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Stabilization of Black Cotton Soil by Using Rice Husk and Bagasse Ash

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Abstract: ***Black cotton soil is expansive type of soil that expands suddenly and starts swelling once it comes in contact with water. The strength of the soil is very poor due to its physical properties. Expansive soils exhibit improved response in behaviour with different types of stabilizers. Stabilization with admixtures is found to be an effective technique to improve the strength properties of the black cotton soil. During this study the potential of rice husk ash and bagasse ash are found to be useful admixtures to improve the strength properties of the expansive soil. The rice husk is an agricultural by-product from rice milling and bagasse ash is a sugarcane waste from sugar industry. In this research an approach is made to improve the properties of black cotton soil with combination of bagasse ash and rice husk ash. The results show substantial improvement in engineering properties of black cotton soil with the admixtures.***

Keywords: Black Cotton Soil, Rice Husk Ash, Bagasse Ash.

I. INTRODUCTION

For any land based, the inspiration is incredibly to support the whole structure, so as for the inspiration to be study the soil around it play really an essential role.Black cottons oil causes many problems to road. About 20% of the soil found in India is expansive in nature. In rainy season black cotton soil absorbs water which results into swelling and softening of soil. In addition to this it also becomes easily compressible. Black cotton soil has tendency to swell due to wet condition. In summer season, it shrinks and produces cracks.

Thus, as a result of this black cotton soil suffer from early failures in pavements with unevenness ruts, waves and corrugations are formed. It is proposed to study the causes of failure on black cotton soil. Typical behaviour of these soil under different climatic condition has made the constructions and pavements of roads not only expensive but also difficult.

The black cotton soil is very poor and undependable subgrade material. Hence, the main problems to treat the subgrade of soil itself such that the undesirable characteristics are modified by soil stabilization. Stabilization is the process of improving the engineering properties of the soil and making it more stable. In this study, industrial waste from sugarcane industry “Bagasse Ash” and agricultural waste from rice cultivation “Rice Husk Ash” to stabilize the soil.

II. OBJECTIVES

A. To examine the physical and engineering properties of black cotton soil.
B. To compare the improvement of stabilization of black cotton soil with different percentage of bagasse ash and rice husk ash.
C. To determine the best proportion of rice husk ash and bagasse ash for various tests and identify its practical applications.

III. LITERATURE REVIEW

A. Hitesh Sant, ShubhamJain, RahulMeena (2016)

This paper contains the investigation on black cotton soil with bagasse ash. Bagasse ash works as stabilizer for the black cotton soil.it is a byproduct of sugarcane after the incineration. Different mixes of ash with soil are considered here to get the maximum stability, maximum dry density, optimum moisture content, California bearing ratio and unconfined compressive strength.

B. AkankshaGautam and S.K. Mittal (2018)

In this paper, they have examined the nature of black cotton soil and how their property affects the structure. The settlement, cracks, etc., are the reasons of failure of the structure. To ameliorate the stability of black cotton soil, they have presented the solution for it. They used cost effective material called “Bagasse” which is byproduct of sugarcane and for the improvisation of clayey soil’s property they used “Coin Fiber”. Also, they have conducted various tests to the rightful results.

C. Jay Prakash, Kusum kumara, VijayKumar (2017)

They have presented a study which gives the brief about soil stabilization using rice husk ash. Studied on the chemical stabilization using cement, lime etc. Knows that they are harmful for environment as well as for soil. After analysing the factors of chemical stabilization, they come ion the solution for soil stabilizations 'Rice Husk'. The material 'Rice Husk' is not expensive also it is waste material from paddy crop. The rice husk ash contains good amount of silica which is one content who stabilize the soil.

D. AkashKumar, EktaMestry, Priya jambhulkar, DarshanaJadhav (2019)

This paper presented a study which give detail investigation of 'Black Cotton Soil' and they choose 'Rice Husk Ash' which contains silica and additional material as lime. In most part of India, lands have black cottons oil. For the study they have chosen Nashik, Shinde village as study area. Black Cotton Soil has unstable behaviour because of its physical and chemical properties. By using Rice Husk Ash and lime stabilization of soil improves its physical and chemical properties which balances and improves the strength of soil.

