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An Experimental Analysis on Expansive Soils using PPWF & Coconut Fibres including SCBA and Lime

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Abstract: ***In India, one-fifth of our land area is covered by Black Cotton Soil which is also known as expansive soil. These soils are mostly found in arid and semi-arid regions. These soils are found to be highly problematic in constructional activities. It causes severe damages to the structure because of its alternate swelling and shrinkage nature. This happens due to alternate drying and wetting of soil. To avoid these circumstances, soil must be stabilized and strength is to be increased. In present investigation the type of solid industrial and agricultural wastage materials namely polypropylene woven fibres and coconut fibres including sugar cane Baggash ash with lime as an admixture are selected to study the effects of the index and engineering characteristics of problematic soil Like Black Cotton Soils. In order to utilize the PPWF & CF including SCBA with lime for the improvement of problematic clay a detailed programmed studies have been formulated. In the longer term, Lime Stabilization provides performance benefits that reduce maintenance costs. In addition to stabilization of new materials, lime is an excellent choice for the reclamation of road bases. In this project work black cotton soil has been used for which soil stabilization has been done using PPWF & CF with SCBA and some percentages of lime content mixed in the soil to impart durability. Here, Index properties and Engineering properties of soil has been found out by using these above solid industrial and agricultural waste materials.***

Keywords: ***Soil Stabilization, Black Cotton Soil, Index & Engineering Properties of Soil, Polypropylene Woven Fibres, Coconut Fibres, Sugar Cane Baggash Ash, Lime Stabilization***

I. INTRODUCTION

In present scenario a lot of research work is being carried out in the area of using locally available materials in road construction which are not only available in nearby area of construction site but give good soil sub-grade strength also. With the increasing of population and the reduction of available land, more and more construction of buildings and other civil engineering structures have to be carried out on weak or soft soil. Owing to such soil of poor shear strength and high swelling & shrinkage, a great diversity of ground improvement techniques such as soil stabilization and reinforcement are employed to improve mechanical behavior of soil, thereby enhancing the reliability of construction. Black cotton soil is one of the major soil deposits of India. Several methods of soil improvement using pozzolanic materials have been developed and used successfully in practice regarding various civil engineering works. In recent years the use of various waste products in civil engineering construction has gained considerable attention in view of the shortage and high costs of conventional construction materials and the increasing costs of waste disposal and environmental constraints. India produces a huge amount of waste materials as by-products from different sectors like industrial, construction, agricultural, etc. These waste materials if not deposited safely, may be hazardous. In a fast developing country where almost each and every day construction activities takes place in a modern sense to improve the structural strength with economic value, uses of prior modern materials are required. In India, one-fifth of our land area is covered by Black Cotton Soil which is also known as expansive soil. These soils are mostly found in arid and semi-arid regions. These soils are found to be highly problematic in constructional activities. It causes severe damages to the structure because of its alternate swelling and shrinkage nature. This happens due to alternate drying and wetting of soil. To avoid these circumstances, soil must be stabilized and strength is to be increased. Stabilization of Soil is a method to improve the index and Engineering properties of soil. In present search the type of solid wastage material namely Polypropylene woven fibres and coconut fibres with sugar cane Baggash ash including lime are selected to study the effects on index properties of problematic soil like BLACK COTTON SOILS. Lime has been added up to 2 to 5%. LIME STABILIZATION provides presentation benefits that decrease maintenance costs.

