iJRASET
International Journal For Research in Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 10 **Issue:** XII **Month of publication:** December 2022

DOI: https://doi.org/10.22214/ijraset.2022.47784

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International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 10 Issue XII Dec 2022- Available at www.ijraset.com

Improvement in Soil Sub Grade Using Rice Husk Ash and Silica Fume by Soil Stabilization.

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Abstract: ***Black cotton soil shows high swelling and shrinkage and less CBR value and strength due to presence of Montmorillonite mineral. Black cotton soil cannot be use for structural purpose in construction industry due to its expensive nature, therefore to control expensive behavior of the soil rise husk ash and silica fume is used in this experimental study. Rise husk ash used 0-15% by weight for observe experiment results and silica fume 0-12% by weight for observation of experiment results. Plasticity index, Free swell index of soil is decreasing with respect to RHA and SF addition and CBR value and shear strength of soil is increasing with respect to addition of RHA and SF . Optimum percentage of rise husk ash (RHA) and Silica fume (SF) observed as 12% and 9% respectively.***

I. INTRODUCTION

Infra**str**uctures have two elements one is the super structure and another is sub structure known as foundation of the infrastructure, foundation is lower part of the structure rest over the soil, it transfer the total load to the foundation sub soil, therefore bearing capacity of soil must be sufficient for stability of structure.

1) *Micro Structure of Soil:* Soil having commonly three minerals Keolinite, Illite, and Motmorillonite. Montmorillonite having Si-Al-Si seats with weak wander wall forces that retain maximum water and swell up to 250% , 2:1 clay mineral also called smectite.[5][7] Bentonite is common soil contain Montmorillonite mineral.
2) *Black Cotton Soil:* It is residual deposit of basalt and trap rocks, contain much amount of clay mineral, it contain montmorillonite mineral so swelling and shrinkage of this soil is more and shear strength of this soil is low. It shows the differential settlement due to swelling and shrinkage hence not prefer for structural purpose but depth of B.C.S(Black Cotton Soil) is less so this layer is removed for making structures.
3) *Bentonite Soil:* Bentonite soil is formed from volcanic ash, with high percentage of Motmorillonite mineral, Therefore it is also not prefer for the structural purpose due to montmorillonite mineral.
4) *Solid Waste:* In india, solid waste is rising vital problem per capita solid waste generation in india is 62 million tones per year(Calculation as per EIA 2017report), this is big number with respect to the whole world production of solid waste, it can be control by make maximum utilization of solid waste in multiple industries to make sustainable future of India.

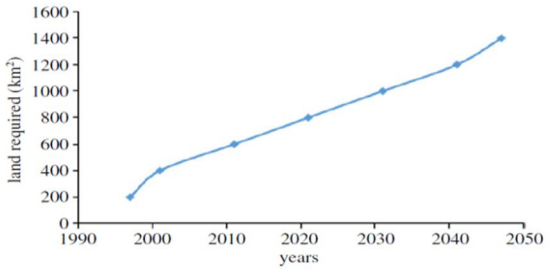

Image-01 Solid waste pollution

5) *Silica Fume:* Silica fume is waste powder produced in silica or ferrosilicate alloys, it is also known as micro silica fume, it is average size of 150nm say similar size of size of pozzolanic material or clay material, so it can be easy to use as fine filler material to any replacement of inert material. Due to its extreme fineness is used in many places like concrete, cement due to its pozzolanic behavior[6][7].It gives direct positive trend to slump value with respect to addition of silica fume in concrete mix.
6) *Rice Husk Ash:* Rise husk is produce refining of rice, it is natural and organic product and rise husk ash is produced by combustion of rise husk in the presence of Oxygen. Rice husk ash is use in creation of pozzonanic material as filler or additive.

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II. LITERATURE PLAN

Singh and Das (2019)- This is experimental study on expensive soil stabilization by silica fume addition (10-100%) on the bases of plasticity index, free swell test, OMC test, UU test, and CBR test. It found to be OMC and UU test results are increasing while plasticity index is in decreasing trend with respect to addition of silica fume.

Kawther Al-Soudany(2019)- In this experimental analysis, fine clayey soil is treated with the silica fume. Observation of this experimental analysis are OMC and plastic limit are increasing and CBR values are also improving with respect to addition of silica fume.

Mostafa and Elgendy (2016)- In this experimental analysis RHA, silica fume and nano silica fume is used to control expensive nature of Sub grade soil. Maximum reduction in plasticity index is observed at 8% RHA and 10% silica fume, 8% RHA and 3% nano silica fume. Strength is also increasing with respect to addition of RHA.

Rêgo ,Nepomuceno (2015)- In this study characterizing the different varieties of residual RHA produced in Brazil and at investigating the microstructure of cement pastes with 20% replacement of ordinary cement by RHAs which presents high and low amorphous silica content. A broad array of techniques was employed in the characterization, such as X-ray diffraction (XRD), thermogravimetric analysis (TG), scanning electron microscopy (SEM), X-ray microanalysis, and porosimetry by mercury intrusion (PMI). The results demonstrate that RHA with low amorphous silica content, finely divided, reduces the calcium hydroxide content and the Ca/Si ratio of calcium silicate hydrate (C–S–H), and also refines the porous structure of the pastes. Residual RHAs with low amorphous silica content thus proved to be suitable mineral addition for cements.

Aparna Roy (2014)- In this experiment rise husk ash and cement is use to make sustainable the expensive soil, in this experimental analysis 10% increment in strength is observe at 6% cementing material use. Cementing material - cement and rise husk ash.

Musa Alhassan(2008)- In this experimental analysis laterite soil is stable by rise husk ash (RHA) 2-12%, addition of rise husk improve MDD and CBR values of soil sample at optimum values of rise husk ash at 6-8%.

Yang-Yin and Mahmudb(2006)- This study based on stabilization of lead content soil- In this experimental analysis leachiblity of lead is reduced with respect to addition of rise husk ash 0-30% and strength is also increase.

Hasim and Mahmud (2004)- In this experiment rise husk ash and cement is use to make sustainable the expensive soil, By X-ray diffraction method in this experimental analysis increment in strength properties is observe at 6-8% cementing material and 10-15% rise husk ash use.

