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# An Experimental Study on Partial Replacement of Cement by Dolomite Powder

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***Abstract: Currently India has taken a major initiative on developing the infrastructures such as express highways, power projects, and industrial structures to meet the requirements of globalization in the construction field, which involves the construction of buildings and other structures. Concrete plays the key role in the construction field and a large quantity of concrete is being utilized in every construction practices. To increase the strength of concrete the water/cementratio has to be reduced, which in turn increases the cement content. To overcome low workability problem different kinds of admixtures are used to achieve the required workability.***

***The dolomite powder which is usually disposed can be used as an alternate for cement, since dolomite powder is rich in magnesium carbonate content and also sufficient calcium content. The dolomite powder is used in different combination to find the feasibility of using the dolomite powder as an alternate to cement. The cement is replaced by 0%, 5%, 10%, 15%, and 20% by the weight of cement and by keeping the replacement of dolomite powder for cement as constant that is 10% by weight of cement. The concrete cubes are casted and compression and split tensile tests were carried out to find the best combination which results in optimum percentage of strength.***

***Keywords: Cement, dolomite powder***

## I. INTRODUCTION

It was observed and noted that since decade of years that the cost of building materials is currently so high that only corporate organizations, individual, and government can afford to do meaningful construction. Waste can be used as filler material in concrete, admixtures in cement and raw material in cement clinker, or as aggregates in concrete. Ordinary Portland cement (OPC) is acknowledged as the major construction material throughout the world. The production rate is approximately 2.1 billion tons per year and is expected to grown to about 3.5 billion tons per year by 2015. According to Adepegba (1989), the annual cement requirement in Nigeria is about 8.2million tones and only 4.6 million tons of Portland cement is produced locally. The balance of 3.6 million tons or imported.

If alternative cheap cement can be produced locally, the demand for Portland cement will reduce. The search for suitable local materials to manufacture pozzolana cement was therefore intensified. Most of the increase in cement demand could be met by the use of supplementary cementing materials, in order to reduce the green gas emission. Industrial wastes, such as silica fume, blast furnace slag, fly ash are being used as supplementary cement replacement materials and recently, agricultural wastes are also being used as pozzolanic materials in concrete. When pozzolanic materials are incorporated to concrete, the silica present in these materials react with the calcium hydroxide released during the hydration of cement and forms additional calcium silicate hydrate (C– S – H ), which improve durability and the mechanical properties of concrete (Igarashi et al, 2005). High strength concrete refers to concrete that has a uniaxial compressive strength greater than the normal strength concrete obtained in a particular region. High strength and high performance concrete are being widely used throughout the world and to produce them, it is necessary to reduce the water binder ratio and increase the binder content. High strength concrete means good abrasion, impact and cavitations resistance. Using high strength concrete in structures today would result in economical advantages. In future, high range water reducing admixtures (Super plasticizer) will open up new possibilities for use of these materials as a part of cementing materials in concrete to produce very high strengths, as someof them are make finer than cement.

## II. OBJECTIVE OF THE STUDY

1) To investigate the best mix proportion for the partial replacement of dolomite powder for cement by the different strength values obtained for different sample specimens.
2) To investigate the feasibility of the partial replacement of dolomite powder in concrete by determining its compressive strength.
3) To find the optimum percentages of dolomite powder to obtain the optimum compressive strength values.

4) To reduce the cost of major materials used in concrete by replacing it with cheaper materials such as dolomite powder.
5) To increase the strength and durability of concrete by using suitable replacement materials.