Salma Siddika etal. (2013) The objective of present research is to study the mechanical properties of jute-coir fiber reinforced hybrid polypropylene (PP) composite according to filler loading variation. In the present work composites were manufactured by using hot press machine at four levels of fiber loading (5, 10, 15 and 20 wt %). Jute and coir fibers were utilized at a Ratio of (1:1) during composite manufacturing. Tensile, flexural, impact and hardness tests were conducted for mechanical characterization. Kuldeep Singh Chouhan and Rajesh Jain (2015) in present study soil sample containing 0% ,9,18,27, of fly ash & the value CBR test strength of soil when get maximum strength to use same content sugar cane fiber 2%,4% ,6% means cut sugar cane fibre1.5 cm and mix with fly ash have been taken . The test result showed significance decrease expansive behavior of black cotton soil the California bearing ratio from 1.19 to 5.65 &unconfined compression ratio from 0.66 to1.43 kg/cm2 maximum dry density reached from 1.66 to 2.11gm/cc also conduct the Triaxial test of soil to determine the value of soil c & Φ all the test conducted as per relevant is code of practice. Kollu. Prabhakar and Koppula. Ramakrishna Reddy (2016) Attempt is made to mitigate the problems of expansive soil by use of Fly ash and small amount of coir fiber. The soil is mixed with fly ash in varying percentage of 20-80% and properties like Atterbergs limit, free swell index, moisture-density relation and CBR are studied. The optimum value of fly ash content in soil is 30% & is selected for further modification with coir fibers content in the range of 0.5-1.5% with different length 10mm, 20mm, and 30mm. Khalid Fazal etal. (2016) did an experimental study which deals with the utilization of coconut Fibre for soil stability. The study includes the properties of fibre Fibre and clay and experimental workouts like tri-axial take a look at, Stress state throughout a tri-axial take a look at, California bearing magnitude relation, unconfined compression take a look at, direct shear take a look at. Coir fibre could be a helpful use waste that improves strength and stiffness of every kind of soil fiber employed in totally different {completely different} proportion and different lengths have an effect on the soil properties. Santosh Kumar Prajapati and Dr. Shubha Khatri (2018) did an experimental analysis for stabilization of BCS by using rice husk ash and wheat husk ash including some percentage of lime. By laboratory tests results it was concluded that by using RHA AND WHA including lime content liquid limit decreases and plastic limit also decreases. Optimum moisture content decreases and maximum dry density increases. Sonali Rai and Dr. Shubha Khatri (2018) in present investigation the type of solid wastage materials namely silica fumes, brick powder and lime are selected to study the effects of the index and engineering characteristics of problematic soil LIKE BLACK COTTON SOILS. In order to utilize the silica fumes & burnt brick powder with lime for the improvement of problematic clay a detailed programmed studies have been formulated. In the longer term, LIME STABILIZATION provides performance benefits that reduce maintenance costs. In addition to stabilization of new materials, lime is an excellent choice for the reclamation of road bases. In this project work black cotton soil has been used for which soil stabilization has been done using silica fumes & brick powder with lime and some percentages of lime and brick powder content mixed in the soil to impart durability. Here, Index properties and Engineering properties of soil has been found out by using these above solid industrial waste materials.

II. METHODOLOGY

In this research a methodology has been carried out to find the solution of expensive soil material like soil is stabilized by using solid industrial and agricultural waste bi-products such as polypropylene woven fibers and coconut fibers including sugar cane Baggash ash with lime in the form of admixture for high performance of high durability of pavements or structure on BCS. BCS is also used for roads, highways, dams and columns etc. In this regard various tests have been performed in laboratory on BCS to find and improve INDEX PROPERTIES OF SOIL MASS and tests which have been performed are: Liquid Limit, Plastic Limit, Shrinkage Limit, Grain Size Analysis, Specific Gravity, and Moisture Content. Light compaction test is also carried out to find out optimum moisture content and maximum dry density. Free Swell Index and CBR test were carried out. Here in this paper we are representing the only liquid and plastic limit tests results.

Table 1: Index Properties of Black Cotton Soil (RGI, BHOPAL, M.P.)

