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An Experimental Analysis on Expansive Soils Using Silica Fumes Including Burnt Brick Dust & 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 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.***

Keywords: Soil Stabilization, Black Cotton Soil, Index & Engineering Properties of Soil, Silica Fumes, Burnt Brick Powder, 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 BRICK POWDER is selected to study the effects on index properties of problematic soil like BLACK COTTON SOILS. Similarly, an industrial waste material like SILICA FUME has been used in experimental work together with lime 2 to 5%. LIME STABILIZATION provides presentation benefits that decrease maintenance costs.

Saeid. Amiralian etal. (2012), this review paper presents the results of research on soil stabilization with lime and fly ash. Soil stabilization performed the use of technique to adding a binder to the soil in order to improve the engineering performance of soil. Researches were illustrated that adding the additives leads to progress in workability and mechanical behavior of soil after stabilization. Lime and fly ash as local natural and industrial resources were applied for chemical stabilization. Sachin N Bhavsar, etal. (2014), In this study, the potential of burnt brick dust as stabilizing additive to expansive soil is evaluated for the improving

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engineering properties of expansive soil. The evaluation involves the determination of the swelling potential, linear shrinkage, atterberg's limits, & compaction test of expansive soil in its natural state as well as when mixed with varying proportion of burnt brick dust (from 30 to 50%). The practices have been performed on three proportions 30%, 40%, and 50% with expansive soil. The research result shows considerable reduction in swelling of expansive soil .With increasing amount of stabilizer swelling decreases. Maximum decrement in swelling has been noted in 50% of replacement of soil by brick dust. Haresh D. Golakiya etal. (2015), In present work attempt has been made to evaluate the effect of waste addition in black cotton soil for improvement of geotechnical property by performing various laboratory test by varying the proportion of industrial waste to find the optimum mixture for use in geotechnical construction work. The electric arc furnaces use dolomite chips of size 20-40 mm as fluxing additive which are obtained by crushing dolomite stones of larger sizes. The unconfined compressive strength value of black cotton soil increases with increase in dolime fine content. Akshatha R etal. (2016), an experiment investigation is carried out to study the effect of brick powder and lime on engineering and strength properties of the black cotton soils. The properties of stabilized soil such as Atterberg's limits, compaction characteristics and California bearing ratio and their variations with content of brick powder and lime were evaluated. S.Prabhavathi etal. (2017), soil stabilization has been done with the help of randomly distributed polypropylene fibers and brick powder (demolition brick masonry waste). The improvement in the shear strength and soil stability parameters has been stressed upon and comparative studies have been carried out using different methods of shear resistance measurement. Sumit Shringi etal. (2018), it's a review paper. From the above results it is concluded that the impact of marble powder on black cotton soil is positive. By replacing soil its dry weight by marble powder it gives maximum improvement in the swelling and linear shrinkage properties of black cotton soil. So use of marble powder is preferable for stabilization because it gives positive results as stabilizer and also it is a waste utilization.

II. METHODOLOGY

In this research a methodology has been carried out to find the slution of expensive soil material like soil is stabilized by using solid and industrial waste bi-products such as Silica Fumes and Burnt Brick Powder 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. Heavy compaction test is also carried out to find out optimum moisture content and maximum dry density.

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

Soil Properties	Test Results	IS CODE	Values
Color	Black	-	-
Specific Gravity	2.5	IS 2720,1980	2
Liquid Limit %	58%	IS 2720,1985	55-58%
Plastic Limit%	30%		25-30%
Plasticity Index%	28%		25-27%
Shrinkage Limit%	10.5%		12.5%
Free Swell Index%	48%	IS 2720,1977	45-48%
I.S. Classification	CH (High Plasticity)	IS 2720	CH
Grain Size Analysis-% passing 75 micron sieve	99%	-	-
Optimum Moisture Content (OMC) %	18%	IS 2720,1974	16-18%
Maximum Dry Density (MDD) g/cc	1.675		1.5-1.7
California Bearing Ratio (CBR)%	3.8	IS 2720,1974	2.5-5
Unconfined compressive strength kN/m^2	114	IS 2720,1991	117

