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Study on Behaviour of Lithomargic Clay with Various Admixtures

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Abstract: ***The lithomargic clay (shedi soil) is an expansive soil and has great affinity towards water. When it comes in contact with water it expands and it behaves as a liquid by losing its strength.When it loses water from it, it shrinks. This property of expansive and shrinkage cause serious problems like formation of potholes, dilation problems etc in the cement constructed over this soil. This makes it unsuitable for construction of any civil structures. The soil contains mainly quartz and kaolinite which increases expansion characteristics of the soil. It does not possess any desirable engineering property and its behaviour is unpredictable, especially when the soil is fully saturated. Therefore construction on this type of soil requires special design and precautions, which leads to extra cost of construction. In this research the soil has been stabilized by adding flyash, cement and lime in varying percentages by weight of soil. Various tests have been carried out to determine the strength properties such as specific gravity, consistency limits, compaction tests and CBR tests. The addition of cement has proved the process uneconomical. The addition of lime and flyash has showed improvement in the strength.***
Keywords: Lithomargic clay, flyash, lime, CBR tests.

I. INTRODUCTION

Infrastructure projects such as highways, railways, water reservoirs, reclamation etc. requires earthmaterial in very large quantity. In urban areas, borrow earth is not easily available which has to behauled from a long distance. More areas are covered with highly plastic and expansivesoil, which is not suitable for such purpose. Extensive laboratory / field trials have been carried out byvarious researchers and have shown promising results for application of such expansive soil afterstabilization with additives such as sand, silt, lime, fly ash, etc. As fly ash is freely available in the Thermal Power Plants, it can be used for stabilization of expansive soils for various uses.

Lithomargic clay (shedi soil) constitutes an important group of residual soils existing under lateriticsoils usually found on western and eastern coasts of India. It is very sensitive to water and loses a greater part of its strength when saturated.In this project the behavior of lithomargic clay (shedi soil) when mixed with different admixture for stabilizing the soil properties can be observed. All the geotechnical tests will be carried out to obtain the satisfactory results. By analyzing the test result the substantial and desirable changes in the properties of lithomargic clay (shedi soil) as a Civil Engineering material on application of various admixtures can be obtained.

For an effective disposal of fly ash avoiding environmental pollution, it is necessary to utilize it on a continuous basis for some beneficial purposes. Its bulk utilization is feasible through civil engineering applications. The test results indicate that the addition of fly ash plays an important role inthe development of strength of the soil. A little addition of cement even at 1% to the soil-fly ash mixes significantly increases the unconfined compressive strength. In the further investigation UCC tests were carried out for different proportion of soil, fly ash with and without addition of cement and lime in small percentage.

II. LITERATURE REVIEW

Bhuvaneshwari. S et.al(2005)carried out a study to check the improvements in the properties of expansive soil with fly ash in varying percentages.The paper describes a method adopted for placing these materials in layers of required thickness and operating a “Disc Harrow”. Based on laboratory and field tests, following conclusions were made that as the locally available borrow soil has generally high plasticity (LL > 50) it was difficult to use it directly for construction. The tests carried out with different proportion of FA indicated that the workability is maximum with 25% FA. Also the dry density observed is maximum for 25% FA.

Suresh P.K et.al(2009)presented results of laboratory investigation made on strength behavior of a weak soil blended with pond ash and coir.. The quantity of pond ash content was varied gradually as 5, 10, 15,20, 25, 30, 35, and 40 percent by weight of total mix..

Maximum value of CBR was obtained at OMC for 0.6% of coir and 15% of pond ash in the soil mix.Maximum value of unconfined compressive strength is exhibited in the soil mix with 15% pond ash with 0.8% coir for both one day and 7 days curing. Thepercentage increaseafter one day curing is 8 and for 7 days curing is 15 for light compaction.

Ramesh. H.N et.al (2011)Studied the strength property of shedi soil depends on density and compactive effort. This paper presents the strength behaviour of pozzolanicNeyveli fly ash treated with shedi soil after curing (Soaked and unsoaked). From the study it is inferred that, addition of 20% NFA to shedi soil, strength increases by 19 folds and 14 folds respectively representing forboth unsoaked and soaked UCC samples compared to shedi soil alone. Based on the experimental results following conclusions were drawn that the strength of Shedi soil increases continuously with the addition of Neyveli fly ash. However for unsoaked condition the increase is 18 folds and for soaked condition is 14 folds compared to Shedi soil alone.