S. No.	PROPERTIES	VALUES
1	Specific Gravity (I.S.2720:PART-3)	2.52
2	Grain Size Distribution (I.S.2720:PART-4)	
	(a) GRAVEL	0.32
	(b) SAND	41.8
	(c) FINES	57.88
3	Liquid Limit (I.S.2720:PART-5)	65
4	Plastic Limit (I.S.2720:PART-5)	41
5	Plasticity Index (I.S.2720:PART-5)	24

6	Free Swell Index (%)	60
7	I.S. Classification of Soil	CH
8	Proctor Compaction Test (I.S.2720:PART-8) (a) MDD (g/cc) (b) MCC (%)	 1.570 17.20
9	CBR (UNSOAKED)	5.59

Table 1 shows the Index Properties of Black Cotton Soils which was taken from RGI CAMPUS, BHOPAL for whole experimental study. Colour of BCS is Black as usual. LL, PL, SL, PI, Sp. Gravity, Free swell index %, I.S. Sieve analysis, OMC & MDD, CBR %, UCS tests have been carried out in REC LAB.

Table 2: Properties of PPWF (LAB TESTING)

S. No.	Properties	Values
1	Unit Weight	0.91 g/cm3
2	Average Diameter	0.034mm
3	Average Length	12mm
4	Breaking Tensile Strength	350MPa
5	Modulus of Elasticity	3500 MPa
6	Fusion point	165°C
7	Burning point	590°C
8	Acid and alkali resistance	Very good
9	Dispercibility	Excellent

Table 3: Properties of Coconut Fibres

Material Property	Values
Density	1.2 g/cm3
Elongation at break	30%
Young's Modulus	3500-6000 Mpa
Fiber Length	60mm-250mm
Diameter	0.1-0.8mm

Table 4: Chemical Properties of Sugar Cane Baggash Ash

S.No.	Chemical Element	% by Weight
1	Silica (SiO_2)	62.43
2	Fe_2O_3	6.98
3	Al_2O_5	4.38
4	K_2O	3.53
5	CaO	2.51
6	SO_3	1.48
7	M_n	0.5
8	Z_n	0.3
9	Cu	0.1

III.EXPERIMENTAL ANALYSIS

After conducting a broad literature survey a methodology of experimental work has been developed regarding experimental analysis. According to an experimental study has been carried out in the laboratory on black cotton soil. To stabilize black cotton soil PPWF and CF with SCBA including lime as an admixture has been used. Index properties of black cotton soil only are investigated here before starting the any other problem. Later then black cotton soil was mixed with PPWF and CF with SCBA including LIME and all these quantities are mixed in a ratio of soil percentage wise. For that also index properties like liquid limit, plastic limit are

investigated to show the effect of PPWF and CF on soil stabilization with SCBA and lime content. Later than light compaction tests, and CBR tests have been carried out to find out Optimum Moisture Content & Maximum Dry Density, strength and thickness pavements etc.

Table:5 Liquid Limit Analysis with 0 to 20% Polypropylene Woven Fibres with SCBA including 5% Lime

Sr. No.	Particulars	Liquid Limit (%)
1.	Only Black Cotton Soils (BCS)	*65*
2.	BCS+5%PPWF+10%SCBA+5%Lime	*63.5*
3.	BCS+10%PPWF+10%SCBA+5%Lime	*60.05*
4.	BCS+15%PPWF+10%SCBA+5%Lime	*55.5*
5.	BCS+20%PPWF+10%SCBA+5%Lime	*50.34*

Table:6 Plastic Limit Analysis of Black Cotton Soils with 0-20% PPWF with SCBA including Lime

Sr. No.	Particulars	Plastic Limit (%)
1.	Only Black Cotton Soils (BCS)	*41*
2.	BCS+5%PPWF+10%SCBA+2%Lime	*40.05*
3.	BCS+10%PPWF+10%SCBA+2%Lime	*37.22*
4.	BCS+15%PPWF+10%SCBA+2%Lime	*35.02*
5.	BCS+20%PPWF+10%SCBA+2%Lime	*30*

Table:7 Liquid Limit Analysis with 0 to 20% COCONUT Fibres with SCBA including Lime