IV. MATERIALS

A. Black cotton soil

Black cotton soil has a huge problem of volume changes as swelling due to excessive amount of water mainly on rainy days and shrinkage due to evaporation mainly on summer days. To reduce these problems in particular seasons or have a permanent solution to such a problem the soil has to stabilize.

Black cotton soil is found in Gujarat, Maharashtra, Karnataka, Madhya Pradesh regions of India

Fig.1 Black cotton soil

B. Bagasse Ash

Bagasse is a by-product or waste from the sugarcane industry that is burned to some temperature and formed sugarcane bagasse ash. This bagasse ash is used for different purposes. The bagasse ash contains a large amount of silica, potassium, calcium, iron, alumina, and carbon which are similar to the chemical composition of traditional stabilizers (cement or lime). So it can be used as a replacement for cement or lime. It is also beneficial to the environment because the amount of production of bagasse is increased nowadays.

Fig.2 Bagasse ash

C. Rice husk ash

It is also a by-product of rice from rice milling in the rice production areas. The rice husk ash contains approximately 65- 90% of silica, which is highly chemically reactive. It is also used as a replacement for traditional stabilizers.

Fig.3 Rice husk ash

V. METHODOLOGY

The various works done are given below:

1) Collection of black cotton soil from Satara district.
2) Buying admixtures from online store.
3) Study of properties of soil and admixtures.
4) Preparing samples of different proportion for testing.
5) Using our college instrument test was conducted.
6) Result analysis and comparison of normal black soil and black cotton soil with admixtures**.**

VI. TEST RESULTS AND DISCUSSIONS

Table I: Liquid Limit Test

SR.NO	Soil proportion(%)	Rice husk ash (%)	Bagasse ash (%)	Liquid limit (%)
1	95	2.5	2.5	65.01
2	92.5	5	2.5	69.37
3	90	7.5	2.5	73.31
4	88.5	10	2.5	70.06

The liquid limit is increasing as increase in admixtures. In the above reading bagasse ash % was kept constant.

Table II: Liquid Limit Test

SR.NO	Soil proportion(%)	Rice husk ash (%)	Bagasse ash (%)	Liquid limit (%)
1	95	2.5	2.5	65.01
2	92.5	2.5	5	77.61
3	90	2.5	7.5	61.81
4	88.5	2.5	10	67.50

Here the rice husk ash % is kept constant in this at 5% bagasse ash and 2.5% rice husk ash it increases then decreases again increases. Comparison of both the reading is represented in the graph below.

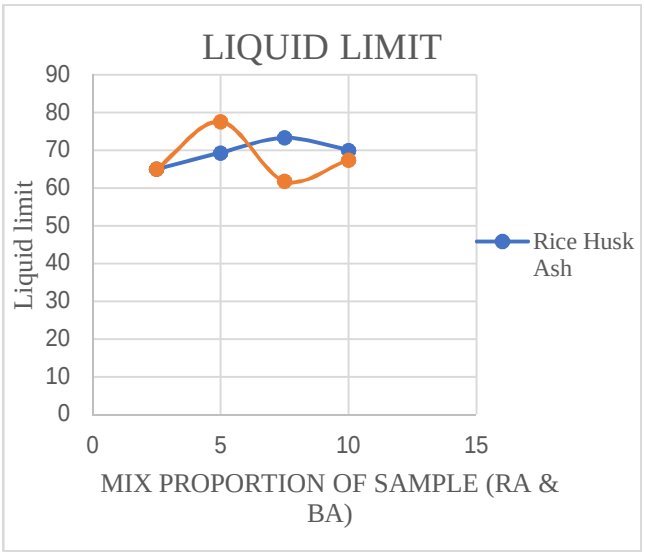

Fig.4 Liquid Limit Graph

Table III Plastic limit Test

SR.NO	Soil proportion(%)	Rice husk ash (%)	Bagasse ash (%)	Plastic limit (%)
1	95	2.5	2.5	37.43
2	92.5	5	2.5	35.60
3	90	7.5	2.5	36.19
4	88.5	10	2.5	37.75

The Plastic limit reading is fluctuating as increase in admixtures. In the above reading bagasse ash % was kept constant

Table IV: Plastic limit Test

SR.NO	Soil proportion(%)	Rice husk ash (%)	Bagasse ash (%)	Plastic limit (%)
1	95	2.5	2.5	37.43
2	92.5	2.5	5	30.07
3	90	2.5	7.5	36.01
4	88.5	2.5	10	36.48

Here the rice husk ash % is kept constant as we can see in higher % of admixture there is minor difference in the value Comparison of both the reading is represented in the graph below.

