iJRASET
International Journal For Research in
Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 3 **Issue:** Issue II **Month of publication:** June 2015

DOI:

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International Journal for Research in Applied Science & Engineering Technology (IJRASET)

Laterite Quarry Waste Interaction Behaviour with Flyash and Lime

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Abstract: Soil is considered by the engineer as a complex material produced by mechanical and chemical weathering of solid rock. The formation of soil is a result of geologic cycle continuously taking place on the face of the earth. Lateritic soils are formed in the tropics through weathering processes that favours the formation of iron, aluminium, manganese and titanium oxides. Some lateritic soils in their natural state need some treatment/modification to meet these specification requirements.

In this project work laterite quarry waste is mixed with varying percentage of flyash, cement and lime in order to study the strength and other properties of soil. Various tests are to be carried out with these mixed soil sample. The tests carried out include particle size distribution, specific gravity, liquid limit, plastic limit, and compaction and C.B.R tests. By analyzing the test result the substantial and desirable changes in the properties of lateritic soil as a Civil Engineering material on application of fly ash, cement and lime can be observed.

As per this research work laterite quarry waste is mixed with 5%,10%,20%,30% of flyash and lime . The addition of these admixtures shows improvement in the properties of laterite quarry waste.

Keywords: Laterite, Lime, Flyash, atterberg limit, compaction test, California bearing ratio, Specific gravity

I. INTRODUCTION

Lateritic soils are formed in the tropics through weathering processes that favours the formation of iron, aluminium, manganese and titanium oxides. These processes break down silicate minerals into clay minerals such as Kaolinite and Illite. Iron and aluminum oxides are prominent in lateritic soils, and with the seasonal fluctuation of the water table, these oxides result in the reddish-brown colour that is seen in lateritic soils. The laterite soil is formed under conditions of high temperature and heavy rainfall with alternate wet and dry periods. Laterite soils are the end products of weathering given sufficiently long time. It is probably the end product of decomposition found in regions of heavy rainfall. Such climatic conditions promote leaching of soil whereby lime and silica are leached away and a soil rich in oxides of iron and aluminium compounds is left behind.These soils have served for a long time as major and sub-base materials for the construction of most highways and walls of residential houses in tropical and sub-tropical countries of the world. Laterite and lateritic soils have a unique distinction of providing valuable building material. These soils can be easily cut with a spade but hardens like iron when exposed to air. Because it is the end- product of weathering, it cannot be weathered much further and is indefinitely durable. Civil engineering applications of these lateritic soils are continually being developed with the use of different types of stabilizers. The stabilized soil-based products are viewed as environmentally-friendly and low-cost energy materials for sustainable building applications. Laterites are widely distributed throughout the world in the regions with high rainfall, but especially in the inter-tropical regions of Africa, Australia, India, South-East Asia and South America, where they generally occur just below the surface of grasslands or forest clearings. For soils to be suitable in civil engineering projects, they must meet existing local requirements for index properties in addition to certain strength criteria. Some lateritic soils in their natural state need some treatment/modification to meet these specification requirements. This treatment/modification of soil to improve the engineering properties of soil is known as soil stabilization. By the method of soil stabilization many soil which has found not useful have been used in many engineering projects. Engineers are facing the problem of getting good soil for construction. If the soil is loose enough then it need to be strengthened by using different admixtures. Many research works are carried out based on the stabilization of soil. Based on the research work result soil stabilization can be done and soil can be used for different construction purposes. Many materials like ashes, lime, cement, crushed aggregate, gravel, asphalt etc are used for soil stabilization. In this project work laterite quarry waste is mixed with varying percentage of fly ash and lime in order to study the strength and other properties of soil. Fly ash is the finely divided mineral residue

