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Engineering Properties of Expansive Soil, Stabilized with Rice Husk Ash and Lime Sludge

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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. Soil can be modified or improved by many methods which include mechanical methods, use of chemicals or wastes as stabilizing agent etc. From the above said methods, improvement to soil by using waste material is beneficial and effective one. In our country, wastes are generated from various ways. It includes domestic wastes, industrial wasters, agricultural wastes etc. It is very difficult to dispose these wastes without affecting the environment and its surroundings. To overcome these problems, it can be used as a stabilizing agent in the soil. By using the wastes as stabilizing agent, it not only increases the strength of soil but also paves way in reducing the construction cost, easy way for waste disposal and turns the environment to be eco-friendly. This paper presents about an experimental study carried out to find the effect of Rice Husk Ash (RHA) which is an agricultural waste on index and engineering properties of the expansive soil. The properties such as compaction, California bearing ratio, unconfined compressive strength is determined with partial replacement of RHA in black cotton soil at various percentages(2.5%, 5% etc) in addition of lime in small amount to it at a constant rate of 2%. On the results achieved, it gives a conclusion that the Optimum moisture content (OMC) increases with the addition of RHA in soil. The California Bearing ratio is also having a tremendous increase in strength with soil mixed with RHA and the optimum percentage of RHA with soil is found to be 5% and RHA with lime and soil is found to be 10% effectively. Thus a promising and improving result is obtained in stabilizing the soil with Rice Husk Ash in both cost and strength evaluation.
keyword : lime,rice husk ash, black cotton soil,water.

I. INTRODUCTION

The RHA can only be used for the more expensive stabilizing agents (cement/lime) because it has inadequate cementation property required to bind the material. Hence, in the present study, a small amount of lime sludge was mixed with RHA and the effect of soil stabilization on soil properties like, optimum moisture content, maximum dry density, California bearing Ratio and unconfined compressive stress is observed and the optimum content is found out from the maximum improvement. By paying a small cost for lime, a tremendous improvement of CBR-value of soil is observed which indicates the cost-effectiveness of construction.

II. LITERATURE REVIEW

A. General

The literature reviews presented in this chapter explains review of previous research work in stabilization of soil. The reviews were restricted primarily to the use of waste materials in civil engineering application.

1) P. K. Jayasree, K. Balan, Leema Peter, K. K. Nisha(2013) In this project, Soil stabilization with rise husk ash and lime sludge has proved to be effective in controlling the volume change behavior of expansive soils. The utilization of rise husk ash a waste by product of rise husk ash to change the volume change behavior is investigated. The testing program includes a series of consolidation three dimensional shrinkage strain tests on both unreinforced and reinforced soil specimens. A considerable reduction in volume change behavior of expansive soil is observed after stabilizing the expansive soil with rise husk ash and lime sludge.

2) George V. Thomas1, C. Palaniswami2, S. R. Prabhu3, Murali Gopal1 and Alka Gupta1(2013) The study was the feasibility of co-composting rise husk ash and lime was tested with and without lime and rock phosphate amendment. The results revealed that the composting process facilitated by poultry manure amendment brought about bioconversion of rise husk ash to a final product in 45 days and the final product possessed physic-chemical characteristics required for quality organic manure. The results of plant test using cowpea as bioassay plant revealed that the compost reached adequate maturity from biological point of view for use as an organic input in crop production.

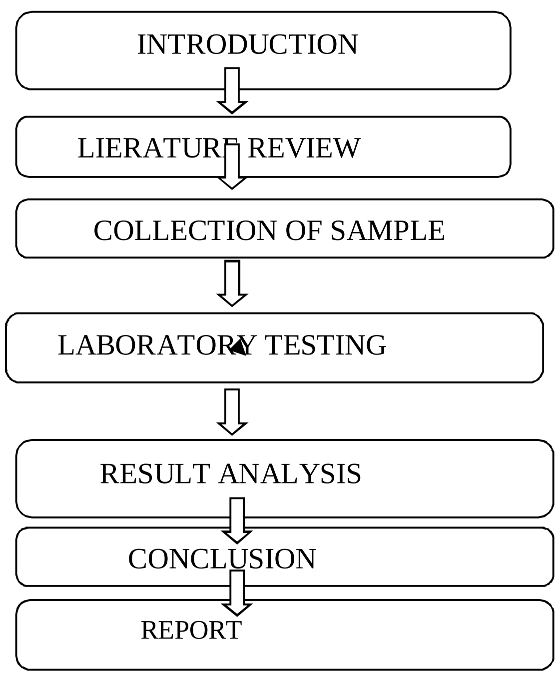
3) AmitTiwari and H. K. Mahiyar (2014) In this project **,**analyze property of soil such as Atterberg's Limits, Compaction Curve (O.M.C. and M.D.D.), Shrinkage Limit, California Bearing Ratio, Swelling Pressure, Permeability, direct shear test, effect of Fly Ash, Coconut fiber & crushed Glass with various percentages along with Black cotton Soil, combination on the above proportion of ingredients, use of waste products instead of conventional materials like cement, lime, etc .This experimental study on 48 trial samples test were the physical properties of soil such as hygroscopic moisture content grain size distribution, specific gravity, Atterberg's limits, Direct shear test, Swelling pressure, MDD-OMC, CBR, Permeability test values are determined.

