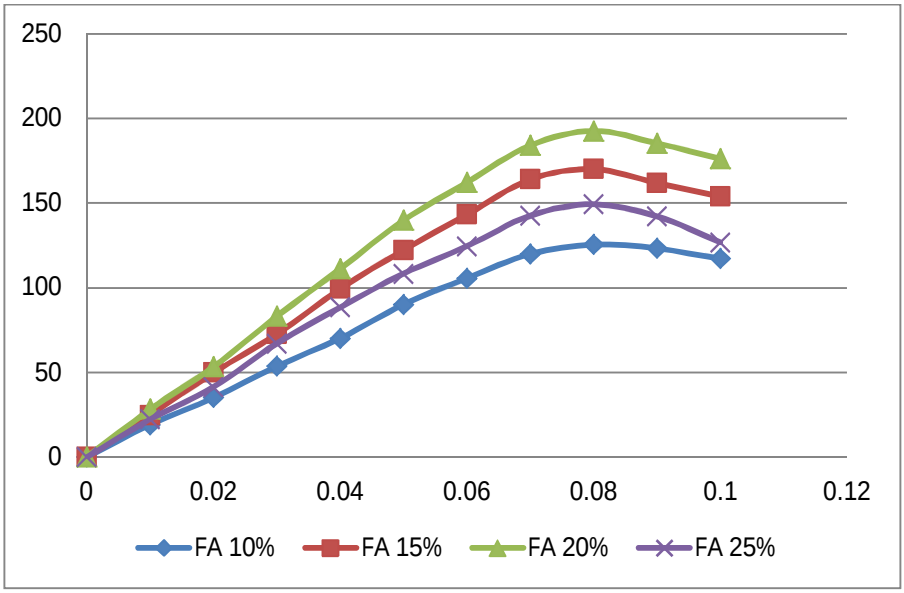
1) Variation of UCS on addition of Coir fiber

S : CA	Curing period	UCS (Kn/m^2)
100 : 0	7	86.57
99.5 : 0.5	7	117.77
99 : 1	7	138.05
98.5 : 1.5	7	158.37
98 : 2	7	181.31



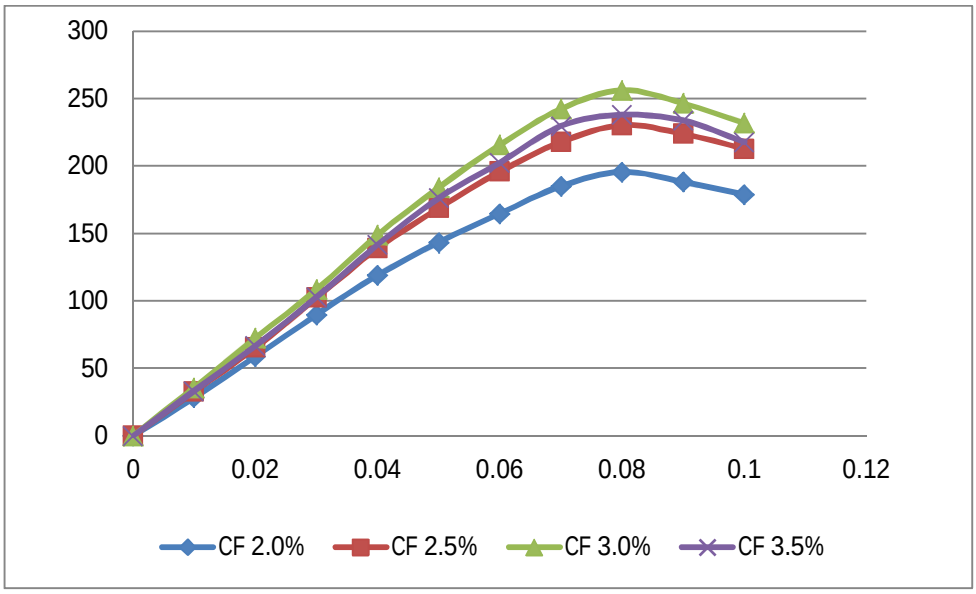
2) Variation of UCS on addition of fly ash

S : FA	Curing period	UCS (Kn/m^2)
90 : 10	7	125.51
85 : 15	7	170.00
80 : 20	7	192.64
75 : 25	7	149.30



3) Variation of UCS on Addition of coir Fiber and Fly Ash

S : CA : FA	Curing period	UCS (Kn/m^2)
78 : 2 : 20	7	195.57
77.5 : 2.5 : 20	7	230.18
77 : 3 : 20	7	256.09
76.5 : 3.5 : 20	7	238.01



VI. CONCLUSION

A. Standard Proctor Test

1) The OMC of the soil keep on increasing and MDD keep on decreasing for addition of coir fiber.
2) The OMC of the soil keep on increasing and MDD keep on decreasing on addition of fly ash.
3) The OMC of the soil keep on increasing and MDD keep on decreasing on addition of 20 % of fly ash.