III. METHODOLOGY

1) *Goal Set Up (Target):* Increase stability of Black cotton soil sample, reduce expensive nature of the soil on the bases of following parameters-

a) Liquid limit, Plastic limit and plasticity Index

b) Specific Gravity

c) Standard Proctor Test

d) Differential Free Swell (D.F.S.)

e) California Bearing Ratio (C.B.R.) Test

2) *Origin Of Soil And Nature of The Soil:* Black cotton soil is taken from Simaria Tal Dabra, Gwalior (M.P.) India. Basic nature of soil is non acidic with high expensive nature it swell up to 230% of it dry condition.

3) *Sample Terminology and Design:* Soil sample made with ceramic waste and rice husk ash as following-

4) *Designing of soil sample:* Soil sample made by variable value of ceramic waste powder as well as rise husk ash powder as following two stages in the first stage individual sampling of ceramic waste, after achieve optimum value of ceramic waste using rice husk ash in variable percentage with fix value of ceramic waste (optimum value).

5) *Preparation and Properties Of Rise Husk Ash:* Rise husk is burn in a pan in the presence of Oxygen up to converted in ash. It possesses following properties Water Absorption- 104% of its dry weight and Specific gravity is 2.05.

6) *Properties of Silica Fume:* Silica fume is a kind of Industrial waste and available in market at very cheap price therefore it is taken from a alloy industry. It posses following properties-

Specific gravity = 2.2 and Water absorption 11.6% by its dry weight.

7) *Nomenclature of Samples:* Naming of different samples by some notation as-

RHA- Rice Husk Ash

SF- Silica Fume

BCS- Black cotton soil

Rise husk ash used 0-15% by weight for observe experiment results and silica fume 0-12% by weight for observation of experiment results.

Table 1 (Nomenclature of sample made by BCS)

Name	content
BCS-SF0-RSA0	Control sample with 0% SF and 0% RHA
BCS-SF3-RSA0	BCS sample with 3% SF and 0%RHA
BCS-SF6-RSA0	BCS sample with 6% SF and 0%RHA
BCS-SF9-RSA0	BCS sample with 9% SF and 0%RHA
BCS-SF12-RSA0	BCS sample with 12% SF and 0%RHA
BCS-SF9-RSA03	BCS sample with 9% SF and 3%RHA
BCS-SF9-RSA6	BCS sample with 9% SF and 6%RHA
BCS-SF9-RSA9	BCS sample with 9% SF and 9%RHA
BCS-SF9-RSA12	BCS sample with 9% SF and 12%RHA
BCS-SF9-RSA15	BCS sample with 9% SF and 15%RHA

IV. RESULT

A. Liquid Limit Test (L.L)

Liquid limit is decreasing with respect to Silica fume and RHA percentage increase, decrement rate in liquid limit is more in case of Silica fume.

Fig. 4.1:- Variation of liquid limit for BCS-Silica fume content

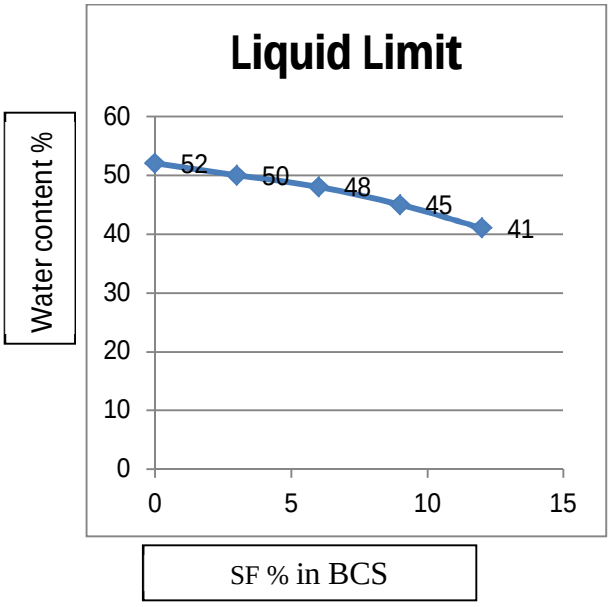


Fig.4.2:- Variation of liquid limit for BCS-RHA content

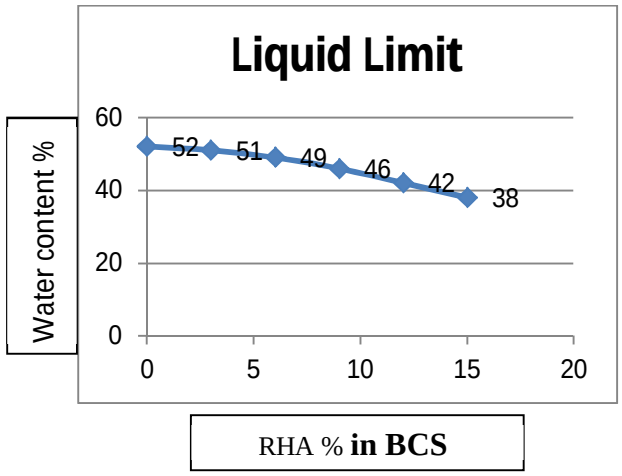
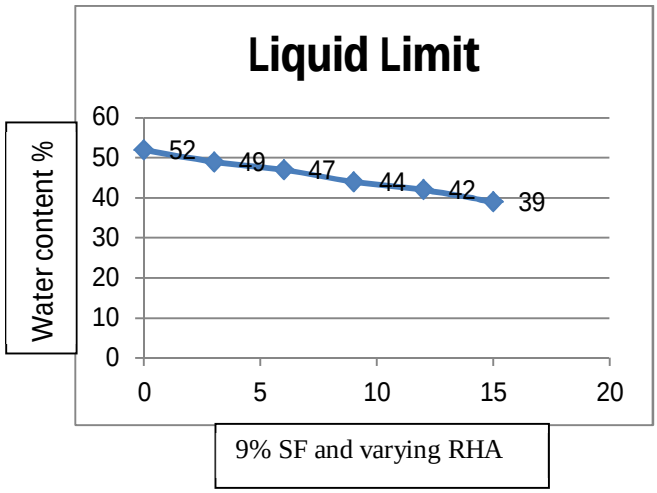


Fig4.3:- Variation of liquid limit for BCS and Silica fume-RHA content



B. Plastic Limit Test (P.L)

Plastic limit is decreasing with respect to Silica fume and RHA percentage increase, decrement rate in plastic limit is more in case of Silica fume.