Sr. No.	Particulars	Liquid Limit (%)
1	Only Black Cotton Soils (BCS)	*65*
2	BCS+5%CF+10%SCBA+2%Lime	*60.70*
3	BCS+10%CF+10%SCBA+2%Lime	*55.25*
4	BCS+15%CF+10%SCBA+2%Lime	*51.50*
5	BCS+20%PPWF+10%SCBA+2%Lime	*45.34*

Table:8 Plastic Limit Analysis on Black Cotton Soils with 0-20% COCONUT Fibres with SCBA including Lime

Sr. No.	Particulars	Plastic Limit (%)
1	Only Black Cotton Soils (BCS)	*41*
2	BCS+5%CF+10%SCBA+2%Lime	*38*
3	BCS+10%CF+10%SCBA+2%Lime	*35.25*
4	BCS+15%CF+10%SCBA+2%Lime	*32.51*
5	BCS+20%CF+10%SCBA+2%Lime	*27.05*

IV. RESULTS & DISCUSSIONS

After conducting experimental analysis results are plotted in excel sheet and discussions have been made.

Impact of Different Percentages of PPWF with SCBA including Lime in Black Cotton Soils on LIQUID LIMIT

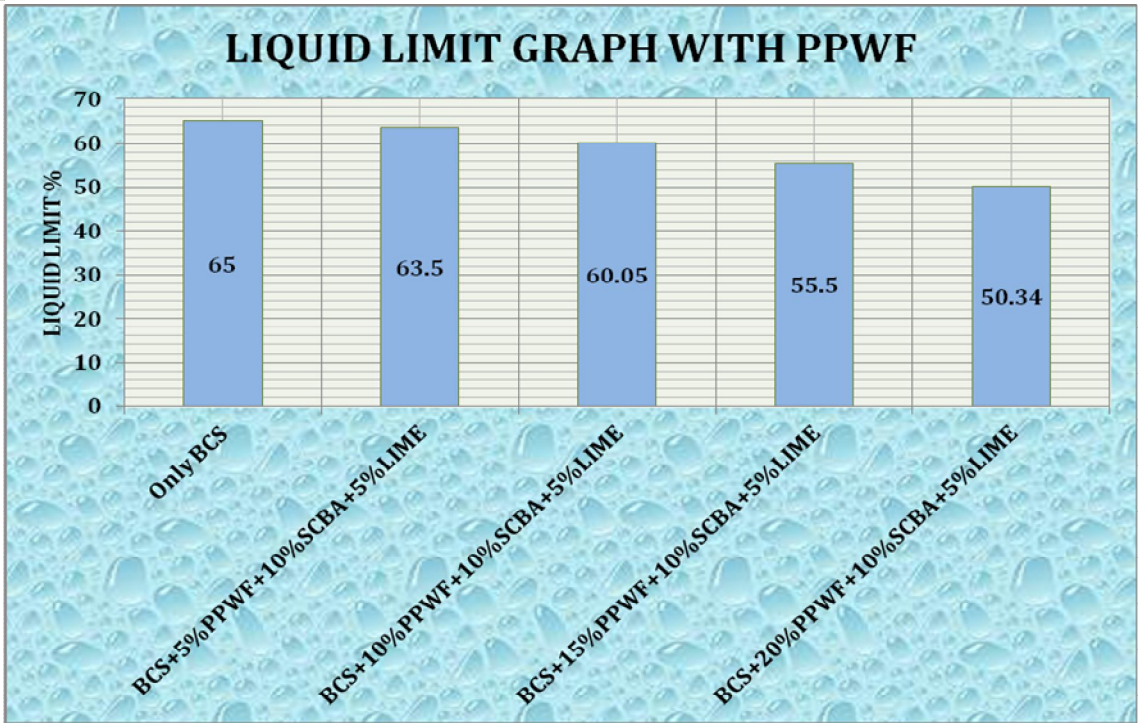

Figure 1: Effects of PPWF with 0-20% on Liquid Limit (%) in BCS including 5% Lime & 10% SCBA

Figure 1 shows the effect of Liquid Limit behaviour on different percentage of PPWF. It can be seen that with addition of 0-20% PPWF+10%SCBA+5%LIME, the liquid limit continuously decreases from a water content of 65% to 50.34%. Figure 5.1 Show the variation of liquid limit of a black cotton soil with increasing proportion of PPWF.