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Table 1 shows the Index Properties of Black Cotton Soils which was taken from RGI CAMPUS, BHOPAL for whole experimental study. Color 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: Geotechnical Properties of Burnt Brick Dust/Powder (LAB TESTING)

Geotechnical Property	Composition Values %
Grain Size Analysis	%
(a) Gravel Size (%)	0
(b) Sand Size (%)	86
(c) Fines (%)	14
Plasticity Characteristics	%
(a) Liquid Limit (%)	NP
(b) Plastic Limit (%)	NP
(c) Plasticity Index (%)	NP
Max. Dry Density (g/cc)	1.3
Optimum Moisture Content (%)	33
Soaked CBR (%)	21.17

Table 3: Chemical & Physical Properties of Silica Fumes

Properties	Specified Value ASTM (C1240-4)	Jindal (Raigarh) Plant Analysis Results
Sio_2	Minimum 85%	87.64
H_2O	Max. 3%	0.28
Loss on ignition	Max. 6%	1.20
Specific surface area	Min $15m^2/g$	18.5
Pozzolanic index activity (7 days)	Min. 105% of control	124
Retained on 45 micron sieve	Max. 10%	0.25
Bulk Density	$500\text{-}700kg/m^3$	625

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 silica fumes and burnt brick powder 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 Silica Fumes with brick dust 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 silica fumes and brick dust on soil stabilization with lime content. Later than light compaction tests, unconfined compression and CBR tests have been carried out to find out Optimum Moisture Content & Maximum Dry Density, strength and thickness pavements etc.

Table:4 Liquid Limit Analysis with 0 to 40% Silica Fumes including 20% Lime & 20% BP on BCS

Sr. No.	Particulars	Liquid Limit (%)
1.	Only Black Cotton Soils (BCS)	*58*
2.	BCS+20%Lime+20%BP+10%SF	*55*
3.	BCS+20%Lime+20%BP+10%SF	*53*
4.	BCS+20%Lime+20%BP+10%SF	*51*
5.	BCS+20%Lime+20%BP+10%SF	*49*

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Table:5 Unconfined Compressive Strength (UCS) kN/m2 of Black Cotton Soils with 20% lime and 20% BP with varying percentages of Silica Fumes

Sr. No.	Particulars	UCS kN/m2 for 3 Days	UCS kN/m2 for 7Days
1	Only Black Cotton Soils (BCS)	117.5	130.0
2	BCS+20%Lime+20%BP+10%SF	153.09	173.9
3	BCS+20%Lime+20%BP+10%SF	166	189.1
4	BCS+20%Lime+20%BP+10%SF	173.25	199.6
5	BCS+20%Lime+20%BP+10%SF	181.9	200.1

Table:6 Variation of OMC, MDD, UNSOAKED CBR (%) & FREE SWELL INDEX of Black Cotton Soils with 20% lime and 20% BP with varying percentages of Silica Fumes

Sr. No.	Engineering Properties	Particulars				
1	IS light compaction for low traffic volume flexible pavements	Only BCS	BCS+20%Lime +20%BP +10%SF	BCS+20% Lime +20%BP +20%SF	BCS+20% Lime +20%BP +30%SF	BCS+20% Lime +20%BP +40%SF
	MDD g/cc	1.675	1.7	1.75	1.80	1.83
	OMC %	18	17.8	16.5	15.8	15.01
2	CBR % for unsoaked soil	3.8	4.67	7.81	11.82	20.07
3	Free Swell Index %	48	40	35	32.5	30

IV. RESULTS & DISCUSSIONS

After conducting experimental analysis results are plotted in excel sheet and discussions have been made. Impact of Different Percentages of Silica Fumes with Lime and Brick Powder in Black Cotton Soils on liquid limit