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resulting from the combustion of coal in electric generating plants. Around 150 million tonnes of fly ash get accumulated every year at the thermal power stations in India**.** Fly ash consists of inorganic, incombustible matter present in the coal that has been fused during combustion into a glassy, amorphous structure. Fly ash particles are generally spherical in shape and range in size from 2 µm to 10 µm. They consist mostly of silicon dioxide (SiO_2), aluminiumoxide (Al_2O_3) and iron oxide (Fe_2O_3). Fly ash like soil contains trace concentrations of the following heavy metals: nickel, vanadium, cadmium barium, chromium, copper, molybdenum, zinc and lead. Hence it is necessary for the effective disposal of flyash without causing any environmental problems. Disposal of flyash in open area can cause environmental problems. Hence research works are carried out on the effective utilization of flyash. One of the method to utilize flyah is to use flyash as a stabilizer. Hydrated lime (calcium hydroxide) is a dry, colorless crystalline powder manufactured by treating calcium oxide (quicklime) with water, in a process called "slaking." Also known as slack lime, builders lime or pickling lime. Hydrated lime is used in the manufacture of steel and metals. . In construction, the dominant use of hydrated lime is in soil stabilization for roads, earthen dams, airfields, and building foundations. Hydrated lime can be used to raise the pH of acidic soils.

Various tests are to be carried out with these mixed soil sample. The tests carried out include particle size distribution, specific gravity, liquid limit, plastic limit, and compaction and C.B.R tests.By analyzing the test result the substantial and desirable changes in the properties of lateritic soil as a Civil Engineering material on application of fly ash, cement and lime can be observed.The objectives of this research is the

effective utilization of flyash, cement and lime in improving the strength characteristics of laterite quarry waste .Utilization of coal for thermal power generation produces large quantities of fly ash, the disposal of which is often problematic. The use of fly ash as landfill creates environmental pollution. Hence an attempt is made to use flyash as one of the admixture.

II. LITERATURE REVIEW

A. Evaluation of Changes in Index Properties of Lateritic Soil Stabilized with Fly Ash

AgapitusAmadi (2010) his study was to evaluate changes in the index properties (i.e., particle size distribution, Atterberg limits and compaction characteristics) of a residually derived lateritic soil following fly ash application. . Lateritic soil – fly ash mixtures with up to 20% fly ash by dry weight of soil were tested and specimens for compaction characteristics were prepared at different compaction states (optimum, dry and wet of optimum moisture content) and compacted using British Standard Light (BSL) compactive effort. From this study, it was established that the index properties of the study soil were substantially improved and therefore fly ash offers the potential for stabilization/modification of lateritic soil for a variety of civil engineering projects.

B. Use of certain Admixtures in the construction of pavement on expansive clayey subgrades

D.Neeraja et.al.,(2010) in this paper, an attempt has been made to utilize industrial wastes like Rice Husk Ash (RHA), Fly Ash (FA) and Ground Granulated Blast furnace Slag (GGBS) as stabilizing agents. In addition to these, Lime was also added as stabilizing agent. The effect of Lime, RHA, FA and GGBS on certain properties of soil such as Optimum moisture content (OMC), Maximum Dry Density (MDD), Unconfined Compressive Strength (UCS) and California Bearing Ratio (CBR) has been studied. It has been established by experiments conducted on the samples that there is a maximum change in the properties with addition of lime up to 5%, RHA and GGBS up to 15% per cent and FA up to 20%. Of all the admixtures, Lime shows considerable increase in strength characteristics at an optimum lime content of 5% which gave maximum.

C. Effect of Flyash on Geotechnical properties of Local Soil-Fly ash Mixed Samples

Tanaya Deb et.al., (2014) Concerning the major challenges regarding the safe reuse, management and disposal of flyash an attempt has been made to mix fly ash at 10, 15, 20, 25, and 30% on the basis of dry weight with local silty-clay soil. The study is carried out through large scale tests to simulate field conditions as closely as possible and found to be a very effective means to control the specific gravity (G), liquid limit (LL) and plastic limit (PL), linear shrinkage (L-S), initial void ratio (ei), initial degree of saturation (Si), maximum dry density (MDD) and optimum moisture content (OMC) at standard Proctor compaction energy, hydraulic conductivity (k), unconfined compressive strength (UCS), free swelling index (FSI), and swelling potential (SP) characteristics. The test results concluded that, decrease in values of specific gravity, plasticity index and linear shrinkage in the soil-fly ash mix samples irrespective of fly ash type. With the increase of ash content in the soil-ash mix samples, MDD decreases and OMC increases irrespective of ash type. .