A Comparison Study with Different Percentage of PPWF from 0-20% Including 10% SCBA with 5% Lime Content Mixed in Black Cotton Soils Shows the Impact on PLASTIC LIMIT

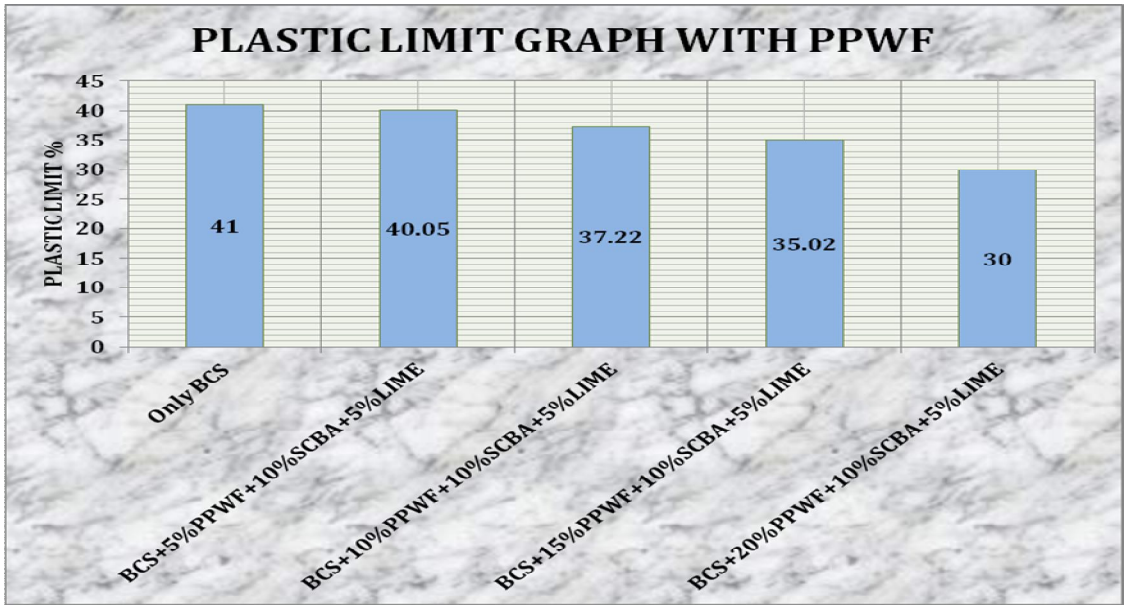

Figure 2: Effects of PPWF with 0-20% including 10%SCBA with5% Lime Content on Plastic Limit

Figure 2 shows the impact of PPWF mixed with black cotton soils with 10% SCBA including 5% Lime as an admixture on Plastic limit. Sugar cane Baggash ash contains pozzolanic activity due to silica as 65% by chemical properties of control and analysis shows its limit by varying percentages of PPWF. When SCBA is taken as 10% as constant and Lime is also 5% as constant and

when these are added up with varying percentages of 0-20 % PPWF in BCS OR EXPANSIVE SOILS absorb rare or small water content so Plastic limit percentage is decreased for all the percentage amount of PPWF continuously because of its (PPWF) H_2O content 3% to 5%.