## III. LITERATURE REVIEW

Salim Barbhuiya (2011): He carried out an investigation to explore the possibilities of using dolomite powder for the production of SCC. Test results indicated that it is possible to manufacture SCC using fly ash and dolomitepowder. The mix containing fly ash and dolomite powder in the ratio 3:1 was found to satisfy the requirements suggested by the European Federation of Producers and Contractors of Specialist Products for Structures (EFNARC) guidelines for making SCC. Compressive strengths of SCC with 75% fly ash and 25% dolomite powder were found to be satisfactory for structural applications.
Kamal M.M, et al (2012): He evaluated the bond strength of self-compacting concrete mixes containing dolomite powder. Either silica flume or fly ash was used along with dolomite powder to increase the bond strength considerably. Seven mixes were proportioned, and push-out test was carried out. The variation of the bond strength for different mixes was evaluated. The steel concrete bond adequacy was evaluated based on normal bond strength. The result showed that the bond strength increased as the replacement of Portland cement with dolomite powder increased. All SCC mixes containing dolomite powder up to 30 % yielded bond strength that is adequate for design purpose. The availability of this type of concrete provided unique merits for faster construction. They reported that the shear strength of RC beams was better than that of the conventional SCC without dolomite powder.
Deepa Balakrishnan S and Paulose K.C (2013): He carried out an investigation on the workability and strengthcharacteristics of self-compacting concrete containing fly ash and dolomite powder. They made high volume fly ash self-compacting concrete with 12.5percent, 18.75percent, 25percent and 37.5percent of the cement (by mass)replaced by fly ash and 6.25percent, 12.5percent and 25percent of the cement replaced by dolomite powder. Thetest results for acceptance characteristics of self-compacting concrete such as slump flow test, J-ring test, V-funnel test and L-box test were presented. The mixes were then tested for other mechanical properties like, cube compressive strength at 7th day, 28th day and 90$^{th}$ day, cylinder compressive strength at 28th day, split tensile strength, and flexural strength at 28th day. For all levels of cement replacement, concrete achieved superior performance in the fresh and hardened states when compared with the ref mixture.

## IV. CHARACTERIZATION OF CONSTITUENT MATERIALS

### *A. Cement*

The cement used in this project is ordinary Portland cement which is 53 grade & the name of the cement isCoromandel king.

Table 1: Physical properties of cement

| Properties | Obtained values | Requirements as per IS: 4031-1988 |
|---|---|---|
| Fineness | 7% | Not more than 10% |
| Initial setting time | 45min | Not less than 30min |
| Final setting time | 525min | Not more than 600min |
| Normal consistency | 31% | - |
| Specific gravity | 3.10 | 3.10-3.19 |

### *B. Dolomite Powder*

The mineral dolomite crystallizes in the Trigonal-rhombohedral system. It forms white, tan, gray, or pink crystals.Dolomite is a double carbonate, having an alternating structural arrangement of calcium and magnesium ions. Unless it is in fine powder form, it does not rapidly dissolve. Crystal twinning is common. Solid solution exists between dolomite, the iron-dominant ankerite and the manganese-dominant kutnohorite. Small amounts of iron in the structure give the crystals a yellow to brown tint. Manganese substitutes in the structure also up to about three percent MnO. High manganese content gives the crystals a rosy pink colour. Lead, zinc, and cobalt also substitute in the structure for magnesium. The mineral dolomite is closely related to huntite $Mg_3Ca(CO_3)_4$. The specific gravity of Dolomite powder is 2.8.

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Table 2: Physical properties of dolomite powder

| S.No | DESCRIPTION | TEST RESULTS |
|---|---|---|
| 1 | Appearance | Very fine powder |
| 2 | Color | White |
| 3 | Odor | Odor less |
| 4 | Specific gravity | 2.8 |
| 5 | Fineness | 6% |

## V. EXPERIMENTAL WORK

### A. *Mix Design*

Design of M30 grade concrete

MIX PROPORTIONS

Cement =48.77 Kg/$m^3$

Fine Aggregate =87.169 Kg/$m^3$

Coarse Aggregate =138.65 Kg/$m^3$

Water =25 Liters

Water Cement Ratio =0.45

MIX PROPORTION= 1:1.6:2.64

## VI. DETAIL OF THE SPECIMEN

Table 3: Dimensions of the test specimens

| SPECIMEN | CUBES | | | CYLINDERS |
|---|---|---|---|---|
| DIMENSION | (150*150*150) mm | | | 150 mm Diameter & 300 mm height |
| SAMPLE/NOOF DAYS | 7 DAYS | 14 DAYS | 28 DAYS | 28 DAYS |
| A | 2 | 2 | 2 | 1 |
| B | 2 | 2 | 2 | 1 |
| C | 2 | 2 | 2 | 1 |
| D | 2 | 2 | 2 | 1 |
| E | 2 | 2 | 2 | 1 |
| TOTAL | 10 | 10 | 10 | 5 |

## VII. METHOD FOR PREPERATION OF CONCRETE CUBE

1) Laboratory grade materials are procured, and calculation of mix design can be done.
2) Potable water is measured for required quantity along with super plasticizers.
3) Super plasticizers are added to the water 15minutes before adding to the concrete mix.
4) Molds should be cleaned and oiled well.