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D. Geotechnical properties of lateritic soil stabilized with sugarcane straw ash

Amu et.al.,(2011) This research determined the geotechnical properties of lateritic soil modified with sugarcane straw ash with a view to obtaining a cheaper and effective replacement for the conventional soil stabilizers. Geotechnical strength tests (compaction, California bearing ratio (CBR), unconfined compression test and triaxial) were also performed on the samples, both at the stabilized and unstabilized states (adding 2, 4, 6, and 8% sugarcane straw ash). The results showed that sugarcane straw ash improved the geotechnical properties of the soil samples. Sugarcane straw ash was therefore found as an effective stabilizer for lateritic soils.

E. Strengthening of soil by using Fly Ash

P.S.Patil et.al.,(2014) in this paper an attempt has made to observe the effect of fly ash admixture on sub grade soil properties such as maximum dry density, California bearing ratio, unconfined compressive strength *etc*. To observe the effect of fly ash admixture was added with soil at 10% to 30% and necessary tests were conducted. All the test result showed an effective increase in results of the test conducted with varying percentage of flyash.

III. METHODOLOGY

Following are the methodology to be carried out,

A. Determining the Physical Properties of laterite soil like Specific gravity, Maximum dry density, Optimum moisture content, Liquid limit, Plastic limit, and Plasticity index.
B. Preparation of soil samples with varying percentage of Flyash and Lime.
C. The effect of flyash and lime on certain properties of soil such as Optimum moisture content (OMC), Maximum Dry Density (MDD), Unconfined Compressive Strength (UCS) and California Bearing Ratio (CBR) are to be studied.

IV. MATERIALS AND METHODS

A. Sample Collection

The material used for this study is laterite quarry waste which is collected from a laterite quarry from Menala which is at a distance of 5 km from Sullia. The stabilizer used is flyash which is collected from thermal power plant and hydrated lime.

B. Experimental Tests

Following the collection of sample from quarry site the soil samples are subjected to laboratory tests inorder to determine its geotechnical engineering properties. The tests conducted included Natural Moisture Content, Atterberg Limits, Particle Size Analysis, specific gravity, Compaction (Standard Proctor), California Bearing Ratio(CBR),direct shear test After finding its engineering properties the soil samples were stabilized with vary 5%,10%,20% and 30% of flyash and hydrated lime by weight of soil and were also made to undergo the same laboratory analysis to determine their geotechnical engineering properties. The tests conducted included Atterberg Limits, Compaction (Standard Proctor), California Bearing Ratio(CBR). These tests were conducted for the laterite quarry waste in accordance with IS:2720(Part 18)-1964, IS:2720(Part 3/sec 1)-1980, IS:2720(Part 5)-1985 and IS:2720(Part 16)-1979.

C. Results

Below are detailed results of all laboratory tests.

The preliminary tests were performed for the identification of the properties of the laterite quarry waste without the addition of stabilizers. Furthermore the results of the laterite quarry waste are summarily tabulated in Table.