Allamaprabhu et.al.,(2012)studied on series of laboratory tests conducted on lithomargic clay (shedi soil), which iswidespread over part of southwest coast of India, to assess whether it could be used as compacted clay liner forhydraulic barriers in engineered landfill. From the studies, it is found that lithomargic soil is near to the recommended specifications for soils to be used as liner material. From the laboratory test results, it can be concluded that lithomargic clay blended with marine claysatisfies the requirements for a good soil liner material.

Ogundalu et.al.,(2014)studied the effect of Soldier-Ant Mound (SAM) on the strength characteristics of lateritic clay soils in order to improve their poor geotechnical properties for road pavement construction. The samples were mixed with Soldier-Ant Mound in variousproportions (0%, 2%, 4%, 6%, 8% and10% by weight) and subjected to soil strength tests: Compaction tests, California Bearing Ratio (CBR)and Unconfined Compressive Strength tests. The results indicated that there is a potential in the use of Soldier-Ant Mound for improving the strength characteristics of lateritic soils for road pavement construction and other earth works.

III. METHODOLOGY

Fig 4.1. Sample of Seivedshedi soil and lime

Shedi soil was collected from Kadaba in Dakshins Kannada district which is 40km away from Sullia. Flyash was collected from Thermal Power plant, Padubidri and Lime was supplied by Ambika Enterprises, Bangalore. Shedi soil is stabilized with the flyash and lime. The quantity of flyash content is varied gradually as 5,10,20,30 and 50 percent by weight of total mix. The fly ash, lime & lithomargic clay soil are mixed fully on dryweight basis in the suitable requiredproportions. There are different test sieve analysis, liquid limit, plastic limit, compaction, CBR test were performed in laboratory as per IS code standards.

The following tests are conducted:

A. Sieve analysis
B. Liquid limits
C. Plastic limit
D. Compaction
E. CBR

Sieve analysis

The Grain size analysis on natural soil were conducted according to I.S. 2720 (Part iv)-1975.

Atterberg's limits

The tests on the liquid limit (LL), plastic limit (PL), and plasticity index (PI) of the soil-additive mixture were conducted according to I.S. 2720 (Part v)-1970.

Volume 3, Special Issue-I1, June 2015
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Fig 4.2 shedi soil plastic limit

Compaction characters

The compaction tests to obtain the moisture-density relationship of the soil-additive mixtures were conducted according to I.S. 2720 (Part viii)-1965.

Fig 4.3shedi soil proctor test

California bearing ratio- (CBR)

The CBR tests were conducted according to I.S. code. A standard CBR mould with a detachable collar was used. The soil-additive mixtures were compacted at the optimum moisture content and soaked in water for 4 days under a surcharge weight of 5.72 kg before testing.

Fig 4.4 shedi soil CBR

IV. OBJECTIVES OF WORK

In the present investigation, an attempt is made to examine strength behaviours of Shedi soil, which is quite problematic, abundantly available in the region of South Canara District of Karnataka State, India. Shedi soil is characterized by its poor strength in compression and shear particularly in wet condition it exhibits appreciable strength. Roads constructed on this type of soil sub-grade become problematic during monsoon and exhibit spongy nature and poses difficulties for design, construction, and maintenance of most of the rural roads in these regions..

The main objectives of the present study are as follows:

To stabilize the locally available weak sub-grade, (i.e. Shedi soil) by varying the percentage of fly ash and lime.

To study the influence of fly ash content on the OMC and MDD, strength parameters.

To arrive at the optimum fly ash content.

V. SCOPE OF THE STUDY

The scope of the work includes characterization of the Shedi soil and flyash, determining the moisture-density relationship with respect to IS-light compaction for the soil blended with varying flyash content and lime and determine the laboratory UCS and CBR.

Volume 3, Special Issue-I1, June 2015
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International Journal for Research in Applied Science & Engineering Technology (IJRASET)

VI. RESULTS

These were the results obtained for the basic tests conducted on lithomargic clay.