5) Initially coarse aggregate, fine aggregate and cement is mixed well, and a good dry mix is prepared.
6) Then water is to be added to it.
7) Mix it thoroughly, uniform mix is obtained after 2-3 minutes of effective mixing.
8) Then the mixed concrete is filled to mold (cubes of 150*150*150mm, cylinders of 150 mm diameter and 300 mm height) in 3 layers with good compaction.
9) The prepared cubes were demolded after 24hrs and then placed for curing.

### A. *Casting, Demoulding, And Curing*

1) By referring to IS 10262-2009 and IS 456- 2000, the mix design is carried out for M30 grade of concrete. The required materials are batched based on the values obtained by mix design. The proportion of cement, sand and coarse aggregate is 1:1.6:2.64. At first the mixdesign values are calculated for 1 $m^3$ volume and then it computed for standard cube mouldsof size 150x150x150 mm & cylindrical moulds of size (150x300) mm. For each fraction of volume of dolomite powder, two cube moulds are casted and quantities of each material are calculated for those standard values of the moulds and one cylindrical mould is casted.
2) After casting the cubes and cylinders are left for a setting time of 24 hours in the laboratory to hardening. The cubes & cylinders are demolded in the laboratory after 24 hours of casting. During demolding the care should betaken to not affect the concrete cubes & cylinders, as they may leads to development ofthe cracks due to improper demolding. After demolding the concrete specimens are kept inwater suitable for curing and then compressiontests are conducted for 7, 14, and 28 days.

Fig 1: Dry mixing

Fig 2: Wet Mixing

Fig 3: oil Applying.

Fig 4: pouring of concrete

Fig 5: Compacting

Fig 6: casting

Fig 6: demolding

Fig 7: curing

## VIII. TESTS ON FRESH CONCRETE

### *A. Slump Test*

Unsupported fresh concrete flows to the sides and a sinking in height takes place. This vertical settlementis known as slump. In this test fresh concrete is filled into a mould of specified shape and dimensions and the settlement or slump is measured when supporting mould is removed. Slump increases as water-content is increased. For different works different slump values have been recommended. The slump is a measure indicatingthe consistency or workability of cement concrete. It gives an idea of water content needed for concrete to be usedfor different works. A concrete is said to be workable if it can be easily mixed, placed, compacted and finished. A workable concrete should not shown any segregation or bleeding. The internal surface of mould was thoroughlycleaned and it was filled in three layers and each layer was tamped with twenty five strokes of the tamping rod. The mould was removed from the concrete immediately by raising it slowly and carefully in a vertical direction.Slump was measured (in mm) immediately by determining the difference between the height of the mould and that of the highest point of the specimen being tested.

Table 4: Slump values

| Sl.No | REPLACEMENT (%) | SLUMP (in mm) |
|---|---|---|
| 1 | 0 | 72 |
| 2 | 5 | 72 |
| 3 | 10 | 70 |
| 4 | 15 | 68 |

## IX. TESTS ON HARDEN CONCRETE

The various tests are made to know strength properties and to know short term durability's. There are listed below.