Impact of COCONUT FIBRES with SCBA + Lime in Black Cotton Soils on LIQUID LIMIT

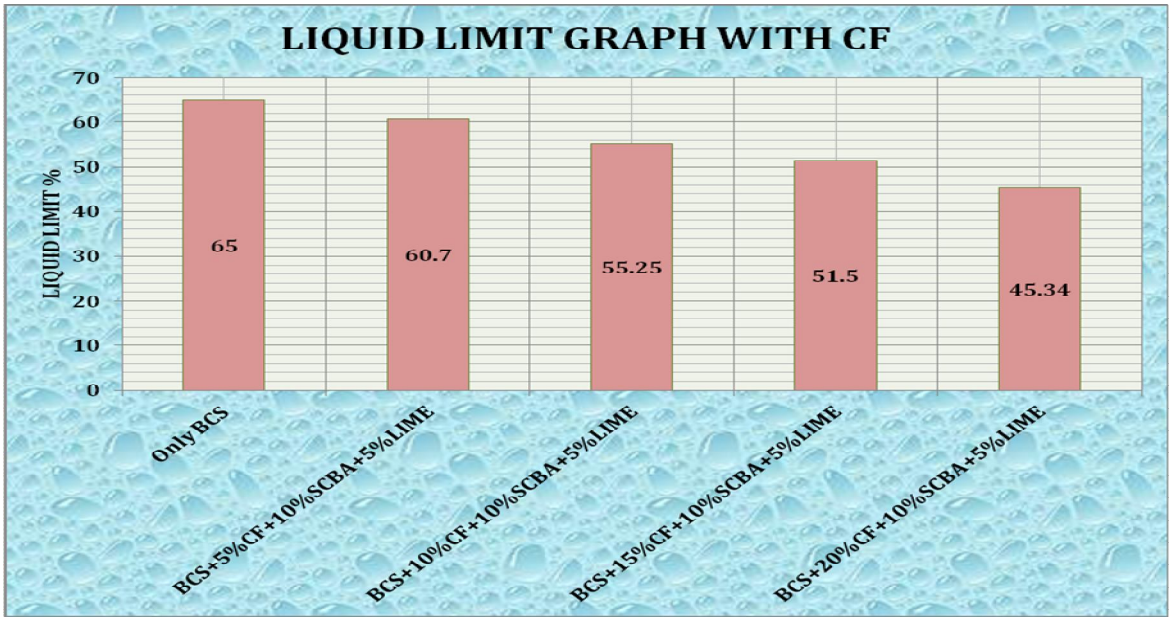

Figure 3 Effects of Coconut Fibres Content with 0-20% with 10%SCBA+5% Lime Content on PL

Figure 3 shows the varying percentages of coconut fibers from 0 to 20% with 10% sugar cane Baggash ash including 5% lime as an admixture in black cotton soil stabilization process. Liquid limit continuously decreases by increasing amount of CF. it means bonding properties of soil particles are much more going to be stronger by pozzolanic reactions and higher density of CF so because of that bonding between CF+SCBA+LIME by which expansive soil bearing capacity increases as compare to Polypropylene Woven Fiber+ SCBA+ LIME.

A Comparison Study with Different Percentage of COCONUT FIBRES from 0-20% Including 10% SCBA with 5% Lime Content Mixed in Black Cotton Soils Shows the Impact on PLASTIC LIMIT