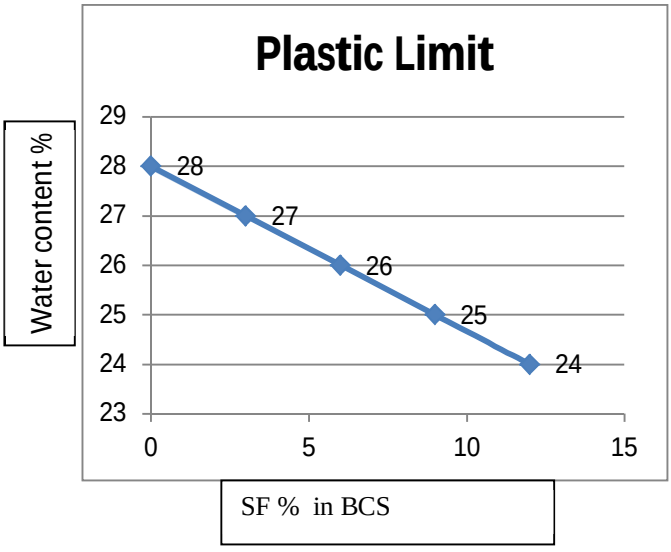


Fig 4.4:- Variation of plastic limit for BCS-SF content

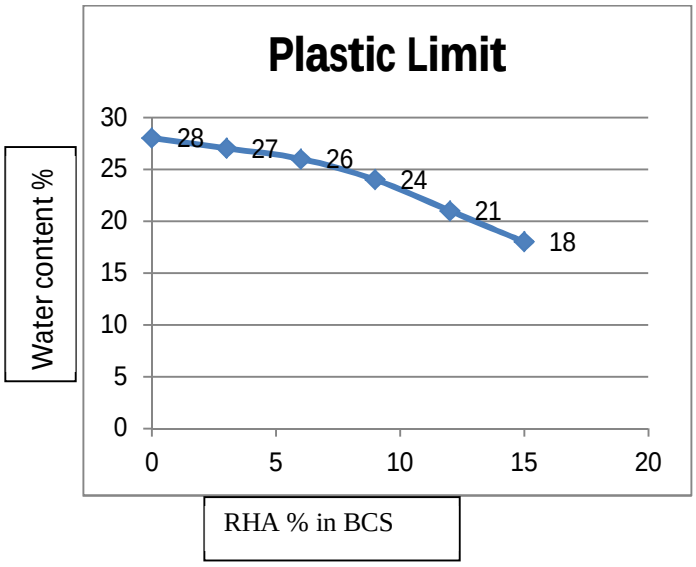


Fig.4.5 :- Variation of plastic limit for BCS-RHA content

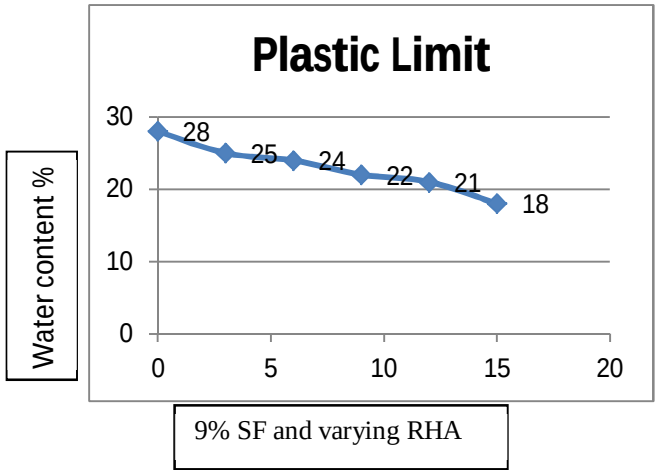


Fig.4.6 :- Variation of plastic limit for BCS and Silica fume-RHA content

C. Plasticity Index (P.I)

Plasticity index also show continue decrease graph with Silica fume addition while addition of RHA gives initial rise in PI then decreasing.