### *A. Compressive Strength Test*

Compressive strength test is one of the basic tests for concrete. According to IS 516-1959 this compressive strength of the cube was determined. To find out the compressive strength of the concrete the cubes of standard size 150x150x150mm should be casted. After curing 3days, 7days and 28days the cubes were placed in CTM andby applying the compressive load the strength can be calculated by using below formula.

fc = (Load/Area) in N/mm$^2$

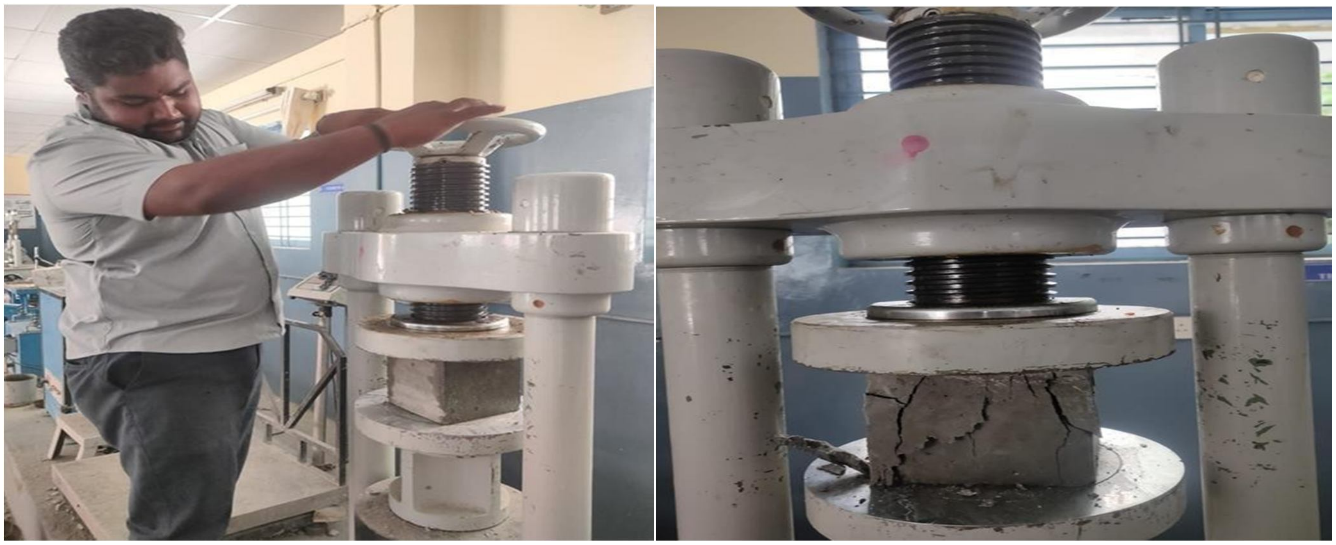

Fig 8: compression test

### *B. Split Tensile Strength Test*

Tensile strength of concrete greatly affects the extent and size of cracking in concrete. Tensile strength of concrete is less when compared with its compressive strength. Cylinders of diameter 150mm and height 300mm were used to determine the split tensile strength. After curing, the specimens were tested on the compression testing machine of 2000kN capacity. Three specimens were casted for each age and average value is taken. For this purpose, the concrete cubes were tested in a compression testing machine after 7-14- and 28-days curing period.

Fig 9: Split tensile strength test

## X. RESULTS AND DISCUSSION

In this chapter various test results and discussion are made. The test results including fresh concrete test like slump test and harden tests like compressive strength, and other durability tests. The specimens are casted for different proportion of partial replacement of cement such as 0%, 5%, 10%, 15%, 20%. All results are mentionedin the tables and plotted graphs for that in this chapter and also compared with normal conventional M-30 grade concrete.

### *A. Compressive Strength Test On Hardened Concrete*

Compressive strength of normal concrete mix and cement replaced concrete mixes were determined at 3,7 and 28 days. The test results are shown in tables and graphs.