Table7.1. Basic properties of shedi soil

Grain size distribution(%)	
Gravel size fraction	63.7
Sand size fraction	36
Silt and Clay	0.3
Specific gravity	2.8
Insitu density test(kN/m^3) Core cutter method	18
Field moisture content(%)	10.66
Consistency limits(%)	
Liquid limits	45.95
Plastic limit	36.79
Compaction test Standard proctor test	
OMC(%)	28.2
MDD(kN/m3)	15.2
Shear tests Unconfined compression test	
C (kN/m^3)	34.31
φ(degrees)	30
Direct shear test(kN/m3)	23
CBR tests(%)	
Soaked condition	10.17
Unsoaked condition	4.72

Table 7.2.Test results of clay with additives

LITHOMARGIC CLAY +CEMENT	5%	10%	20%	30%	50%
Specific gravity	2.5	2.54	2.6	2.68	2.8
Liquid limit	42.5	42	41	40	35
Plastic limit	38.8	37.8	37.2	33.2	29.25
OMC(%)	26	29.6	25	25	18.3
MDD(kN/m^3)	23.6	25.3	26	24	21.3
CBR Soaked	10.6	-	-	-	-
CBR Unsoaked	18.1	18.7	11.7	19.4	14.16
LITHOMARGIC CLAY +FLYASH	5%	10%	20%	30%	50%
Specific gravity	2.02	2.13	2.3	2.54	3
Liquid limit	45	44	41	37	31
Plastic limit	30.8	32.3	30.4	29.5	27.18
OMC(%)	36.7	49.0	32.9	21.5	27.34
MDD(kN/m^3)	25	27.4	25.7	25.3	24.8
CBR Soaked	0.76	0.29	0.76	0.73	0.58

Volume 3, Special Issue-I1, June 2015
ISSN: 2321-9653
International Journal for Research in Applied Science & Engineering Technology (IJRASET)

CBR Unsoaked	10.5	12.2	16.6	22.1	18.99
LITHOMARGIC CLAY +LIME	5%	10%	20%	30%	50%
Specific gravity	2.41	2.56	2.61	2.86	3.32
Liquid limit	55	53.9	56	51	60
Plastic limit	40.8	41.7	41.3	40.5	43.83
OMC(%)	32	31	29.4	12.8	18.03
MDD(kN/m^3)	25	24	21	21.2	21.0
CBR Soaked	8.75	14.1	19.7	7.77	-
CBR Unsoaked	37.2	31.9	35.6	20.7	-

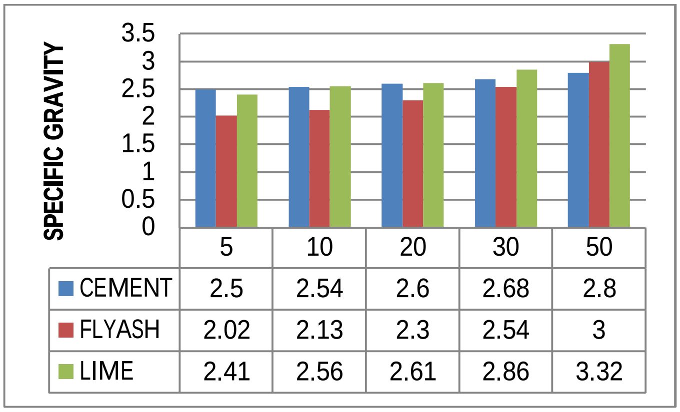


Fig 7.3.variation of specific gravity with varying % of additives

The above figure shows the variation of specific gravity with varying % of additives, the optimum value increases with increase in additives. The optimum value of cement, flyash and lime is 2.8, 3, 3.32 at 50% increment respectively.

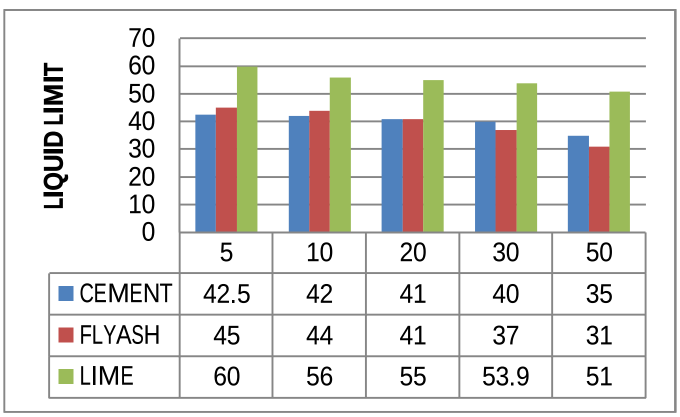
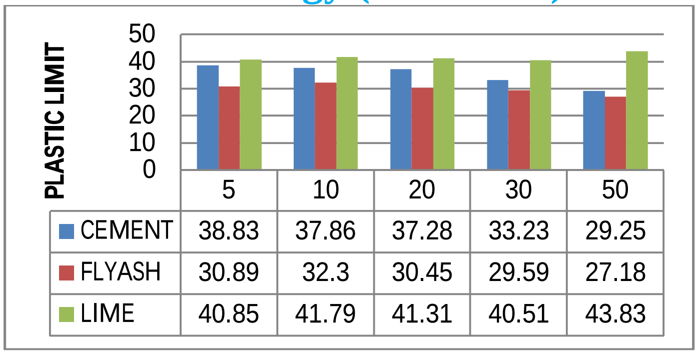