III. METHODOLOGY

A. General

The procedure for executing the process of soil stabilization by adding RHA (Rice Husk Ash) was shown in this methodology The process in which we carried out the process was listed in this methodology.

B. Methodology process



C. Moisture Content Test

The test procedure is followed as per IS: 2720 (Part 2) – 1973 **.**The test is conducted on three samples and the average is taken as moisture content. The natural moisture content of the sample is 14%

D. Specific Gravity Test

The test procedure is followed as per IS: 2720 (Part 3) – 1980**.**The test is conducted on three samples and the average is taken as the value of Specific Gravity. The Specific gravity of the sample is 2.25

E. GRAIN SIZE DISTRIBUTION

The grain size distribution is obtained by conducting wet sieve analysis and hydrometer analysis. The tests were conducted as per IS: 2720 (Part 4) – 1985.

IV. RESULTS OF GRAIN SIZE DISTRIBUTION

The composition of gravel, sand, silt and clay obtained from mechanical sieve lysis and Hydrometer analysis are given below

Grain size distribution test result

SI.NO	SOIL CLASSIFICATION	PERCENTAGE OF PASSING
1	GRAVEL	0
2	SAND	24.21
3	SILT	25.62
4	CLAY	50.17

A. Atterberg's Limit Test

Liquid limit and Plastic Limit test were conducted as per IS: 2720 (Part 5) –1985. Shrinkage limit is determined as per IS: 2720 (Part 6) – 1972 and the soil is classified based on plasticity chart as per Bureau of Indian Standards.

1) Atterberg's Limit

S.No	DESCRIPTION	RESULT	REMARKS
1	Liquid limit	48%	-
2	Plastic limit	25.8%	-
3	Shrinkage limit	12.62%	-
4	Toughness index	1.72	(It) >1 Soil nor friable at plastic state
5	Differential free swell index	49%	-
6	Flow index(If)	17.5	-
7	Plasticity index(Ip)	23.2	(Ip) >17 Highly plastic
8	Liquidity index(Il)	-0.407	(Il)<0 Very stiff
9	Consistency index(Ic)	1.37	(Ic)>1 Very stiff
10	Soil Classification	CH	Clay of High compressibility

B. Compaction Tests

1) Standard Proctor's Compaction test

The optimum water content (OMC) and maximum dry density (MDD) is obtained by conducting Standard Proctor's Test as per IS: 2720 (Part 7) – 1980. The relation between moisture content and dry density is obtained from compaction test. The optimum moisture content and maximum dry density obtained from compaction test on soil are given below.

Compaction test results

Compaction tests	OMC (%)	MDD (g/cc)
Standard Proctor's Compaction test	14	1.64

C. Unconfined Compressive Strength Test

The Unconfined Compressive Strength and Cohesion is obtained by conducting Unconfined Compressive Strength test. The test was conducted as perIS 2720(Part 10): 1991.The test were conducted on soil samples prepared under light energy of compaction. The relation between stress and strain obtained as a result of Unconfined Compressive Strength test on sample prepared under light compaction.

The unconfined compressive strength and cohesion obtained as a result of unconfined compressive strength test conducted on soil samples prepared under light compaction is shown below

Ucc Test Results Of Soil

Type of Compaction	Unconfined compressive Strength kN/m2	Cohesion kN/m2
Light compaction	58.64	4.61

V. EXPERIMENTAL STUDY

A. General

The experimental study involves Standard Proctor’s Compaction tests, California Bearing Ratio tests and unconfined compressive test on soil with varying percentage of coir pith namely 2%, 2.5%, 3%, 3.5% and 4%.All the tests were conducted with light energy of compaction.