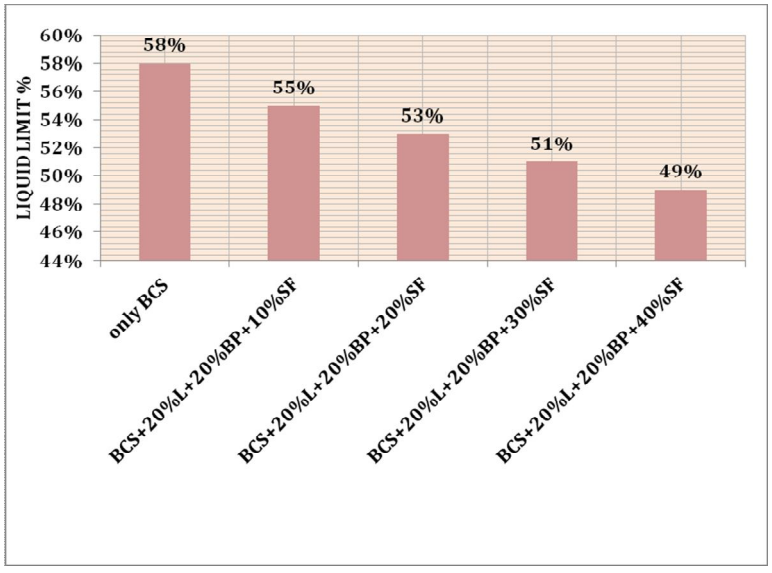


Figure 1Effects of Silica Fumes with 0-40% on Liquid Limit (%) in BCS including 20% Lime & 20% Brick Powder

Black cotton soil is also called as expensive soils because of absorbing its high moisture content. In this regard Burnt brick powder and lime as an admixture have been added in black cotton soils with constant percentages and i.e. 20% for both respectively. These quantities of BP and Lime have been mixed in soil with varying percentages of Silica Fumes from 10% to 40%. BP is a non-plastic

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material and lime is also acts as a water reducing agent so when they are added to the soil so liquid limit is decreased continuously with increase of Silica Fumes. Figure 5.8 For BCS+20%L+20%BP+10%SF Liquid Limit is obtained as 55%. Similarly, for BCS+20%L+20%BP+40%SF Liquid Limit is 49%. Liquid limit of Black cotton soil was decreased by addition of lime and brick dust at different percentages. 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 brick dust in black cotton soil.

A Comparison Study with Different Percentage of Silica Fumes from 0-40% Including 20% Lime Content % 20% Brick Powder Mixed In Black Cotton Soils Shows the Impact on OMC

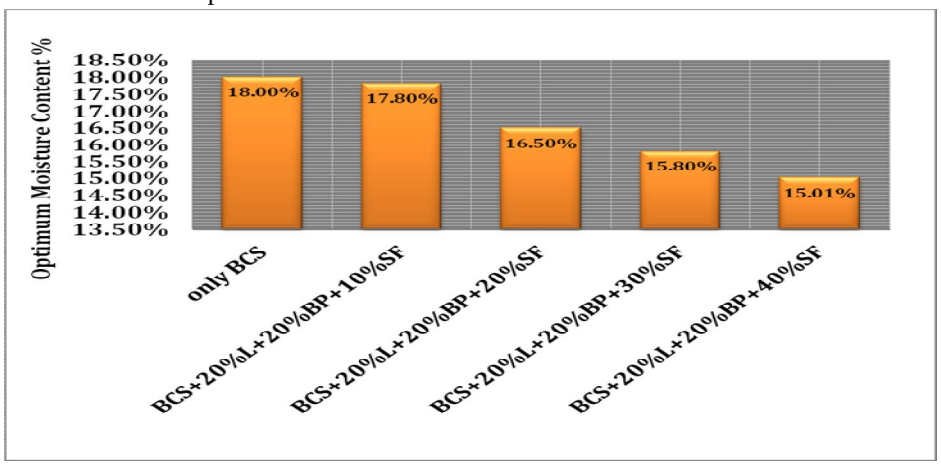


Figure 2 Effects of Silica Fumes with 0-40% including 20% Lime Content and 20% Brick powder on Optimum Moisture Content %