Fig 7.4.variation of liquid limit with varying % of additives

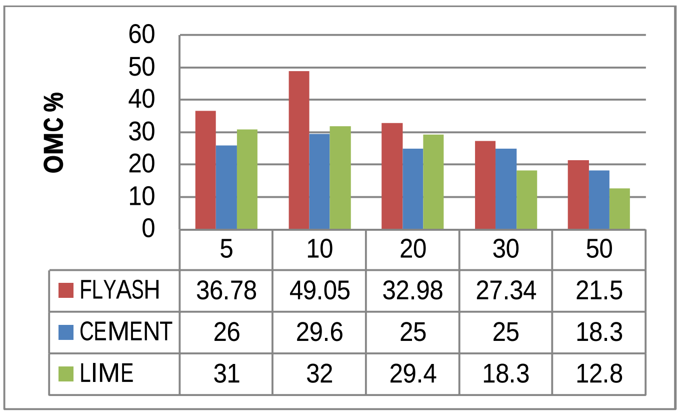
The above figure shows that the variation of liquid limit with varying % of additives, at 5% increase in cement increase 42.5% and further decreases, whereas the addition of fly ash at 5% gives an optimum of 45% and for lime at 50% gives 60%of liquid limit.



	5	10	20	30	50
CEMENT	38.83	37.86	37.28	33.23	29.25
FLYASH	30.89	32.3	30.45	29.59	27.18
LIME	40.85	41.79	41.31	40.51	43.83

Fig 7.5.variation of plastic limit with varying % of additives

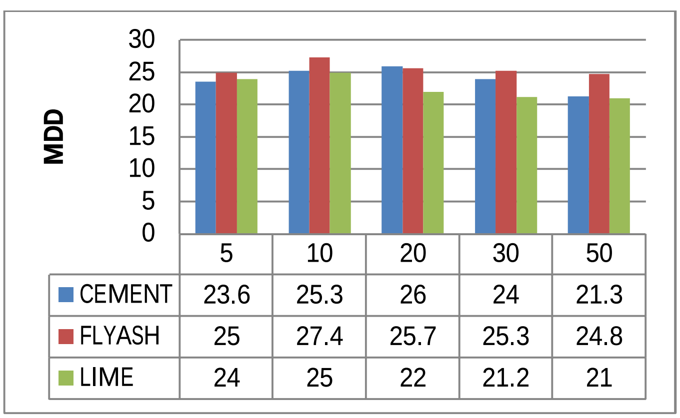
The above figure shows that the variation of plastic limit with varying % of additives, at 5% addition of cement gives 38.83%, for flyash at 10% optimum gives 32.3% plastic limit whereas for lime increase in lime content increases the plastic limit.



	5	10	20	30	50
FLYASH	36.78	49.05	32.98	27.34	21.5
CEMENT	26	29.6	25	25	18.3
LIME	31	32	29.4	18.3	12.8

Fig 7.3.variation of OMC with varying % of additives

The above figure shows that the variation of OMC with varying % of additives, increase of fly ash by 10% gives the optimum moisture content of 49.05%, with the increase in % of cement at 10% gives an optimum moisture content of 29.06% and increase in lime content at 10% optimum the optimum moisture content is 32%.