Table 1: Laterite soil properties

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Volume 3, Special Issue-I1, June 2015
ISSN: 2321-9653

Soil properties	Value
Grain size distribution (%)	
Gravel size fraction	50
Sand size fraction	47.3
Silt and clay	0.7
Specific gravity	2.27
Field moisture content(%)	12
Consistency limits (%)	
Plastic limit	35
Liquid limit	45
CBR (US) (%)	11.62

D. Specific Gravity

This was carried out to determine the fineness of the sample i.e. to have an idea of the quality of fine particle contained in the sample.The variation of specific gravity with various percentage of flyash and lime is shown in fig below

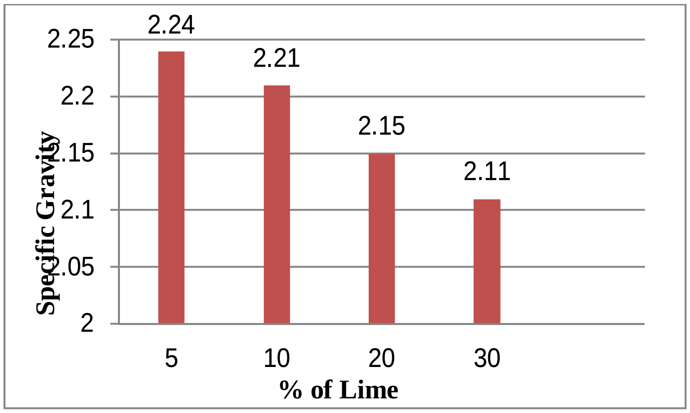

Fig 1: Variation in specific gravity with various % of lime

The above graph shows variation in specific gravity with various % of lime. The addition of lime showed decrease in the specific gravity.

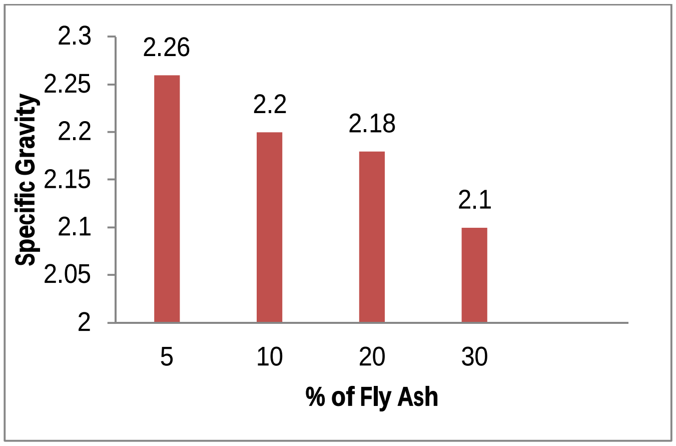

Fig 2: Variation in specific gravity with various % of FA

The above graph shows that Variation in specific gravity with various % of FA. The % varies with 5%, 10%, 20%, 30%.as the flyash content increases the specific gravity drcreases.this is because of the hollow,thin walled structure of flyash and and having low weight than soil.

E. Atterberg Limit Test

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Volume 3, Special Issue-I1, June 2015
ISSN: 2321-9653

This was done to determine the liquid limit, plastic limit. The variation of liquid limit and plastic limit with various percentages of flyash and lime is shown in the fig below

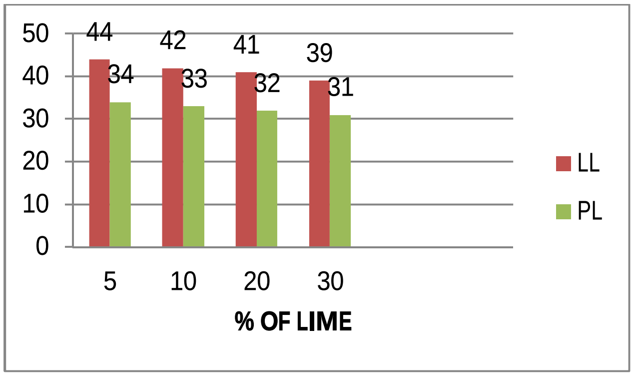

Fig 3: variation in liquid limit and plastic limit with various % of lime

The above graph shows the variation in liquid limit and plastic limit with various % of lime. The % varies with 5%, 10%, 20%, 30% of lime. Liquid limit and plastic limit decreases with the increase in the % of lime.