Figure 2 shows the decrement in Optimum Moisture Content with increasing amount of Silica Fumes from 10%-40% including 20% lime and 20% brick powder in black cotton soils. As brick powder is a non-plastic materials and lime acts as a water reducing agent so because of that ingredients water content will be reduced as soil particles will be more dense during compaction so void ratio will be decreased. For only black cotton soil OMC is 18% but for BCS+20%L+20%BP+10%SF OMC is decreased by 17.8% with very little reduction and up to 40%SF+20%L+20%BP OMC will be reduced by 15.01%.

A Comparison Study with Different Percentage of Silica Fumes from 0-40% Including 20% Lime Content % 20% Brick Powder Mixed In Black Cotton Soils Shows the Impact on MDD

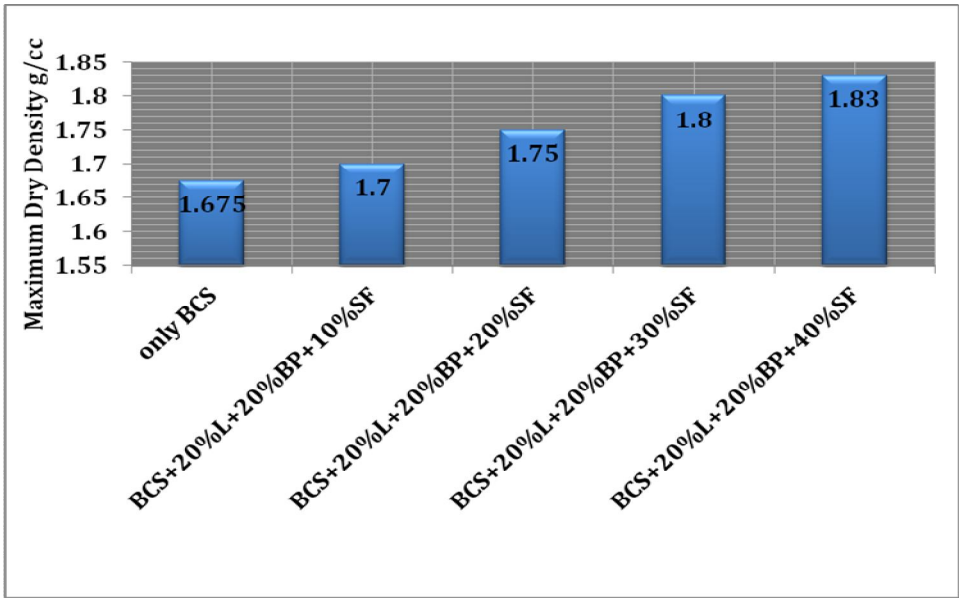


Figure 3 Effects of Rice Husk Ash Content with 5-20% including 5% Lime Content on OMC (%)

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From Figure 3 It is observed that maximum dry density (MDD) of the expansive soil-micro silica fume composite decreases with the increase in micro silica fume content up to 40% whereas the optimum water content (OMC) increases. This occurs due to the reason that the void spaces between the micro silica fume particles are occupied by the expansive soil particles. From figure 5.12 it is concluded that when micro silica fumes is added with lime and brick powder do void spaces are occupied by dense material to reduce moisture content and because of that maximum dry density increases.