	5	10	20	30	50
CEMENT	23.6	25.3	26	24	21.3
FLYASH	25	27.4	25.7	25.3	24.8
LIME	24	25	22	21.2	21

Fig 7.6.variation of MDD with varying % of additives

The above figure shows the variation of MDD with varying % of additives, the addition of cement at 30%gives an optimum of 23.5 kN/m^3 MDD, addition of flyash at 10% gives an MDD of 27.4 kN/m^3 and addition of lime at 10% gives 25 kN/m^3 maximum dry density.

Volume 3, Special Issue-I1, June 2015
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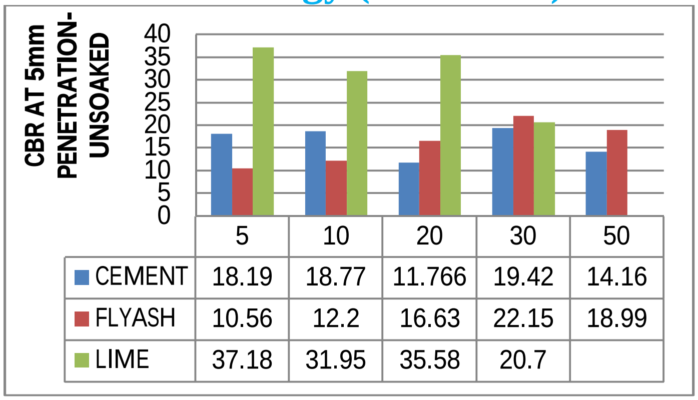

Fig 7.3.variation of CBR with varying % of additives

The above figure shows that the variation of CBR with varying % of additives, addition of cement and flyash at 30% gives an optimum 19.42% and 22.15% respectively, and addition of lime at 5% gives an optimum of 37.18% at unsoaked conditions.

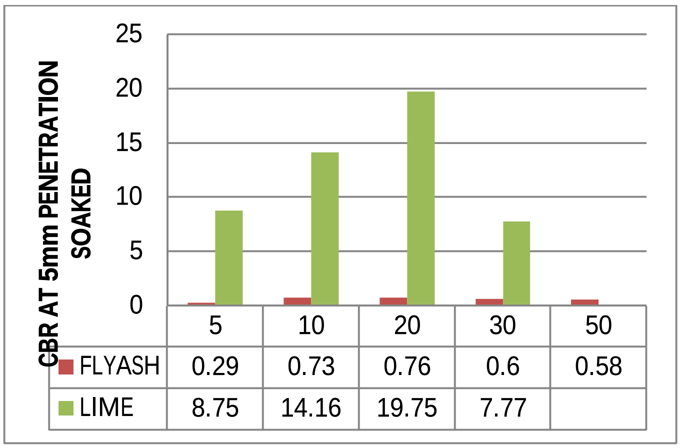

Fig 7.3.variation of CBR with varying % of additives

The above figure shows that the variation of CBR with varying % of additives. At addition of flyash and lime at 20% gives an optimum of 0.76% and 19.75% respectively at soaked condition.

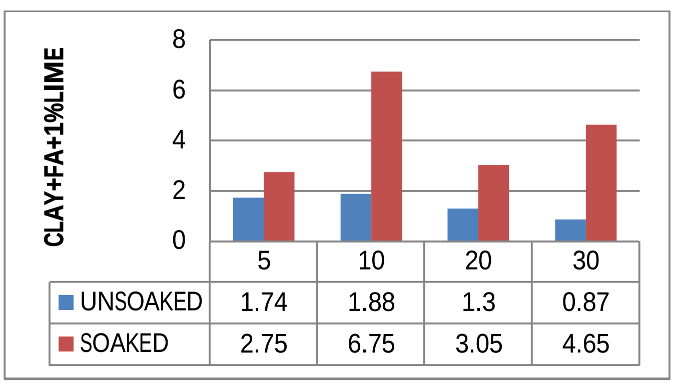

Fig 7.3.variation of CBR with varying % of additives

The above figure shows that the variation of CBR with varying % of additives, for both unsoaked and soaked conditions for addition of clay, flyash, and 1%lime gives an optimum of 1.88 and 6.75 at 10% increase.

VII. CONCLUSIONS

A. Specific gravity increases with increase in percentage of additives.

B. Liquid limit decreases as the percentage of replacement increases and plastic limit varies with varying percentages of replacement of lime,flyash and cement.