1) Standard Proctor’s Compaction Tests Standard Proctor’s Compaction tests is conducted on soil with 2%, 2.5%, 3%, 3.5% and 4% coir pith to determine the optimum moisture content and maximum dry density of soil with varying coir pith content .The following are the compaction curves obtained from the Standard Proctor’s Compaction test .

B. Standard Proctor’s Compaction Tests

1) Standard proctor compaction curve for soil with coir pith The comparison of untreated and treated coir pith compaction curve obtained from addition of coir pith 2%, 2.5%, 3%, 3.5%and 4%shown in

The optimum moisture content and maximum dry density of soil with addition of rice husk ash 2%,2.5%,3%,3.5% and 4% obtained from the above Fig 5.1 are given in Table 5.

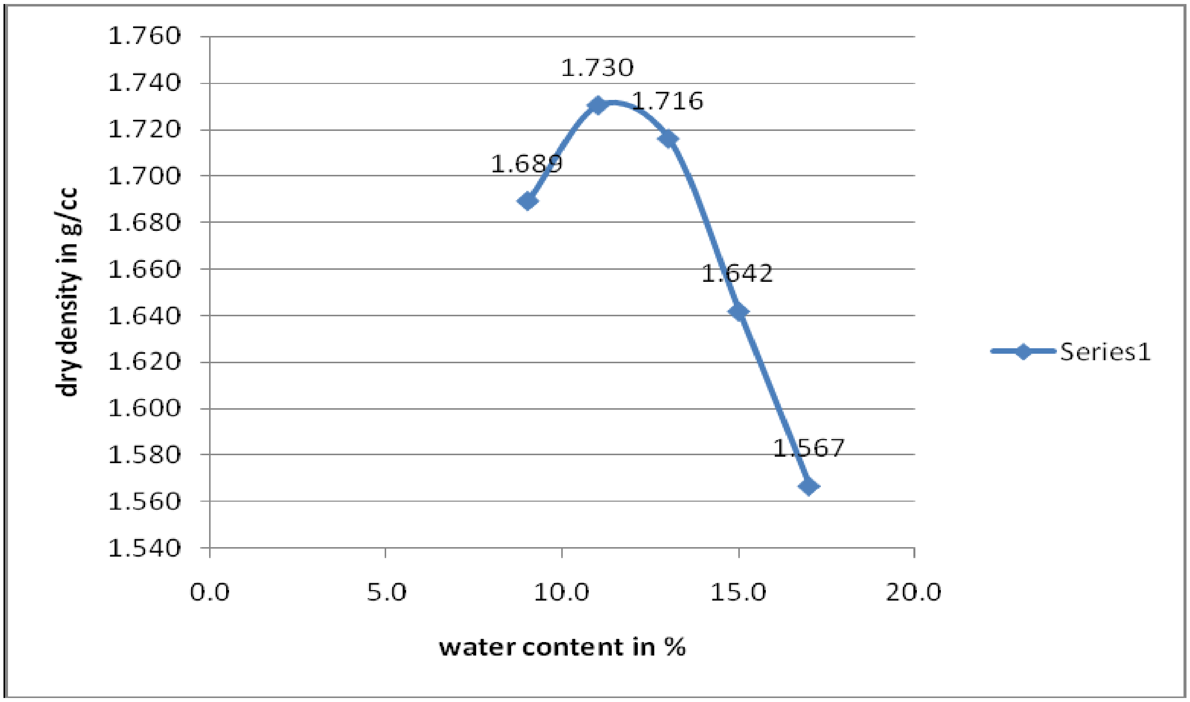
Standard Proctor’s Compaction test results for treated RHA