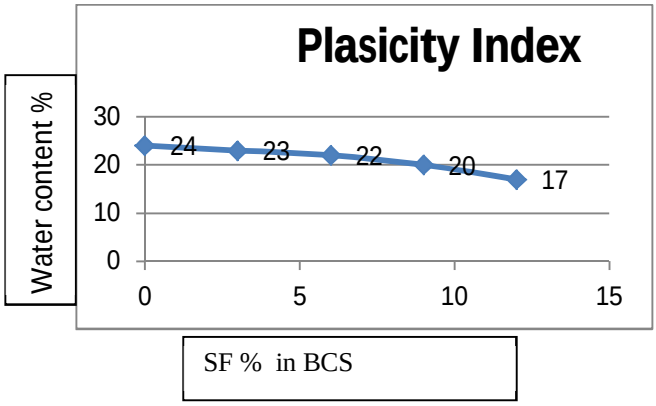


Fig.4.7:- Variation of plastic limit for BCS-Silica fume content

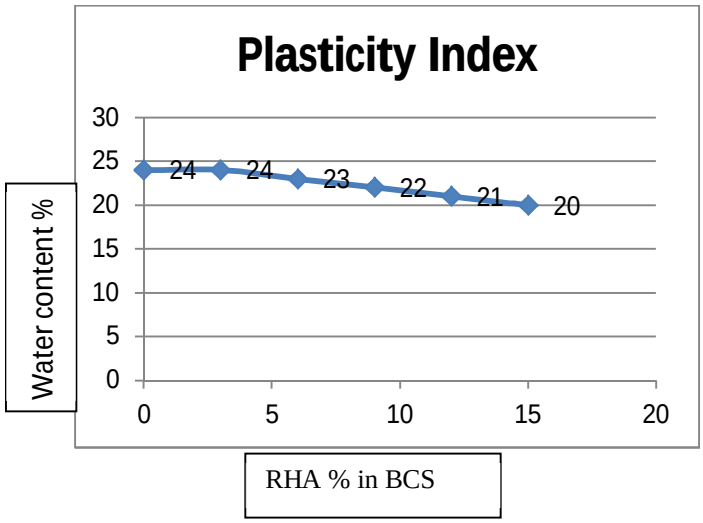


Fig.4.8:- Variation of plastic limit for BCS-RHA content

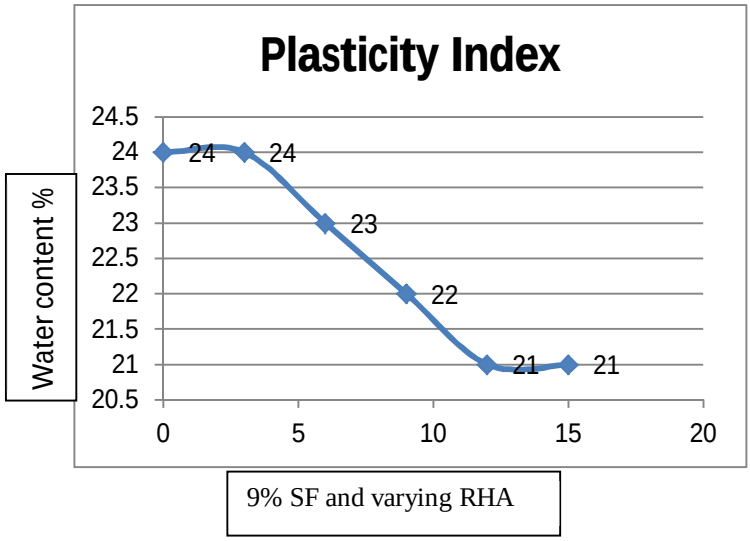


Fig.4.9 :- Variation of plastic limit for BCS and Silica fume-RHA content

D. Specific Gravity Test

Specific gravity of the soil is increasing with addition of Silica fume and decreasing with addition of RHA in soil.