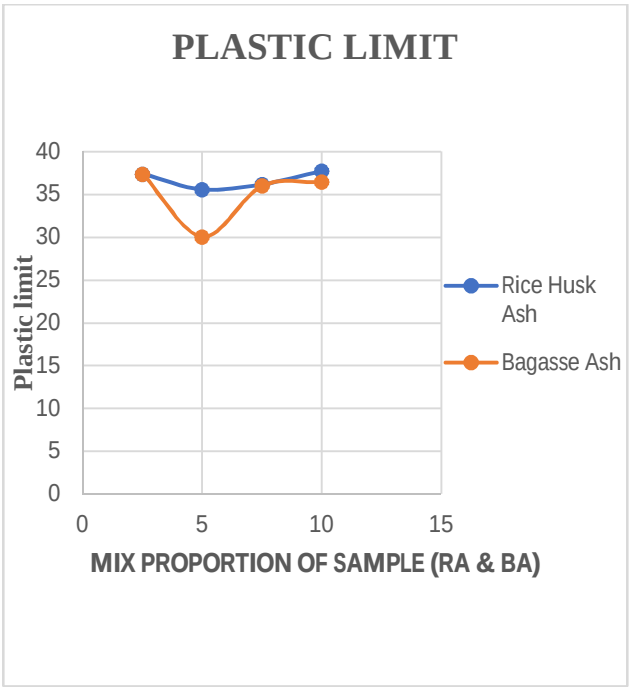

Fig.5 Plastic Limit Graph

Table V:Shrinkage limit Test

SR.NO	Soil proportion(%)	Rice husk ash (%)	Bagasse ash (%)	Shrinkage limit (%)
1	95	2.5	2.5	81.09
2	92.5	5	2.5	81.65
3	90	7.5	2.5	77.5
4	88.5	10	2.5	70.32

From the shrinkage reading we can see at 5% rice husk ash and 2.5% bagasse ash the reading is maximum. In the above reading bagasse ash % was kept

Table VI: Shrinkage limit Test

SR.NO	Soil proportion(%)	Rice husk ash (%)	Bagasse ash (%)	Shrinkage limit (%)
1	95	2.5	2.5	81.09
2	92.5	2.5	5	81.24
3	90	2.5	7.5	83.83
4	88.5	2.5	10	81.90

From the above reading the shrinkage limit in not showing much difference when bagasse ash % is increased below is the comparison of both the data.

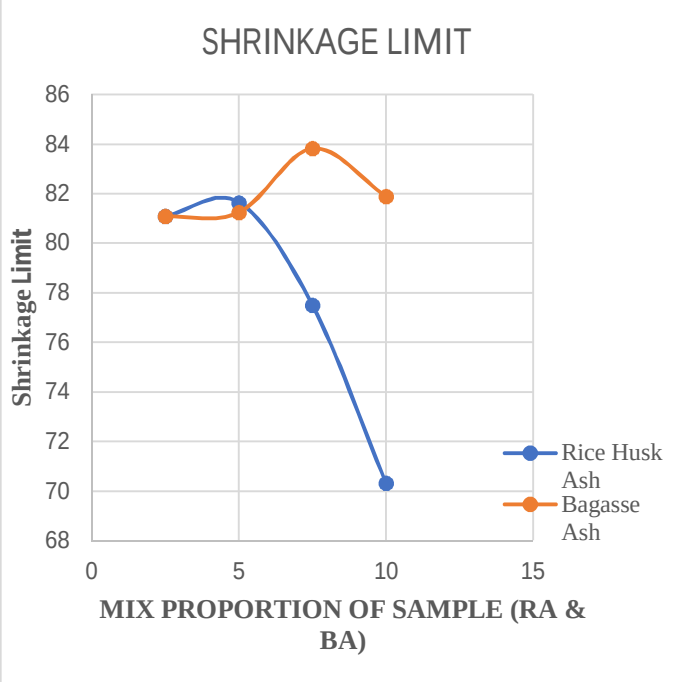

Fig.6 Shrinkage Limit Graph

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Table VII: Unconfined compressive strength Test