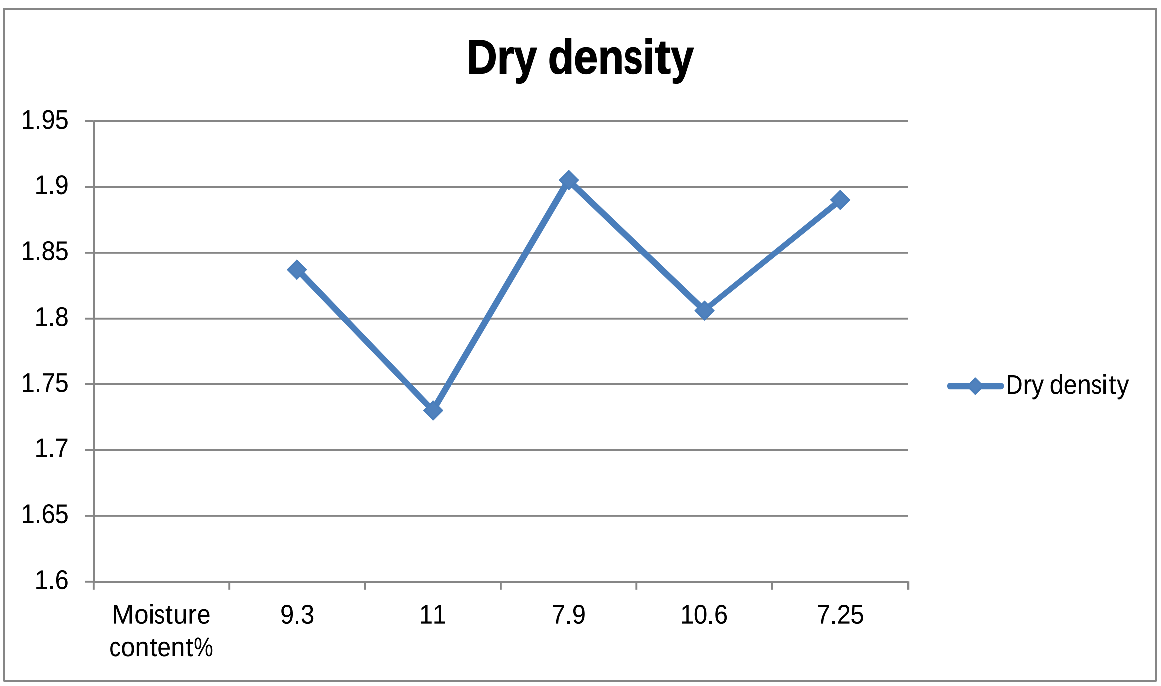
RICE HUSK ASH	RHA 2%	RHA 2.5%	RHA 3%	RHA 3%	RHA 3.5%
Optimum Moisture Content (OMC) in %	14	14	14	14	14
Maximum Dry Density (MDD) in g/cc	1.44	1.56	1.73	1.49	1.41

Standard Proctor’s Compaction test results for untreated RHA

RICE HUSK ASH	RHA 5%	RHA 10%	RHA 15%	RHA 20%	RHA 25%
Optimum Moisture Content (OMC) in %	9.3	11	7.9	10.6	7.25
Maximum Dry Density (MDD) in g/cc	1.837	1.730	1.905	1.806	1.890

Graph





C. California Bearing Ratio Tests

California Bearing Ratio Tests are conducted on soil samples prepared under Light compaction to determine CBR value of soil with varying coir pith content. The test is conducted on soil samples with 2%, 2.5%, 3%, 3.5%and 4% coir pith to determine the optimum coir pith content. The following are the Load vs Penetration curves obtained from the tests.

D. *Unconfined Compressive Strength Test*

This test are conducted on soil samples prepared under Light compaction to determine unconfined compressive strength value of soil, when is then used to calculate the unconsolidated undrain shear strength of clay under unconfined condition with varying coir pith content. The test is conducted on soil samples with 2%, 2.5%, 3%, 3.5%and 4% coir pith to determine the unconsolidated undrain shear strength.

UCC Test result of different percentage of RHA on soil

PERCENTAGE OF RISE HUSK ASH	UNCONFINED COMPRESSIVE STRENGTH KN/M2	COHESION KN/M2
5%	62.56	32.90
10%	180	33.42
15%	197	35.67
20%	152	35.96
25%	167	31.7

VI. RESULTS AND DISCUSSION

This chapter elaborates the results obtained from the above tests on soil sample. The tests were conducted on soil sample at their optimum moisture content. The test results based on the CBR tests.