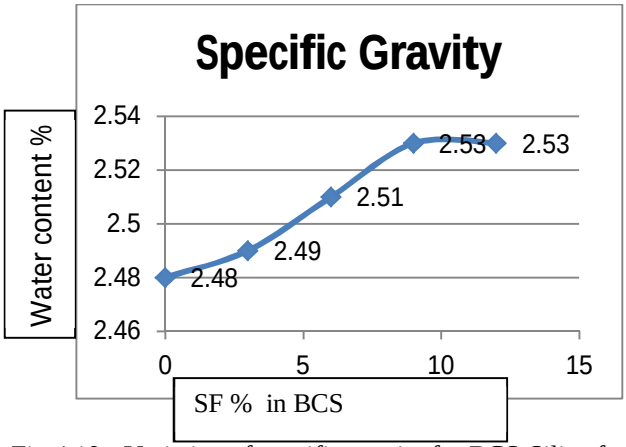


Fig.4.10:- Variation of specific gravity for BCS-Silica fume content

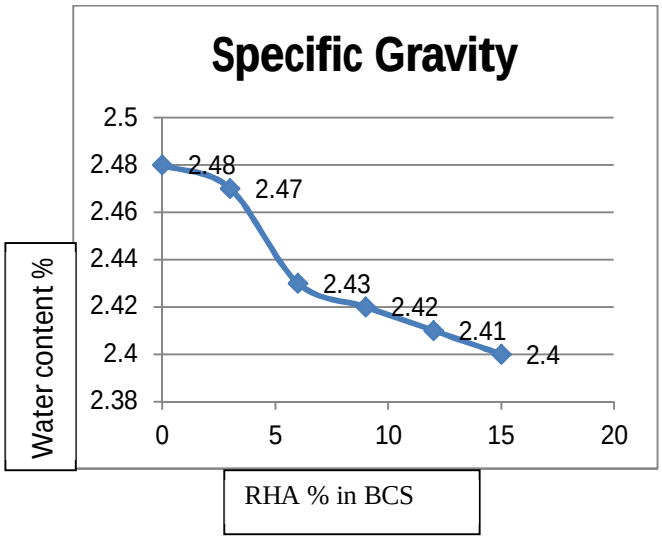


Fig.4.11:- Variation of specific gravity for BCS-RHA content

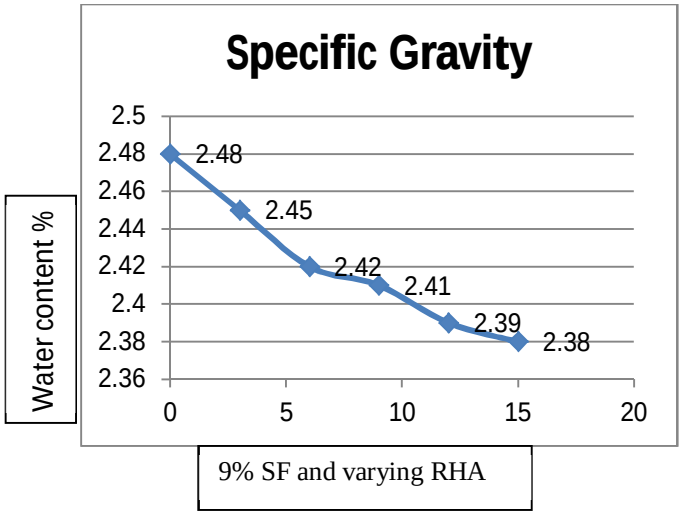


Fig.4.12:- Variation of specific gravity for BCS and Silica fume-RHA content

E. Optimum Moisture Content

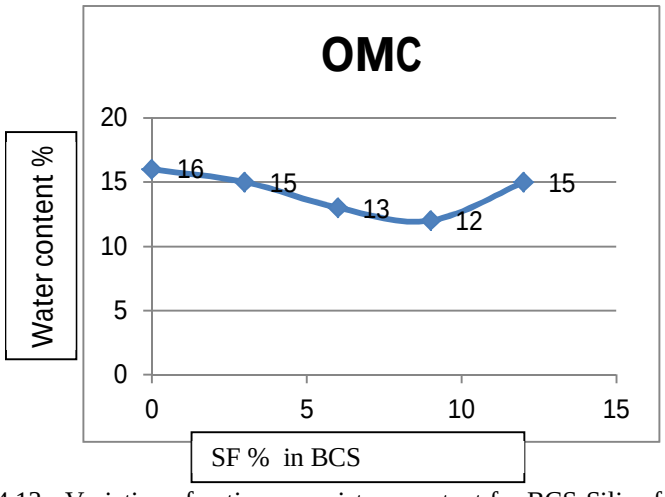


Fig.4.13:- Variation of optimum moisture content for BCS-Silica fume content

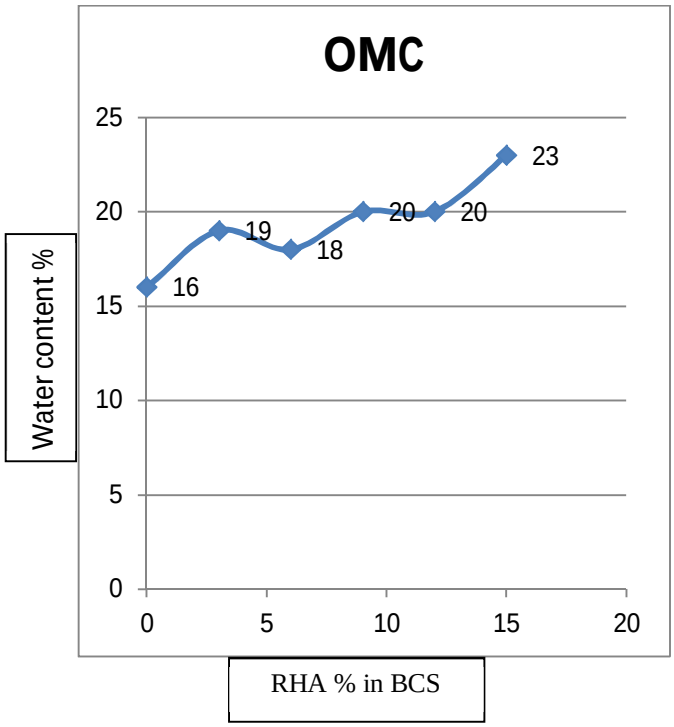


Fig.4.14:- Variation of optimum moisture content for BCS-RHA content

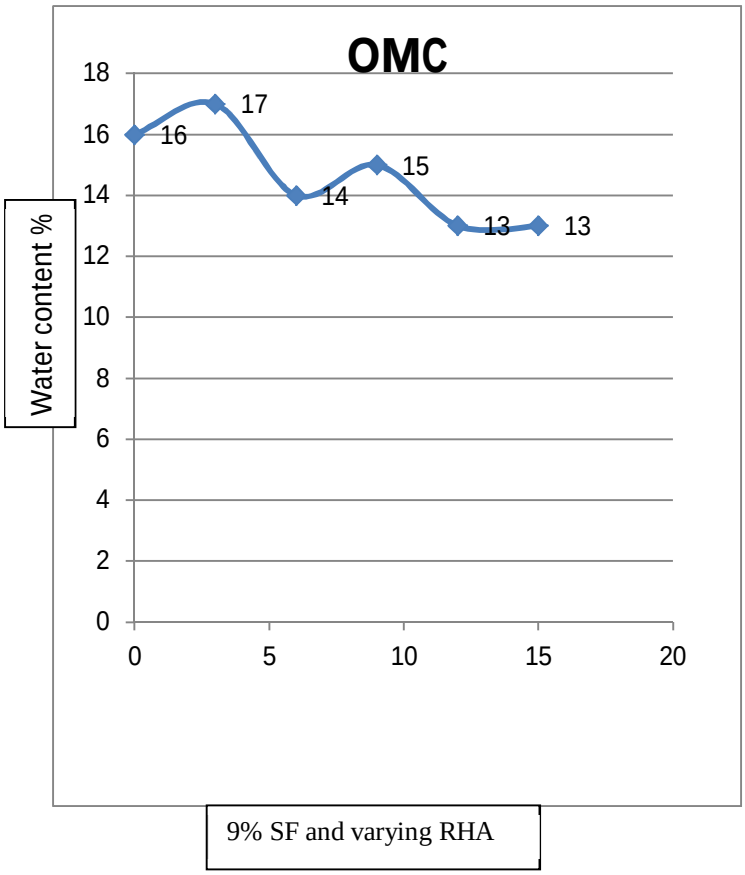


Fig.4.15 :- Variation of optimum moisture content for BCS and Silica fume-RHA content