B. California Bearing Ration Test

1) The CBR value keeps on increasing on addition of coir fiber.
2) The CBR value keeps on increasing on addition of fly ash upto 20 % and then decrease.
3) The CBR value keeps on increasing on addition of coir fiber upto 3% and fly ash upto 20% and then decrease.

C. Unconfined Compression Strength Test

1) The UCS value keeps on increasing on addition of coir fiber.
2) The UCS value keeps on increasing on addition of fly ash upto 20 % and then decrease.
3) The UCS value keeps on increasing on addition of coir fiber upto 3% and fly ash upto 20% and then decrease.

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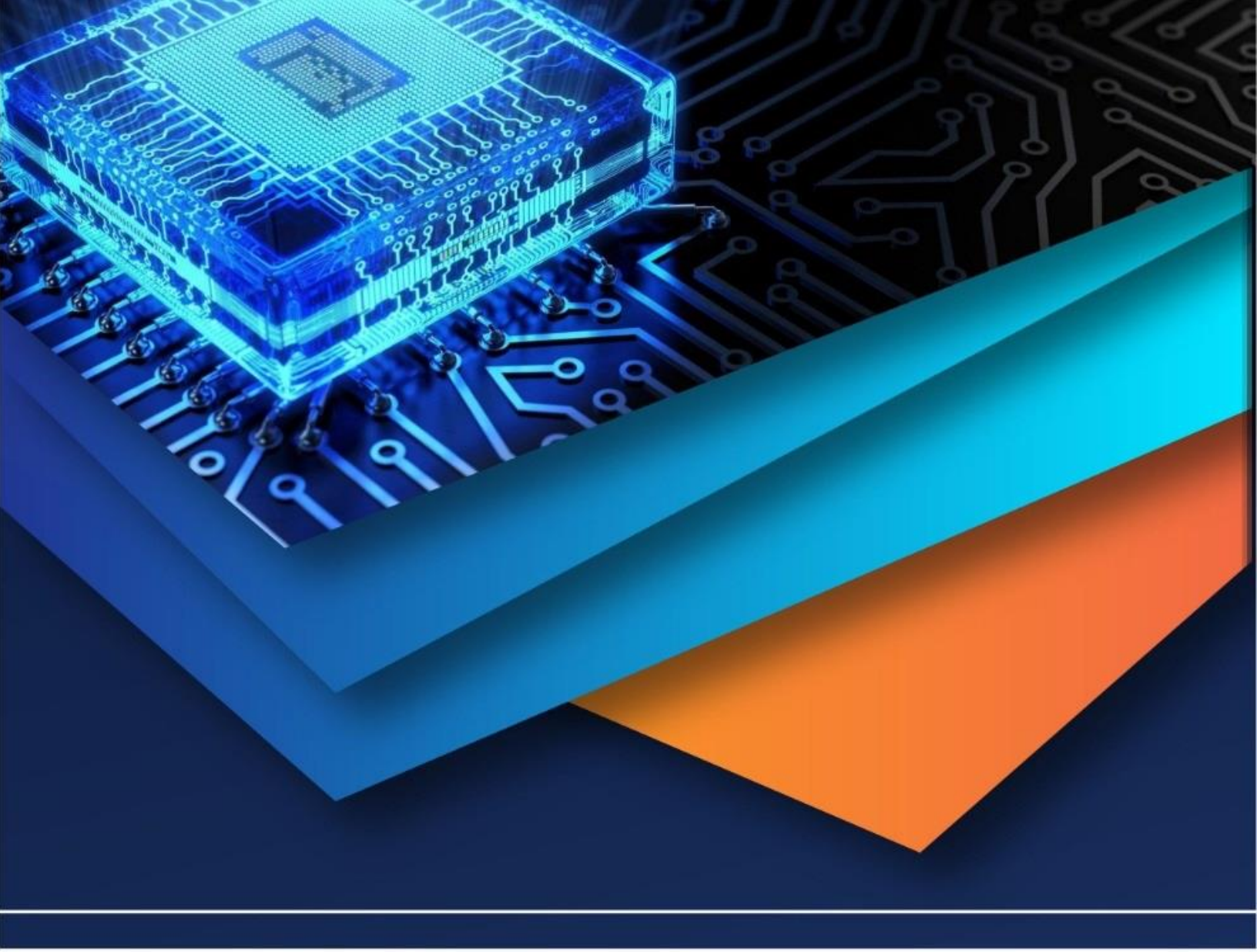

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