A. *Properties Of Soil*

The various properties of the soil namely natural moisture content, specific gravity, liquid limit, plastic limit, shrinkage limit, grain size distribution, optimum moisture content , maximum dry density ,unconfined compressive strength and CBR obtained from chapter 4 are summarized in

Properties of Soil

S.NO	PROPERTIES	RESULT
1	Natural Moisture Content	14%
2	Specific Gravity	2.25
3	Percentage of sand	24.21
4	Percentage of silt	25.62
5	Percentage of clay	50.17
6	Soil classification	1.78 g/cc
7	Optimum Moisture Content	54.71%

B. *Standard Proctor Compaction Test*

1) *Result :* Standard Proctor's Compaction tests are conducted on soil samples and on soil samples with 2%, 2.5%, 3%, 3.5% and 4% rha. The maximum dry density and optimum moisture content corresponding to various percentages of treated and untreated rha were elaborated in chapter 5.The variation in maximum dry density and optimum moisture content with addition of treated rha under light compaction and the variation in maximum dry density and optimum moisture content with addition of treated under light compaction.

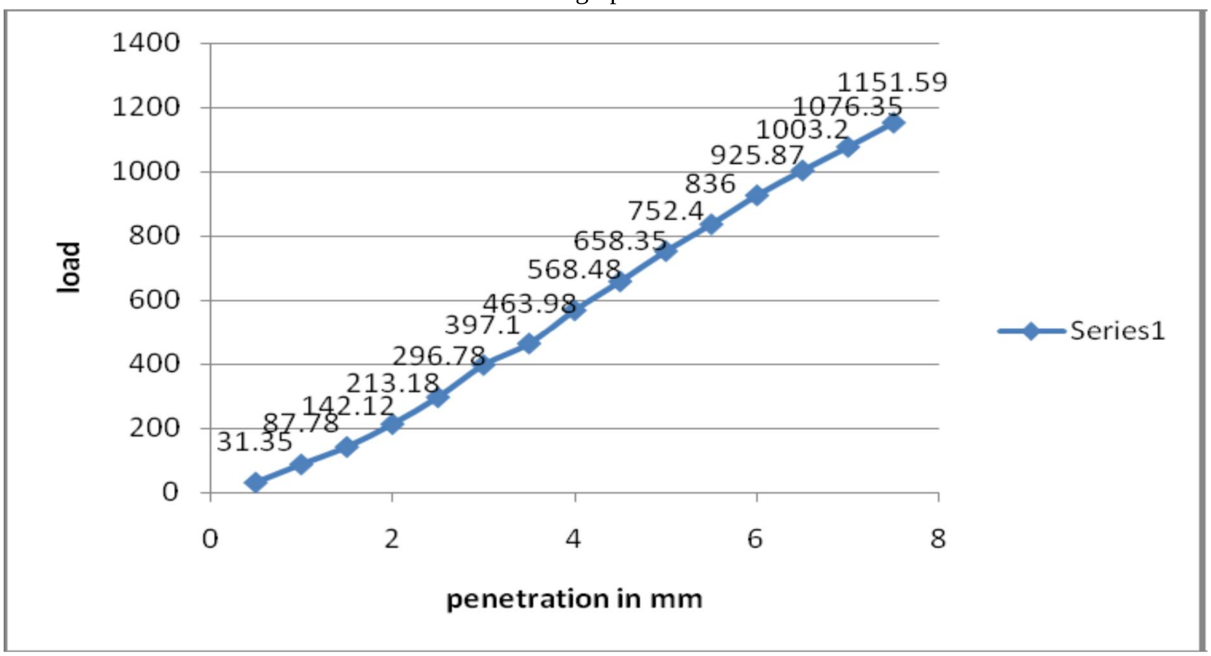
C. *California Bearing Ratio Test*

1) Result California bearing ratio tests are conducted on soil samples and on soil samples with 2%, 2.5%, 3%, 3.5% and 4% coir pith. The tests were carried out on samples prepared under light compaction. The tests were carried out on samples under unsoaked condition. The CBR values corresponding to various percentages of coir pith were elaborated in chapter 5.