A Comparison Study With Different Percentage Of Silica Fumes From 0-40% Including 20% Lime Content % 20% Brick Powder Mixed In Black Cotton Soils Shows The Impact On CALIFORNIA BEARING RATIO % VALUES @5 mm PENETRATION

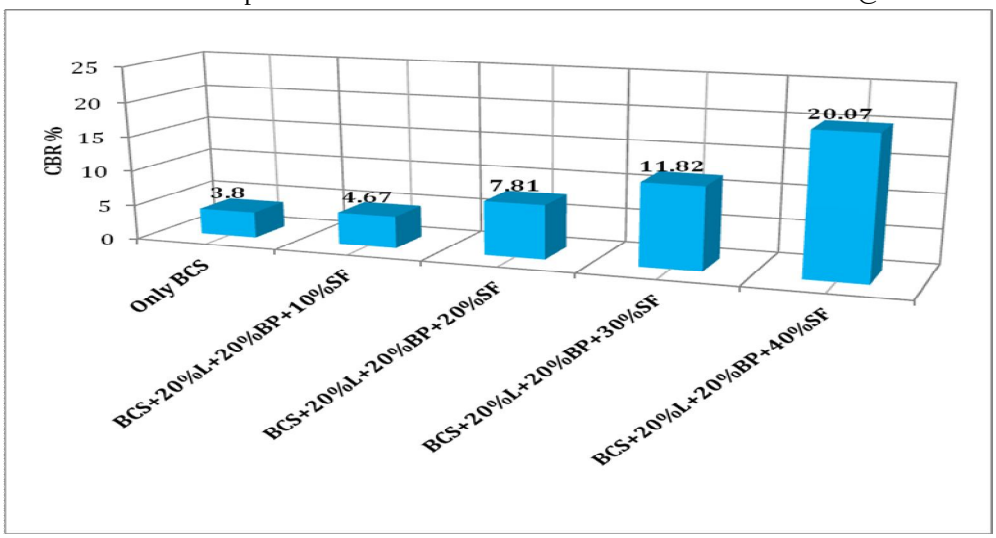


Figure 4 Figure 5.13 Effects of Silica Fumes with 0-40% including 20% Lime and 20% Brick Powder Content on CBR (%) @5mm Penetration

The variation of CBR with lime and burnt brick powder content with addition of silica fumes from 0% to 40% is shown in Figure 4. For the unsoaked soil samples, the value of CBR has slight increase with addition of 10%, 20%, 30% and 40% of Silica Content with 20% Lime content & 20% brick powder in BCS. The decrease in CBR value is due to clay content reduction in soil while only silica fumes were used in the soil. This results in reduction of cohesive force in the soil sample. CBR values increases with increasing percentage amount of Silica Fumes with constant amount of lime and brick powder because of heavier specific gravity of silica fumes, lime and brick powder. CBR value for only black cotton soils is 3.8. After that it has been increased for BCS+10%SF+20%L+20%BP i.e. 4.67% to 20.07% CBR for BCS+40%SF+20%L+20%BP for unsoaked soil sample @ 5mm penetration.

A Comparison Study With Different Percentage Of Silica Fumes From 0-40% Including 20% Lime Content % 20% Brick Powder Mixed In Black Cotton Soils Shows The Impact On UNCONFINED COMPRESSIVE STRENGTH FOR 3 & 7

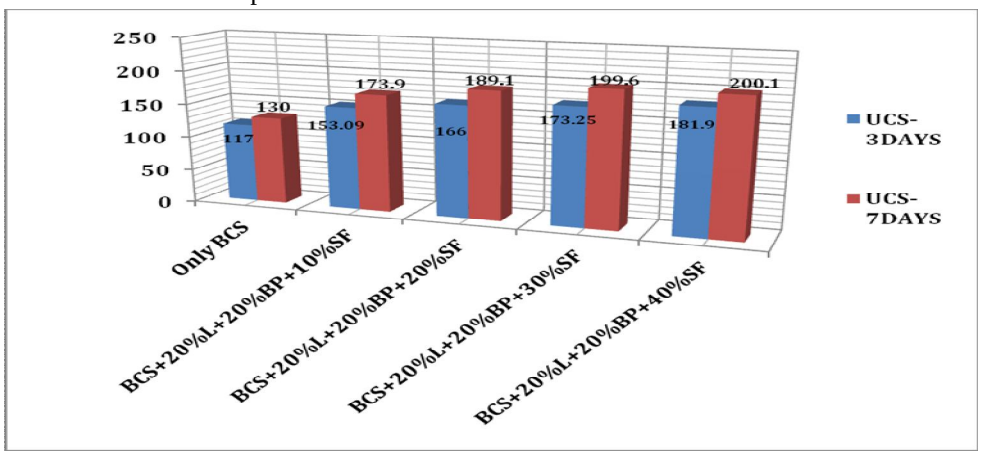


Figure 5 Effects of Silica Fumes with 0-40% including 20% Lime and 20% Brick Powder Content on Unconfined Compressive Strength