SR.NO	Soil proportion(%)	Rice husk ash (%)	Bagasse ash (%)	UCS (KN/m2)
1	95	2.5	2.5	41.25
2	92.5	5	2.5	12.654
3	90	7.5	2.5	27.648
4	88.5	10	2.5	27.648

From the above reading the maximum unconfined compressive strength value is achieved. In the above sample data bagasse ash is kept constant.

Table VIII: Unconfined compressive strength Test

SR.NO	Soil proportion(%)	Rice husk ash (%)	Bagasse ash (%)	UCS (KN/m2)
1	95	2.5	2.5	41.25
2	92.5	2.5	5	12.654
3	90	2.5	7.5	13.734
4	88.5	2.5	10	11.62

Here also we can see at 2.5% rice husk ash and 2.5% bagasse ash UCS value is maximum, but as further increase in % of admixture the value decreases. Below is the graph representation of the readings.

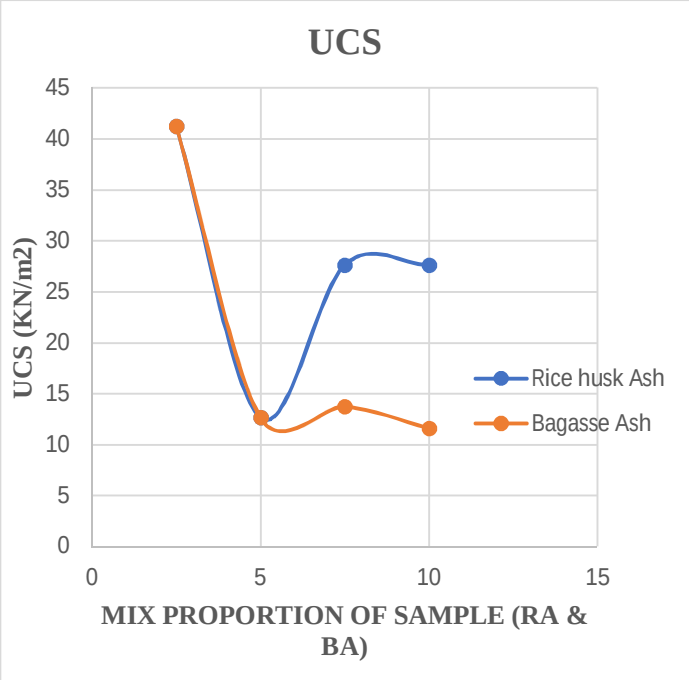

Fig.7 UCS Graph

Table IX: California Bearing Ratio Test

SR.NO	Soil proportion(%)	Rice husk ash (%)	Bagasse ash (%)	CBR
1	95	2.5	2.5	12.1
2	92.5	5	2.5	16
3	90	7.5	2.5	10.8
4	88.5	10	2.5	9.8

In the above result, the CBR value is 12.1 at 2.5% of both the admixtures. Bagasse ash is kept constant in the above sample.

Table X: California Bearing Ratio Test

SR.NO	Soil proportion(%)	Rice husk ash (%)	Bagasse ash (%)	CBR
1	95	2.5	2.5	12.1
2	92.5	2.5	5	11
3	90	2.5	7.5	10
4	88.5	2.5	10	8.2

Here also the reading of CBR is maximum at 2.5% of both the admixtures. Rice husk ash is kept constant in the above sample below is the graphical comparison.