F. Maximum Dry Density

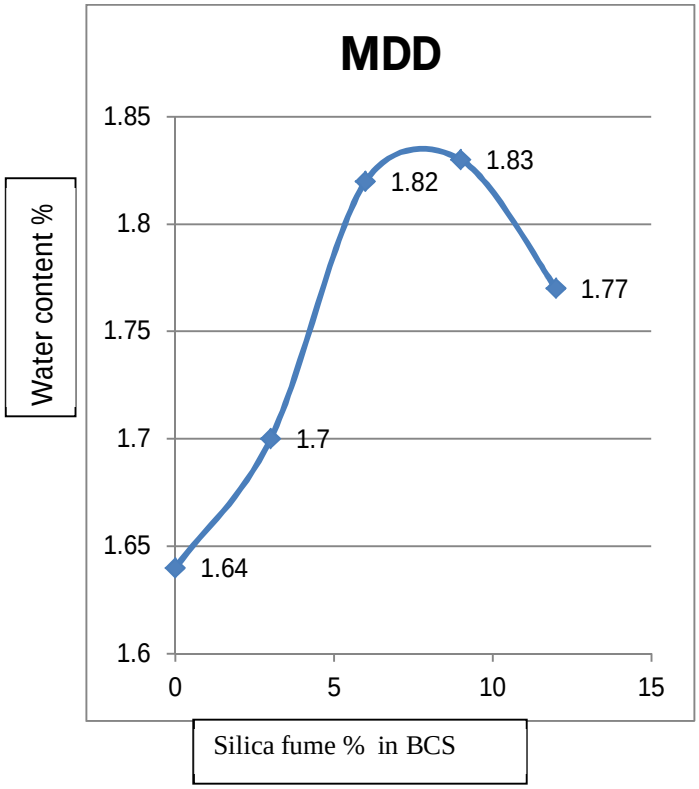


Fig.4.16 :- Variation of maximum dry density for BCS-Silica fume content

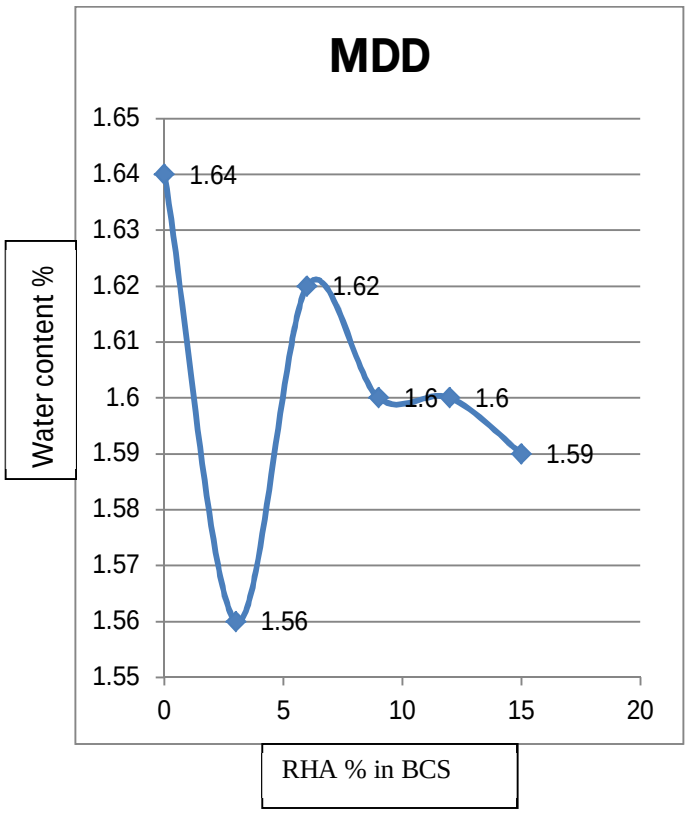


Fig.4.17:- Variation of maximum dry density for BCS-RHA content

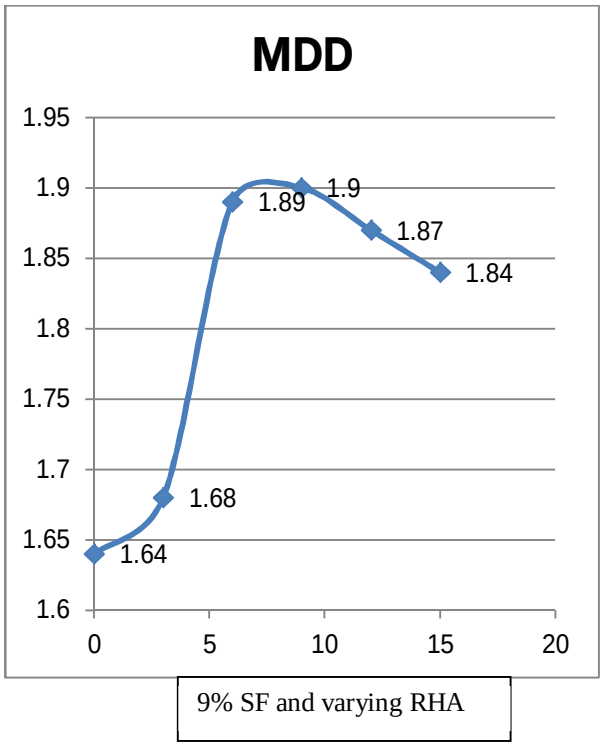


Fig.4.18 :- Variation of maximum dry density for BCS and Silica fume-RHA content

G. Differential Free Swell Test

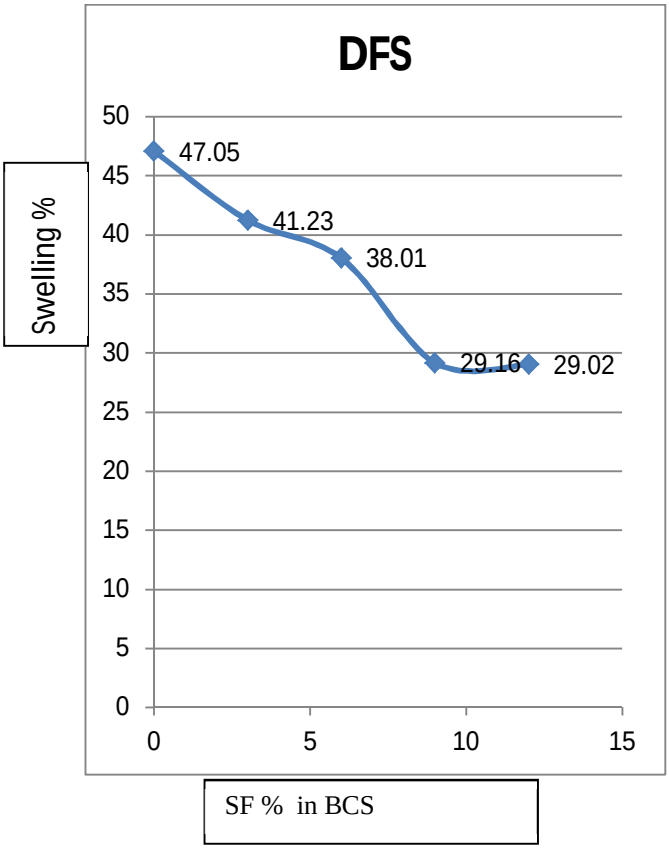