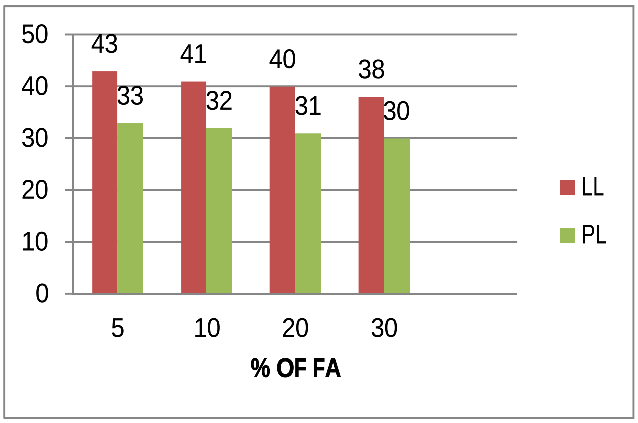

Fig 4: variation in liquid limit and plastic limit with various % of FA

The above graph shows the variation in liquid limit and plastic limit with various % of FA. With the increase in the % of FA the liquid limit and plastic limit goes on decreasing.

F. Compaction Test

This was carried out to determine the Optimum Moisture Content (OMC) and Maximum Dry Density (MDD).MDD and OMC variation is shown in fig below