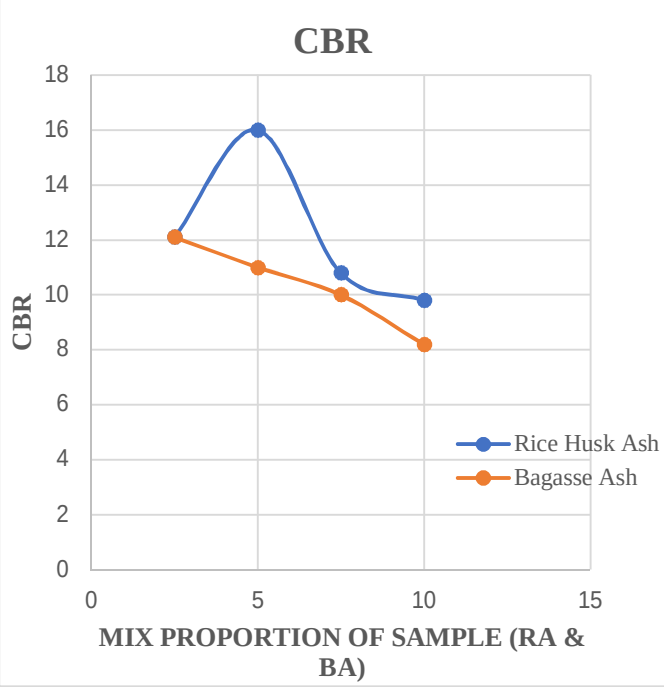

Fig.8 CBR Graph

Table XI: Maximum Dry Density

SR.NO	B.C. Soil (%)	Rice husk ash (%)	Bagasse ash (%)	MDD (g/cc)
1	95	2.5	2.5	1.002
2	92.5	5	2.5	1.34
3	90	7.5	2.5	1.29
4	88.5	10	2.5	1.33

The maximum dry density is 1.34g/cc when soil is mixed with 5% rice husk ash and 2.5% bagasse ash. Here bagasse ash is kept constant in the above sample.

Table XII: Maximum Dry Density

SR.NO	Soil proportion(%)	Rice husk ash (%)	Bagasse ash (%)	MDD (g/cc)
1	95	2.5	2.5	1.002
2	92.5	2.5	5	1.23
3	90	2.5	7.5	1.28
4	88.5	2.5	10	1.278

When rice husk ash kept constant the maximum dry density is 1.28 g/cc at 7.5% bagasse ash. Below is the graphical representation of both the sample.

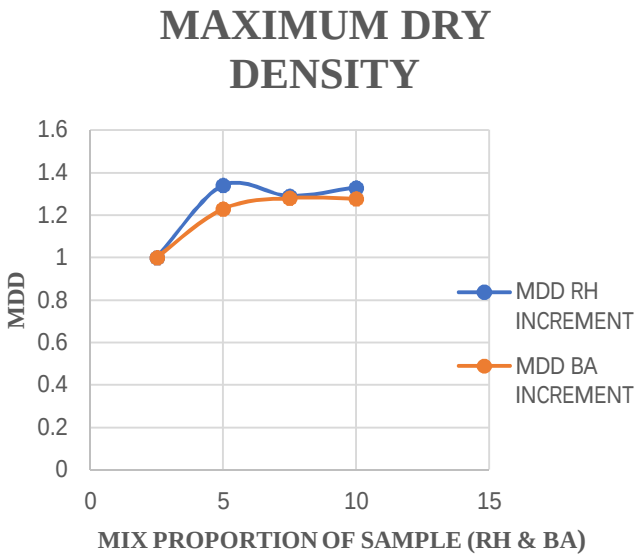

Fig.9 MDD Graph

VII. CONCLUSION

A. Significant improvements are found in the physical and strength properties of the soil with different percentage of admixtures in comparison to plain black cotton soil.
B. The CBR value is found to improve by 11% on addition of 2.5% of both the admixtures.
C. Maximum dry density is increased by 0.25 g/cc at 5% rice husk ash and 2.5% bagasse ash. This shows an improvement of 33%.
D. Unconfined compressive strength of the soil increases by 24.45 kN/m^2 at 2.5% of both the admixtures. This shows an improvement of 60%.
E. Liquid limit decreases by 10% at 2.5% rice husk ash and 7.5% bagasse ash.
F. The maximum shrinkage limit of the soil is increased by 68.83% at 2.5% rice husk ash and 7.5% bagasse ash.