Fig.4.19 :- Variation of differential free swell for BCS-Silica fume content

ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
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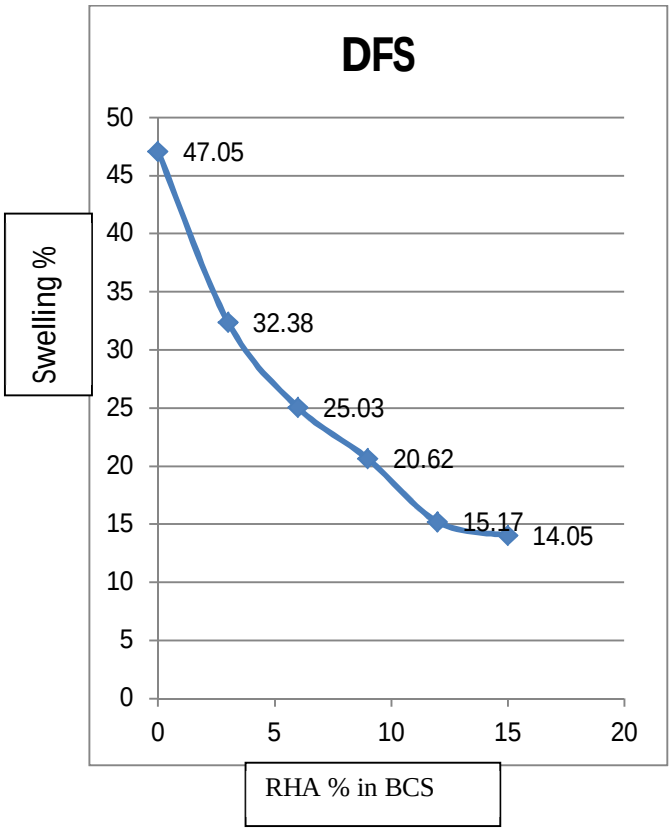

Fig.4.20 :- Variation of differential free swell for BCS-RHA content

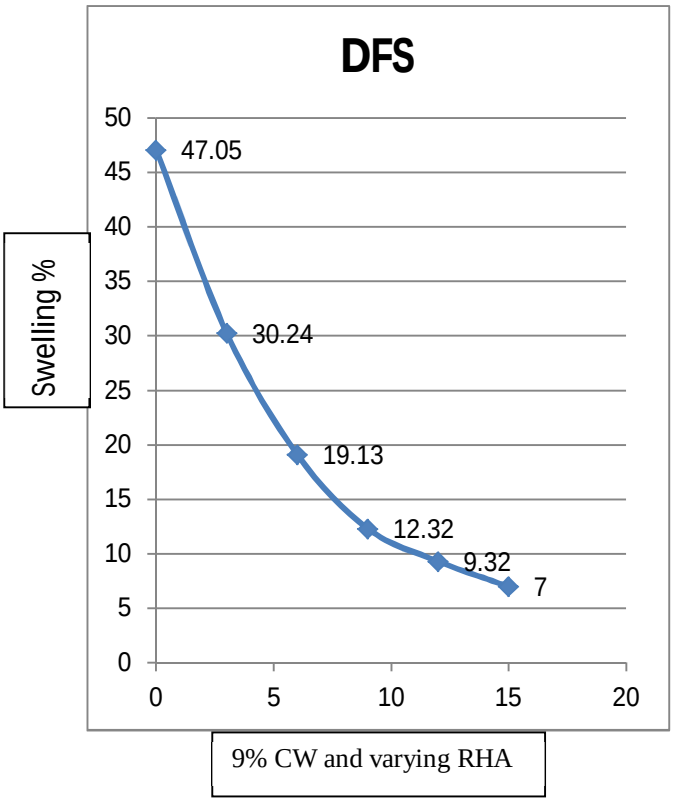

Fig.4.21:- Variation of differential free swell for BCS and Silica fume-RHA content