Table 5: Compressive strength test result

| Percentageof dolomite powder added | Compressive strength (N/mm$^2$) | | |
|---|---|---|---|
| | 7 days | 14 days | 28 days |
| 0% | 18.88 | 26.85 | 29.56 |
| 5% | 17.44 | 25.98 | 32.22 |
| 10% | 18.44 | 26.60 | 32.42 |
| 15% | 17.55 | 25.64 | 30.44 |
| 20% | 15.88 | 25.00 | 29.105 |

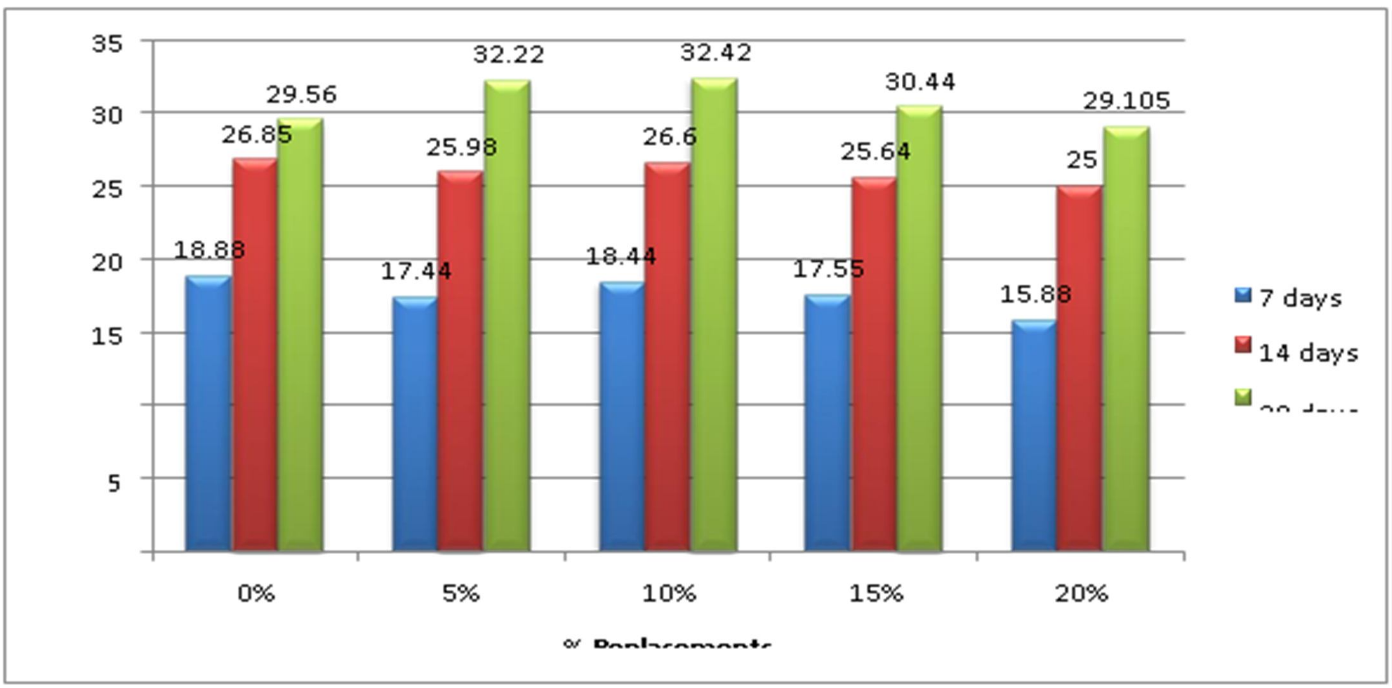


Fig 10: Graph showing compressive strength of concrete for 7,14, & 28 Days

*B. Split Tensile Strength Test On Hardened Concrete*

The split tensile strength of the cylinders used in the construction of prism specimens was determined using CTM of 2000kN capacity. For this purpose, the concrete cylinders and the cylinders were tested after 7, 14and 28 days of curing.

Table 6: Tensile strength test results

| Percentage ite powderadded | Split Tensile strength ($N/mm^2$) |
|---|---|
| | 28 days |
| 0% | 2.82 |
| 5% | 2.82 |
| | 3.25 |
| 15% | 2.97 |
| 20% | 2.54 |