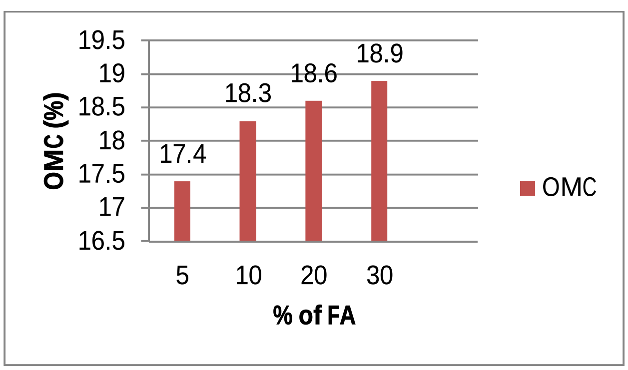

Fig 5: variation in OMC with various % of flyash

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

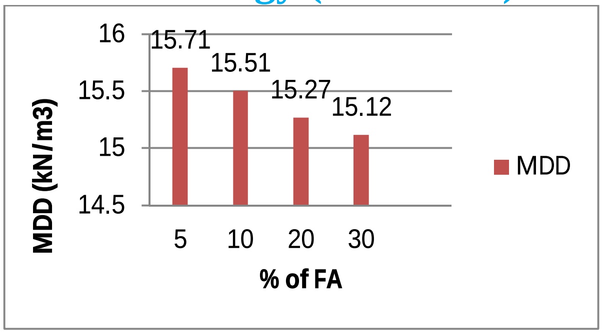

Fig 6: variation in MDD with various % of flyash

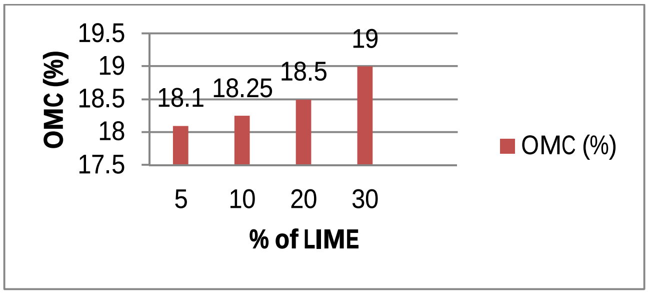

Fig 7: variation in OMC with various % of lime

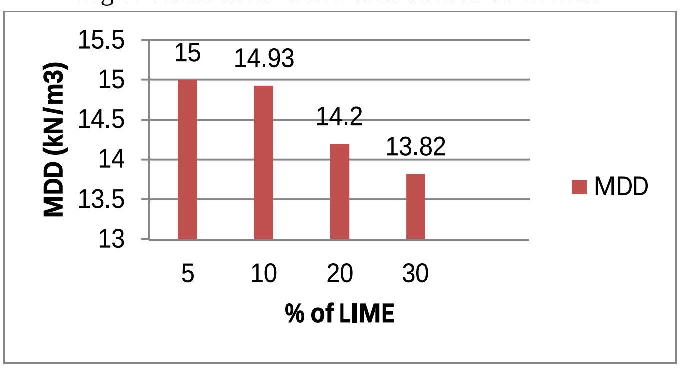

Fig 8: variation in MDD with various % of lime

G. California Bearing Ratio (CBR)

This was carried out to estimate the bearing capacity of the soil to use in sub-grade and base course using the California Bearing Ratio (CBR) Machine. The compacted wet soil was placed on the California Bearing Ratio (CBR) machine. The proofing ring gauge and plunger penetration gauge were set at zero. Immediately the plunger penetration made a contact with the soil, the gauges started working simultaneously and, the readings were taken on the proofing ring gauge.

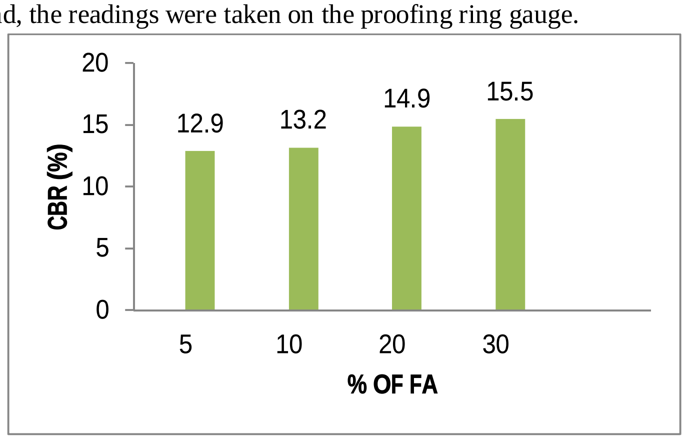

Fig 9: variation in CBR with various % of FA in unsoaked condition

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Above figure shows the variation in CBR with various % of FA in unsoaked conditions, as the % of flyash increases CBR increases.

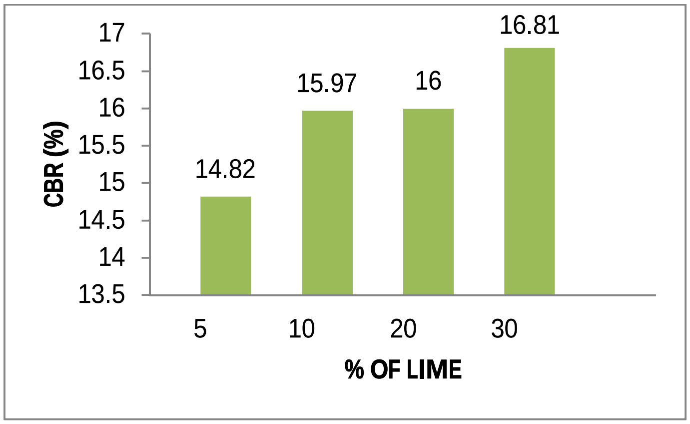

Fig 10: variation in CBR with various % of lime in unsoaked condition

Above figure shows that the variation in CBR with various % of lime in unsoaked condition. As the lime content increases CBR value increases.

V. CONCLUSION

Based on the investigations of the study, the following conclusions can be drawn

A. The addition of flyash and lime showed an decrease in the specific gravity .
B. Liquid limit and plastic limit decreases with addition of lime and flyash respectively.
C. OMC increases and MDD decreases with the addition of flyash and lime.
D. CBR also showed an increase the value by the addition of flyash and lime.
E. By refering to the above points we can conclude flyash and lime can be effectively used to stabilize laterite quarry waste.