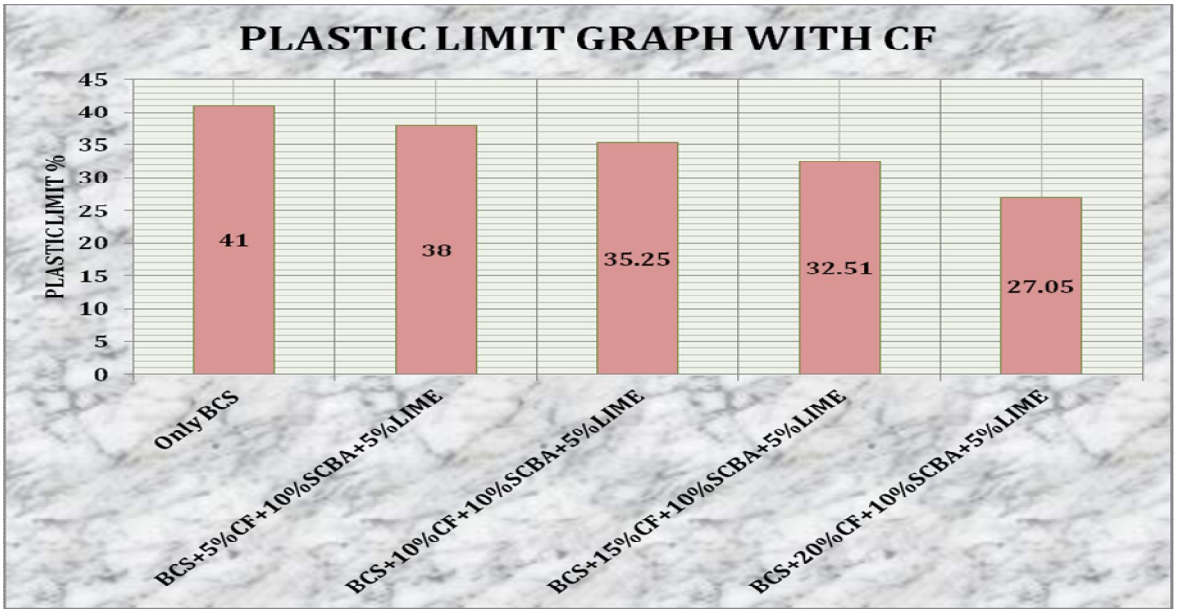

Figure 4: Effects of CF with 0-20% including 10%SCBA with5% Lime Content on Plastic Limit

From Figure 4 it is concluded that the reaction with water occurs even if the soils do not contain significant clay fractions. When clays are present, lime chemical reactions with clays increase the moisture-holding capacity of the soil, which reduces free liquids and decreases in liquid limit and plastic limit decreases because clay particles are reduces by addition of brick dust in black cotton soil. For 5%CF +10% SCBA+5% LIME plastic limit is found to be 38% while for 20% CF+10% SCBA+5% LIME it is found as 27.05% which is a good ratio of decreasing plastic limit by using CF as compare to PPWF in the case of PLASTIC LIMIT as well as in the case of liquid limit.

V. CONCLUSIONS

A. Addition of only polypropylene woven fibers (ppwf) or coconut fibers (cf) in 5% to 20% by dry mass of natural expansive soil (ch) has not given consistent results in plasticity parameters, yet overall there is a tendency of increase in the plasticity index with the addition of ppwf or cf. the highly pozzolanic sugar cane baggash ash (scba) with lime seems to have increased the reactivity of the bcs. liquid limit, plastic limit and shrinkage limit are also increased. omc has been increased and mdd has been decreased. the maximum dry density of expansive soil blended scba+lime mix is reduced as addition of scba. this occurs due to the reason that the void spaces between the scba particles are occupied by the expansive soil particles. the additives have reduced the swell percentage and the rate of swell notably. this implies that the texture and structure of the specimens changed, hence the air entry of specimens increased, allowing faster movement of water into the specimen's hence differential free swell index has been reduced.

B. Liquid Limit & Plastic Limit of Black cotton soil was decreased by addition of lime and SUGAR CANE BAGGASH ASH at different percentages of PPWF from 5-20%. This is because when quicklime chemically combines with water, it can be used very effectively to dry any type of wet soil. Heat from this reaction further dries wet soils. The reaction with water occurs even if the soils do not contain significant clay fractions. When clays are present, lime chemical reactions with clays increase the moisture-holding capacity of the soil, which reduces free liquids and decreases in liquid limit and plastic limit decreases because clay particles are reduces by addition of lime & sugar cane Baggash ash in black cotton soil.