H. California Bearing Ratio

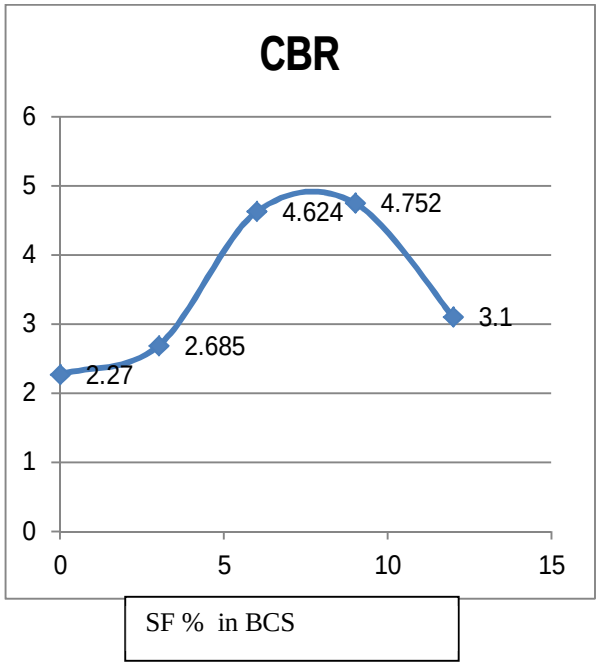

Fig. 4.22:- Variation of CBR for BCS-Silica fume content

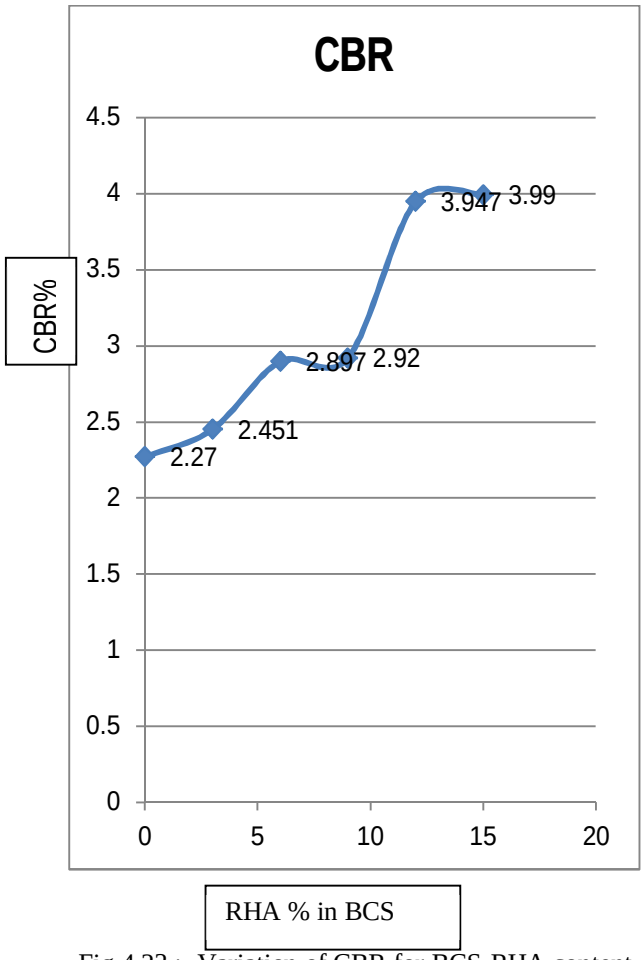

Fig.4.23 :- Variation of CBR for BCS-RHA content

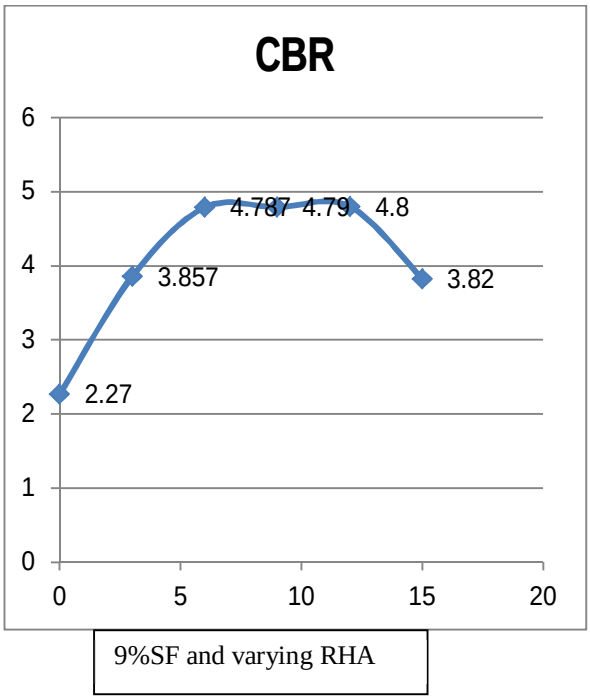

Fig.4.24:- Variation of CBR for BCS and Silica fume-RHA content

V. CONCLUSION

1) Optimum percentage of Silica fume and RHA adulterant in CBC soil on the bases of above parameter given as maximum dry density, optimum moisture content, CBR value.
Silica fume gives assent in dry density, and CBR value, up to 9%.
RHA gives assent in dry density, CBR value with respect to percentage increment of Rice husk ash.
Combination of Silica fume and RHA gives assent in dry density, CBR value, up to 12% (RHA).
Therefore optimum utilization of Silica fume and RHA is 9% and 12% respectively.

2) Solid waste reduction through rise husk ash and silica fume is major problem for Environment can also control by maximize the utilization in industries, therefore this research also contribute in EIA.

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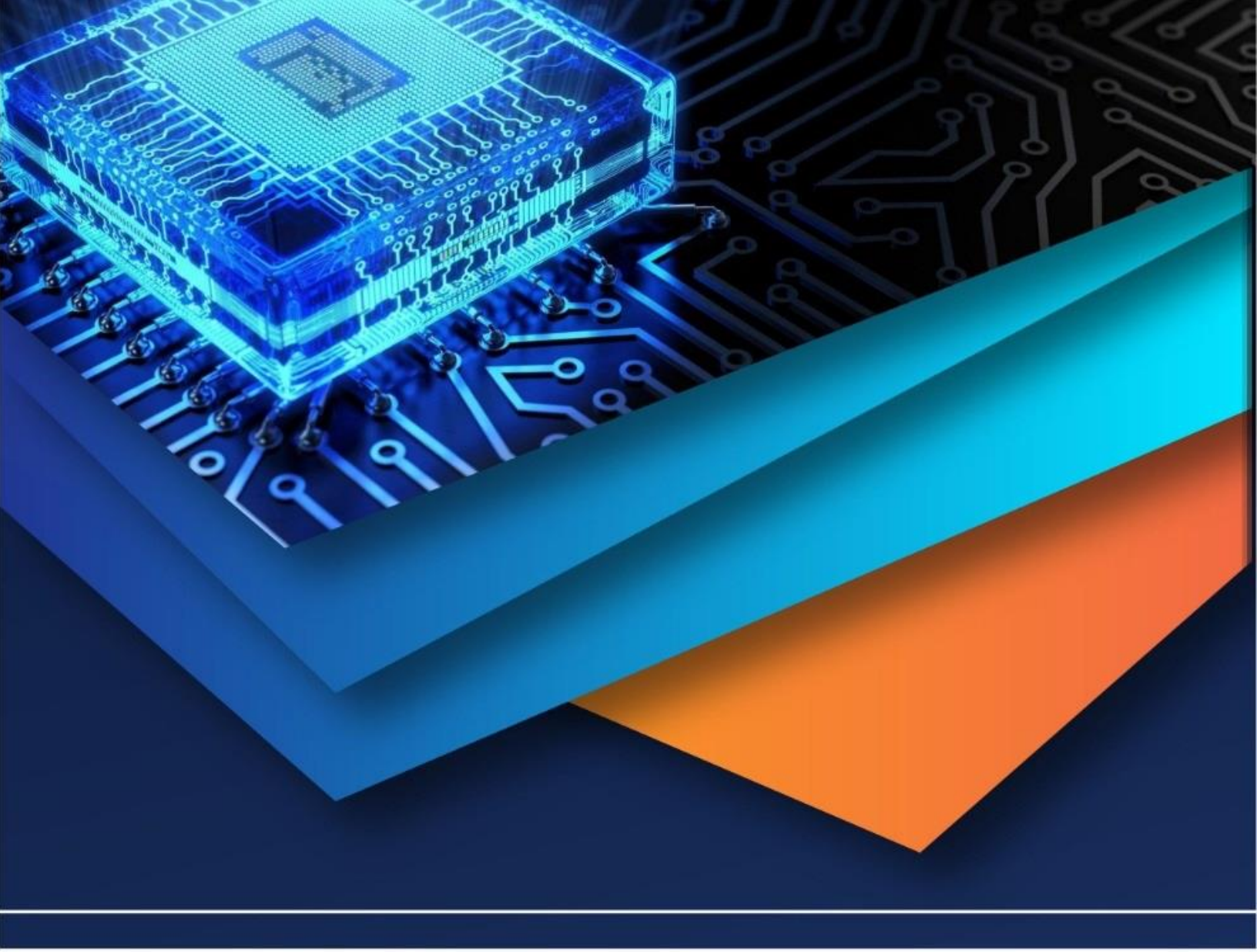

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