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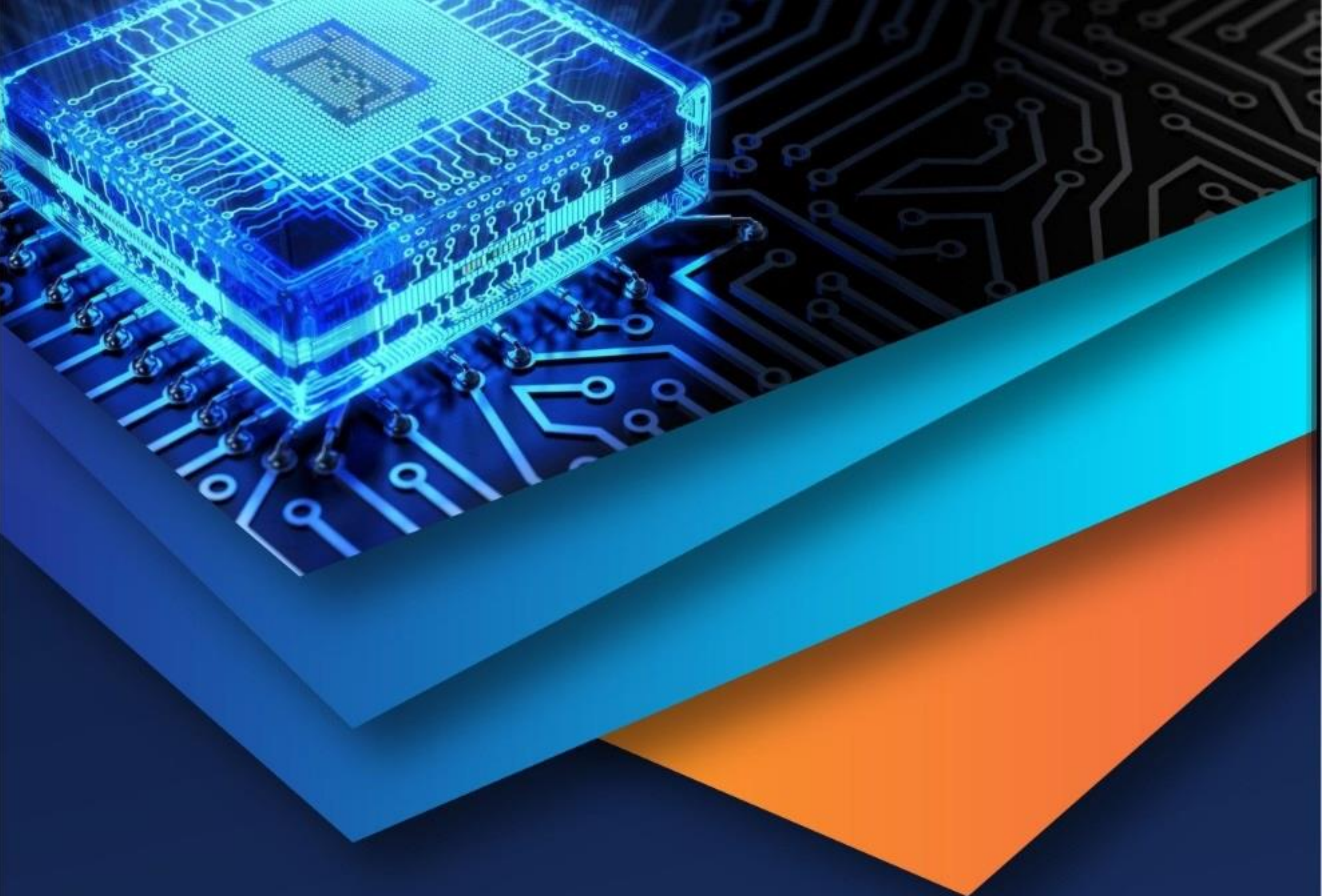

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