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By increasing the percentages of Silica Fumes from 10%-40% including 20% lime and 205brick powder, UCS of soil increases up to a limit. The UCS of Black cotton soil increases to 117 kN/m^2 for only BCS to 181.9 kN/m^2 for BCS+40%SF+20%L+20%BP @3 DAYS. Similarly, 130 kN/m^2 for only BCS to 200.1 kN/m^2 for BCS+40%SF+20%L+20%BP @ 7 DAYS.

V. CONCLUSIONS

A. LIQUID LIMIT of Black cotton soil was decreased by addition of lime and brick dust at different percentages. This is because when quicklime chemically combines with water, it can be used very effectively to dry any type of wet soil

B. The UCS of Black cotton soil increases to 117 kN/m2 for only BCS to 181.9 kN/m2 for BCS+40%SF+20%L+20%BP @3 DAYS. Similarly, 130 kN/m2 only for BCS to 200.1 kN/m2 for BCS+40%SF+20%L+20%BP @ 7 DAYS.

C. CBR values increases with increasing percentage amount of Silica Fumes with constant amount of lime and brick powder because of heavier specific gravity of silica fumes, lime and brick powder. CBR value for only black cotton soils is 3.8. After that it has been increased for BCS+10%SF+20%L+20%BP i.e. 4.67% to 20.07% CBR for BCS+40%SF+20%L+20%BP for unsoaked soil sample @ 5mm penetration.

REFERENCES

[1] Saeid. Amiralian, Amin. Chegenizadeh, and Hamid. Nikraz (2012), "A Review on The Lime and Fly ash Application in Soil Stabilization", International Journal of Biological, Ecological and Environmental Sciences (IJBEES) Vol. 1, No. 3, 2012 ISSN 2277 – 4394.

[2] Sachin N. Bhavsar, Hiral B. Joshi, Priyanka k. Shrof, Ankit J. Patel (2014), " EFFECT OF BURNT BRICK DUST ON ENGINEERING PROPERTIES ON EXPANSIVE SOIL", IJRET: International Journal of Research in Engineering and Technology eISSN: 2319-1163 | pISSN: 2321-7308, Volume: 03 Issue: 04 | Apr-2014, Available @ http://www.ijret.org