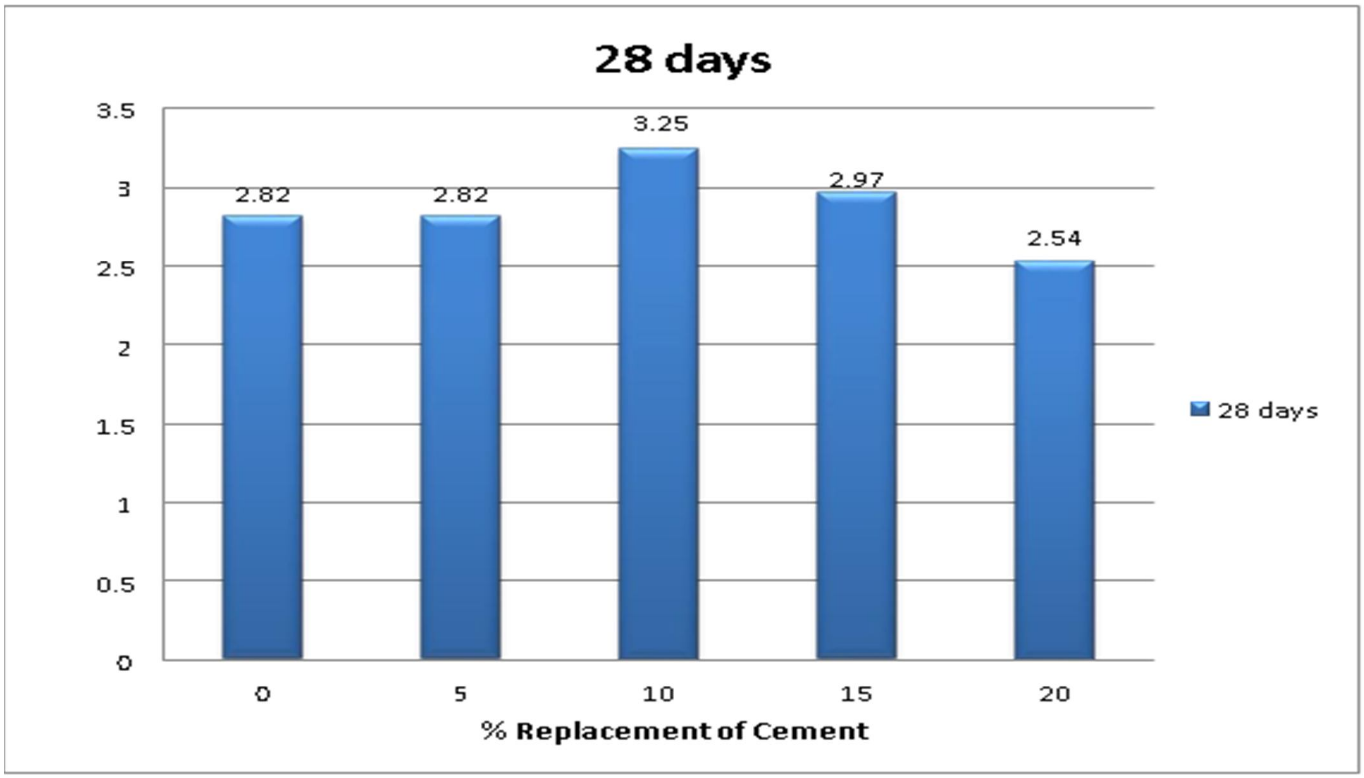


Fig 11: Graph showing split tensile strength for 28 days

## XI. CONCLUSION

The following broad conclusion can be drawn from the limited experimental study on Dolomite powder concrete:

The workability of concrete increases with increasing amount of Dolomite powder up to 15%. According to the results of the compressive strength, addition of 10% of Dolomite powder shows a better result in compressive strength that is 41.6 $N/mm^2$. According to the result of the split tensile strength, addition of 10% of Dolomite powder shows a better result in split tensile strength that is 5.40 $N/mm^2$.

We have put forth a simple step to minimize the costs for construction with usage of dolomite powder which is freely or cheaply available. We have also stepped into a realm the environmental pollution by cement production; being our main objective as Civil Engineers.

Hence, we conclude that the partial replacement of such dolomite powder can be done by replacing the cement percentage wise without altering the strength of concrete.