The variation in CBR value with addition of rha under light compaction and soaked condition is shown in

Light compaction	Bearing Ratio in %
1	25
2	33
3	17
4	14
5	25

graph



VII. CONCLUSION

In this experimental study, the effect of RHA on geotechnical properties of the expansive soil are investigated and analyzed. From the results obtained, it can be concluded there is little improvement in the usage of RHA stabilized soil. The conclusion to the study is summarized as follows:

The specific gravity of the soil decreases with the addition of RHA to the soil. The liquid limit and plastic limit of the soil increases with the percentage increase of RHA. It was also observed that the maximum dry density (MDD) of the soil decreases with the addition of RHA due to lower specific gravity of RHA. The optimum moisture content (OMC) of the soil increases on stabilizing with RHA due to pozzolanic reaction between CaOH of the soil and RHA. The shrinkage limit of the soil decreases with the increase of RHA.

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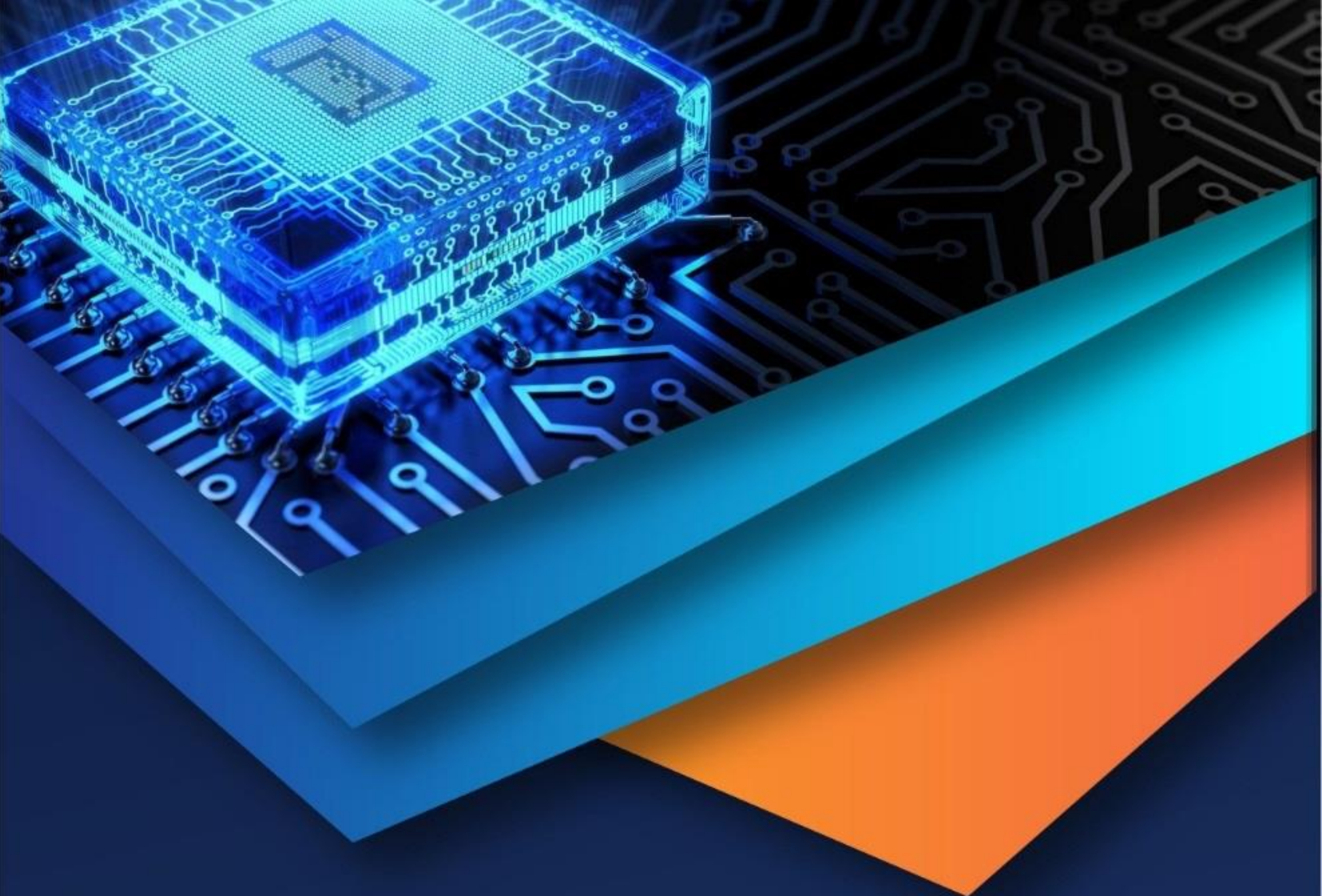

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