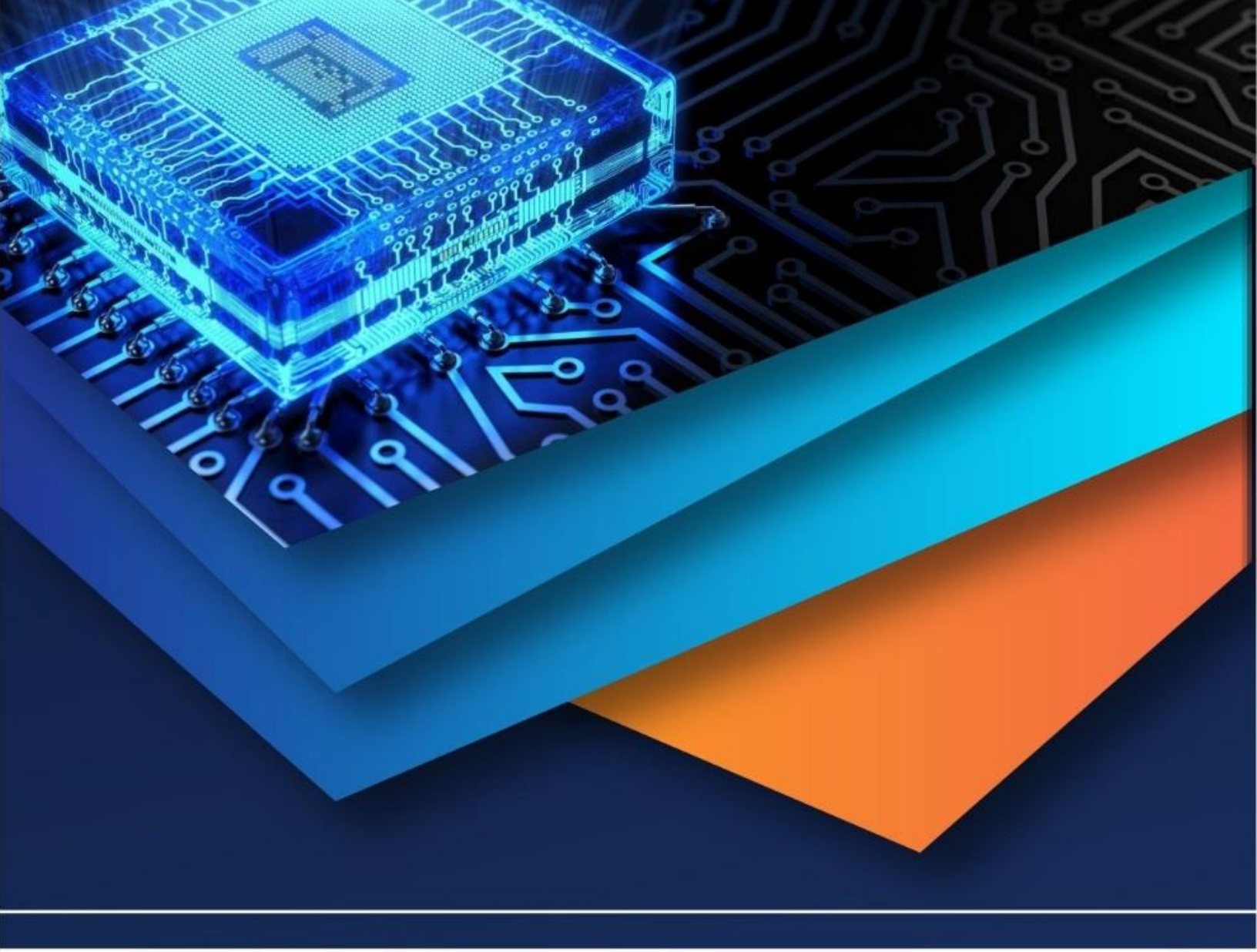
[3] Haresh D. Golakiya, Chandresh D. Savani (2015), "STUDIES ON GEOTECHNICAL PROPERTIES OF BLACK COTTON SOIL STABILIZED WITH FURNACE DUST AND DOLOMITIC LIME", International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395 -0056 Volume: 02 Issue: 08 | Nov-2015 www.irjet.net

[4] Akshatha R and Bharath H M (2016), "Improvement in CBR of Black Cotton SoilUsing Brick Powder (Demolition Brick Masonry Waste) and Lime", International Journal of Innovative Research in Science, Engineering and Technology (An ISO 3297: 2007 Certified Organization), Vol. 5, Issue 9, September 2016.

[5] S.Prabhavathi, K.Gokulraj, S.Naresh and D.Saravanan (2017), "Experimental Investigation on Soil Stabilization of using Fiber Material and Brick Powder", IJIRST –International Journal for Innovative Research in Science & Technology| Volume 3 | Issue 11 | April 2017, ISSN (online): 2349-6010.

[6] Sumit Shringi1, Vishvendra Singh2, Dr. B. Acharya (2018), "REVIEW ON EFFECT OF MARBLE DUST ON GEOTECHNICAL PROPERTIES OF EXPANSIVE SOIL", 2 days, 13th International Conference On Recent Trends In Science, Engineering And Management, Vedanta college of engineering and technology, January 2018.

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