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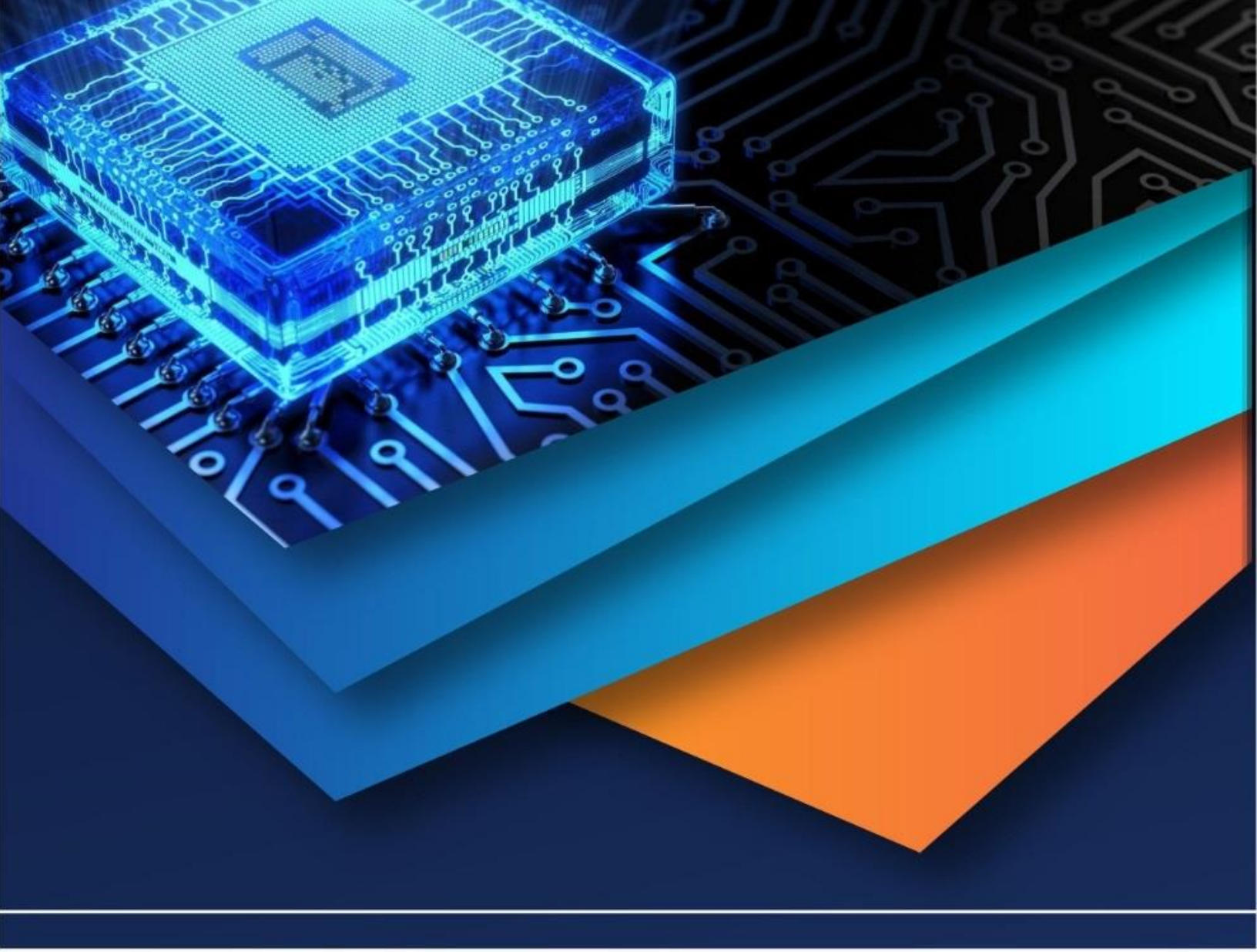

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