C. Optimum moisture content is obtained at 10% replacement of additives.
D. CBR is highest at 5% replacement of lime at unsoaked condition and the replacement of lime at 20% is more at soaked condition.
E. With flyash and lime combination CBR has increased at 10% replacement of flyash along with 1% lime at soaked condition.
F. The replacement of cement does not shows better improvement till 50% replacement and also it makes the process uneconomical.
G. Lime has proved to be a very good additive to be replaced by exhibiting its increasing strength properties with soil.
H. Hence it is proved that lithomargicshedi soil increases its strength if stabilized with certain additives and it can be successfully used in construction field.

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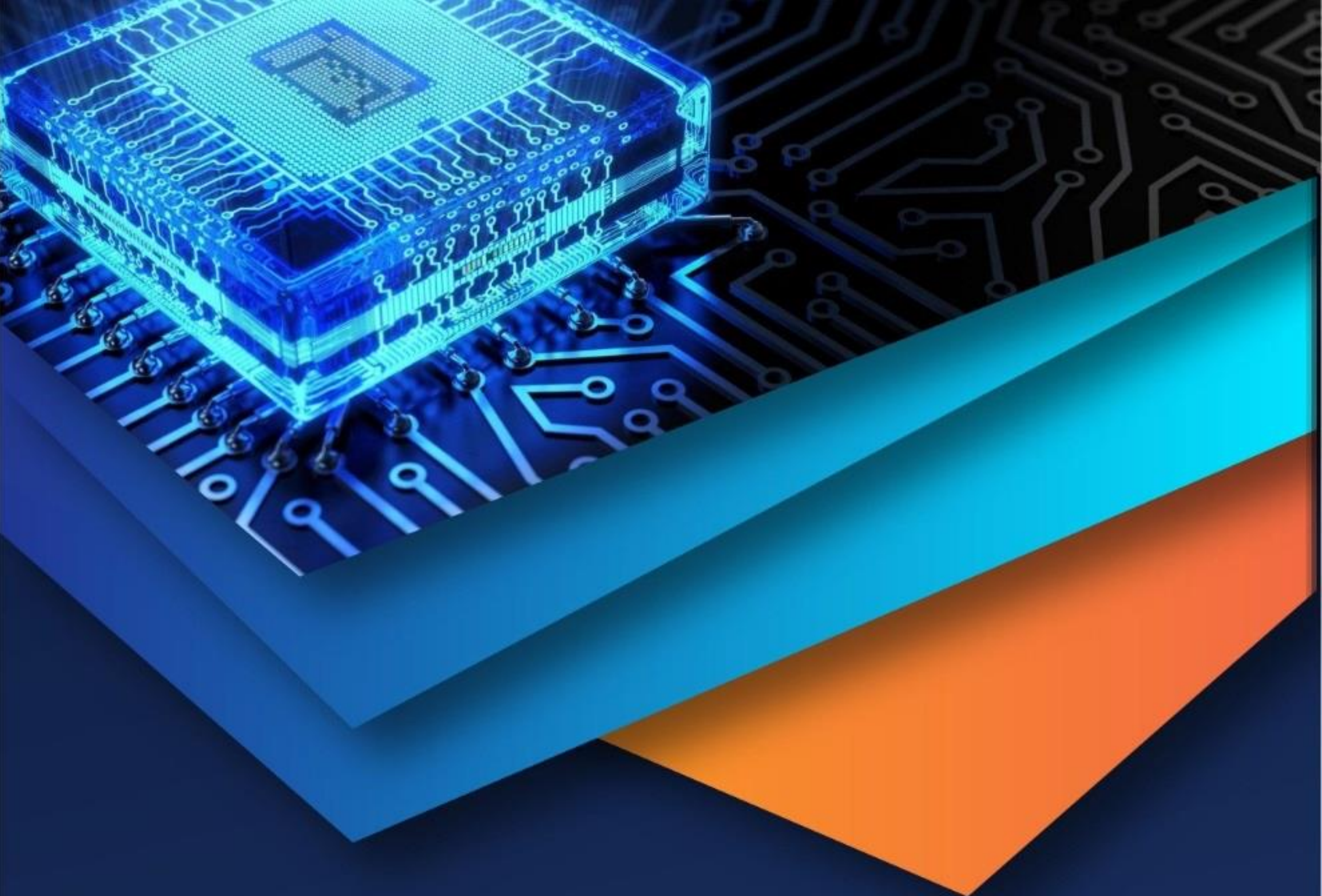

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