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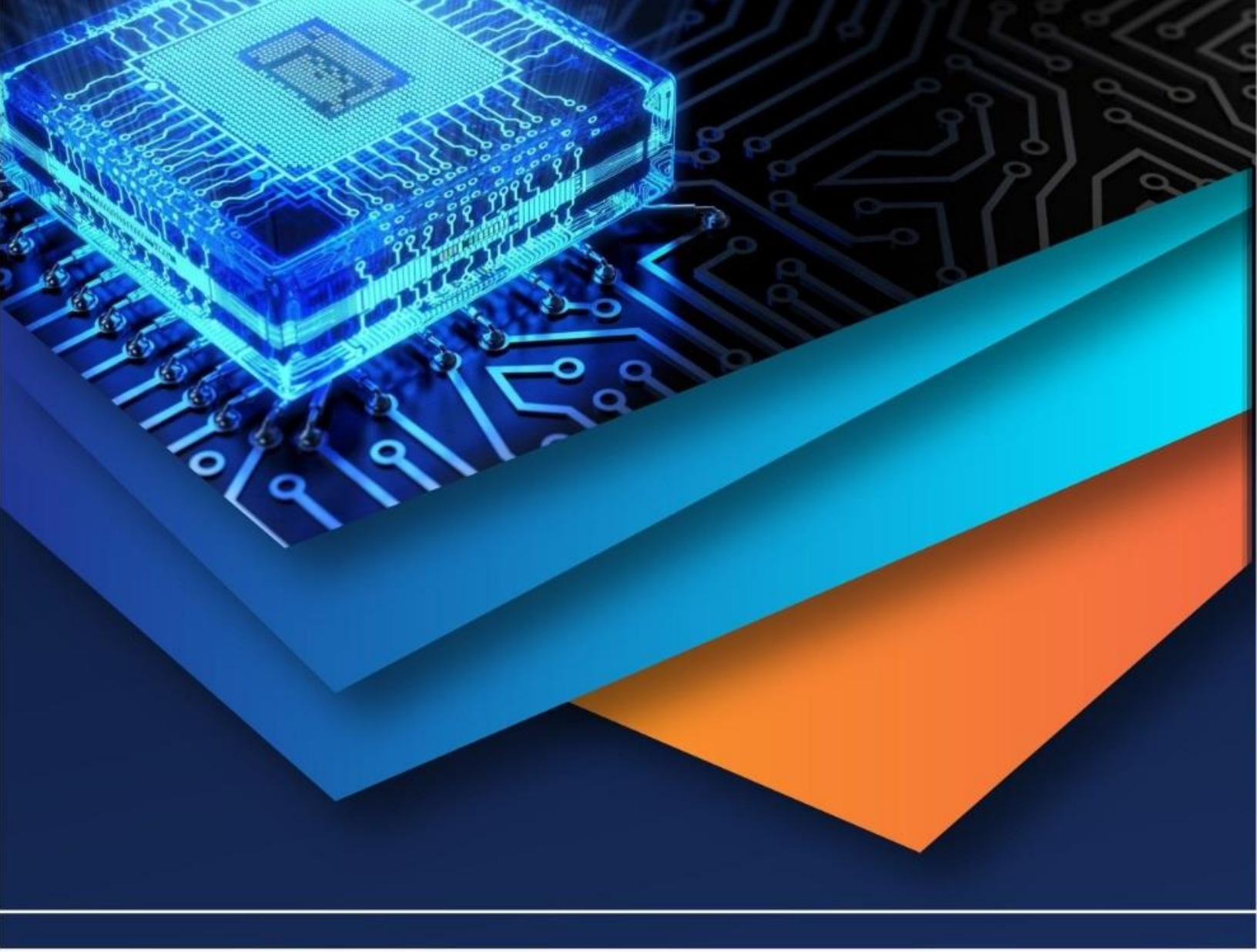

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