## XII. SCOPE OF FUTURE WORK

1) In this project work we have conducted tests only on compression and split tensile test, but also can be check out the strength of flexural test.
2) Compressive strength of the concrete can be studied at later ages like 1 year, 2 years, etc.
3) The long-term durability can also be determined.
4) Modulus of elasticity can also be determined.
5) Use of other mineral admixtures can also be conducted instead of Dolomite powder.

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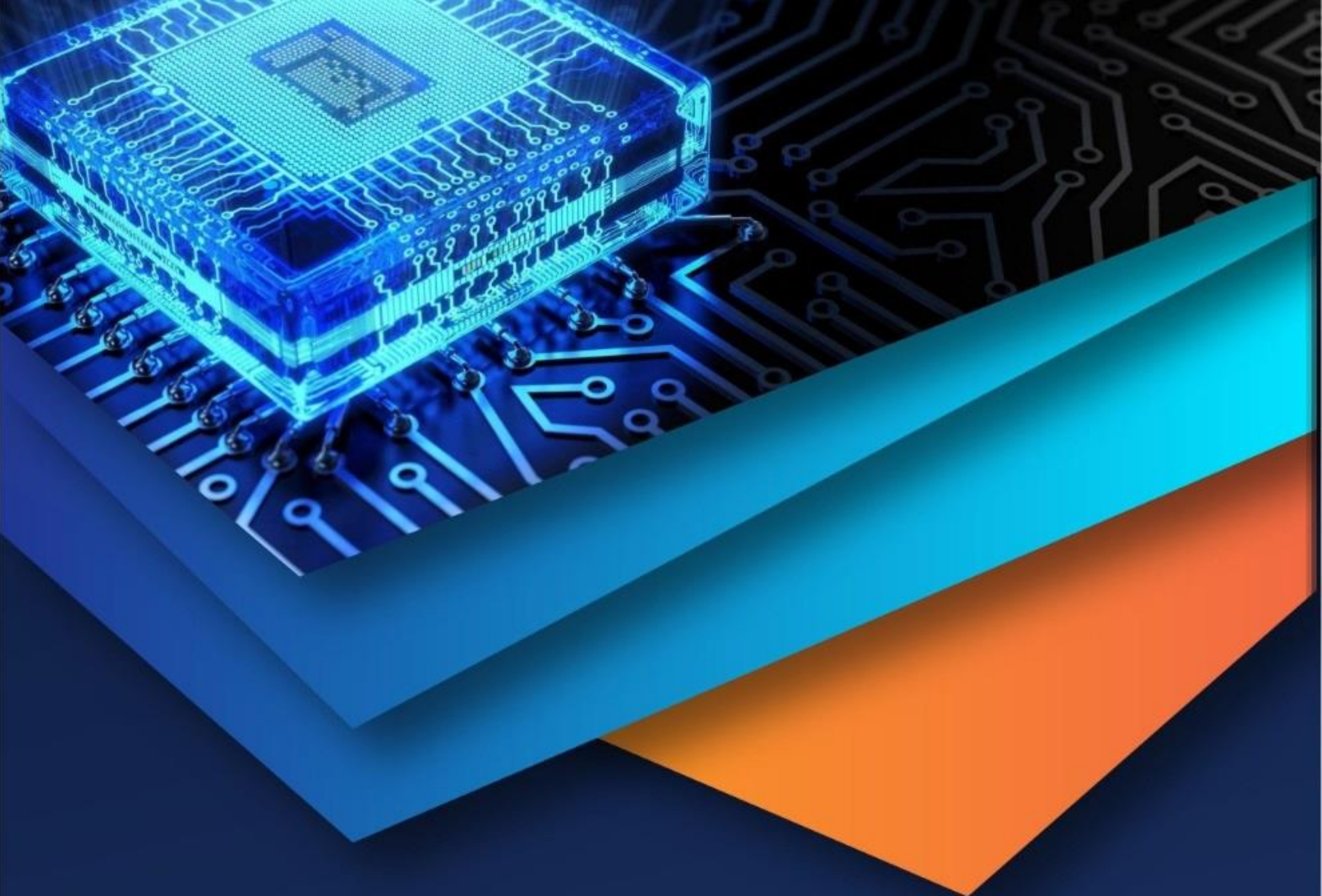


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