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Effects of Disparate Zones of Sand on the Compressive Strength of Concrete

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Abstract: Compressive strength of concrete is the capacity of concrete to bear loads of materials or structure sans breaking or being deformed. Specimen under compression shrinks in size whilst under tension the size elongates. Compressive strength essentially gives concept about the properties of concrete. Compressive strength relies on many aspects such as water-cement ratio, strength of cement, calidad of concrete material. Specimens are tested by compression testing machine after the span of 7 or 28 days of curing. Compressive strength of the concrete is designated by the load on the area of specimen. In this research various proportions of such aggregate mixed in preparing M 30 grade and M 40 grade of Concrete mix and the effect is studied on its compressive strength . Several research papers have been assessed to analyze the compressive strength of concrete and the effect of different zones of sand on compressive strength are discussed in this paper.
Keywords: Sand, Gradation, Coarse aggregate, Compressive strength

I. INTRODUCTION

The grading and maximum size of aggregates is important parameters in any concrete mix. They affect relative proportions in mix, workability, economy, porosity and compressive strength of concrete etc.

Fine aggregate material has been widely used for manufacture of concrete for use in buildings and other infrastructural developments. The acceptability of concrete as the most versatile product in construction is hinged on the availability of the respective material constituents, durability and the relative ease of its moulding to required shapes. Concrete constitutes of Cement, fine and coarse aggregates and water. The aggregates form 75% of concrete by volume whose properties significantly affect the durability and structural performance of concrete. The fine and coarse aggregate proportions vary depending on the design mix required for construction.

Globally, material mined every year amounts to between 47-59 billion tonnes, with fine aggregate (sand) and coarse aggregate (gravel) accounting for the largest percentage (about 68- 85%), as well as the fastest increase in its exploitation rate. River sand has been the most preferred choice of fine aggregate due to its availability, affordability and minimal or no processing requirements. Fineness Modulus is a term used as an index to the fineness or coarseness of aggregate. This is the summation of cumulative percentage of materials retained on the standard sieves divided by 100. It is well–known that aggregate plays an important role in achieving the desired properties of concrete.

A. Sand

Fine aggregate(sand) is the essential ingredient in concrete that consists of natural sand or crushed stone. The quality and fine aggregate density strongly influence the hardened properties of the concrete. The concrete or mortar mixture can be made more durable, stronger and cheaper if you made the selection of fine aggregate on basis of grading zone, particle shape and surface texture, abrasion and skid resistance and absorption and surface moisture. Fine aggregates are the structural filler that occupies most of the volume of the concrete mix formulas. Depending on composition, shape, size and other properties of fine aggregate you can have a significant impact on the output. The role of fine aggregate can be described in few points:

1) Fine aggregates provide dimensional stability to the mixture
2) The elastic modulus and abrasion resistance of the concrete can be influenced with fine aggregate
3) Fine aggregates quality also influence the mixture proportions and hardening properties
4) The properties of fine aggregates also have a significant impact on the shrinkage of the concrete.

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Sieve size	Zone-1	Zone-2	Zone-3	Zone-4
10mm	100	100	100	100
4.75mm	90-100	90-100	90-100	95-100
2.36mm	60-95	75-100	85-100	95-100
1.18mm	30-70	55-90	75-100	90-100
0.6mm	15-34	35-59	60-79	80-100
0.3mm	5-20	8-30	12-40	15-50
0.15mm	0-10	0-10	0-10	0-15
Fineness modulus	4.0-2.71	3.37-2.1	2.78-1.71	2.25-1.35

B. Coarse Aggregate

Coarse aggregate is stone which are broken into small sizes and irregular in shape. In construction work the aggregate are used such as limestone and granite or river aggregate.Concrete Mix is produced by many ingredients or components but is mostly made up of a material called Coarse Aggregates and they are one of the essential components of concrete and occupy large volumes in the concrete mix. Aggregate which has a size bigger than 4.75 mm or which retrained on 4.75 mm IS Sieve are known as Coarse aggregate. Here , in our resesrch paper we used coarse aggregate of 10mm – 20 mm.

C. Concrete

Concrete is a construction material composed of cement, fine aggregates (sand) and coarse aggregates mixed with water which hardens with time. Portland cement is the commonly used type of cement for production of concrete. Concrete technology deals with study of properties of concrete and its practical applications. Concrete has relatively high compressive strength (it doesn't crack under weight), but significantly lower tensile strength (it cracks when being pulled). The compressive strength is typically controlled with the ratio of water to cement when forming the concrete, and tensile strength is increased by additives, typically steel, to create reinforced concrete. In other words we can say concrete is made up of sand (which is a fine aggregate),ballast (which is a coarse aggregate), cement (can be referred to as a binder) and water (which is an additive) .Properties of concrete are influenced by many factors mainly due to mix proportion of cement, sand, aggregates and water. In order to use concrete successfully in a construction project, we should be aware of its properties.
In this paper, we use two grades of concrete; M30 and M40.

1) For M30 Grade

Zones of sand	Design Mix Ratio
Zone I	1 : 1.74 : 2.67
Zone II	1 : 1.66 : 2.76
Zone III	1 : 1.57 : 2.85

2) For M40 Grade

Zones of sand	Design Mix Ratio
Zone I	1 : 1.53 : 2.32
Zone II	1 : 1.46 : 2.15
Zone III	1 : 1.37 : 2.47

Maximum size of aggregate is 20 mm.

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II. CASTING OF CONCRETE CUBES

Equipments Required

1) Cube mould of 150 x 150 x 150 mm
2) Tamping rod 16mm dia , 60cm long
3) Scoop
4) Oil and brush

A. *Brief Procedure*

Fill the concrete in cubes in 3 layers.
Compact each layer with 25 Nos of stroke by tamping rod and finish the top surface by trowel after completion of last layer.
After 24 hours remove specimen out of mould.
Submerge the specimen in clean fresh water till the time of testing.

Cube Moulds filled with concrete

Cubes submerged in tank

B. *Compressive Strength Test*

Compressive strength test, mechanical test measuring the maximum amount of compressive load a material can bear before fracturing. The test piece, usually in the form of a cube, prism, or cylinder, is compressed between the platens of a compression-testing machine by a gradually applied load.
These specimens are tested by compression testing machine after 7 days curing, 14 days curing and 28 days curing. Load should be applied gradually at the rate of 140 kg/cm2 per minute till the Specimens fails. Load at the failure divided by area of specimen gives the compressive strength of concrete.

1) Calculations : For M30 grade Compressive load is given below :

a) *Zone I*

P = 545 KN (7 days) ; P = 755 KN (14 days) ; P = 840 KN (28 days).
Compressive strength (7days) = 545 x 1000/150 x 150
= 24.22 Mpa
Compressive strength (14days) = 755 x 1000/150 x 150
= 33.5 Mpa
Compressive strength (28days) = 840 x 1000/150 x 150
= 37.33 Mpa

b) *Zone II*

P = 590 KN (7 days) ; P = 820 KN (14 days) ; P = 910 KN (28 days).
Compressive strength (7days) = 590 x 1000/150 x 150
= 26.22 Mpa
Compressive strength (14days) = 820 x 1000/150 x 150
= 36.4 Mpa
Compressive strength (28days) = 910 x 1000/150 x 150
= 40.4 Mpa

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c) Zone III

P = 570 KN (7 days) ; P = 790 KN (14 days) ; P = 880 KN (28 days).

Compressive strength (7days) = 570 x 1000/150 x 150
= 25.33 Mpa

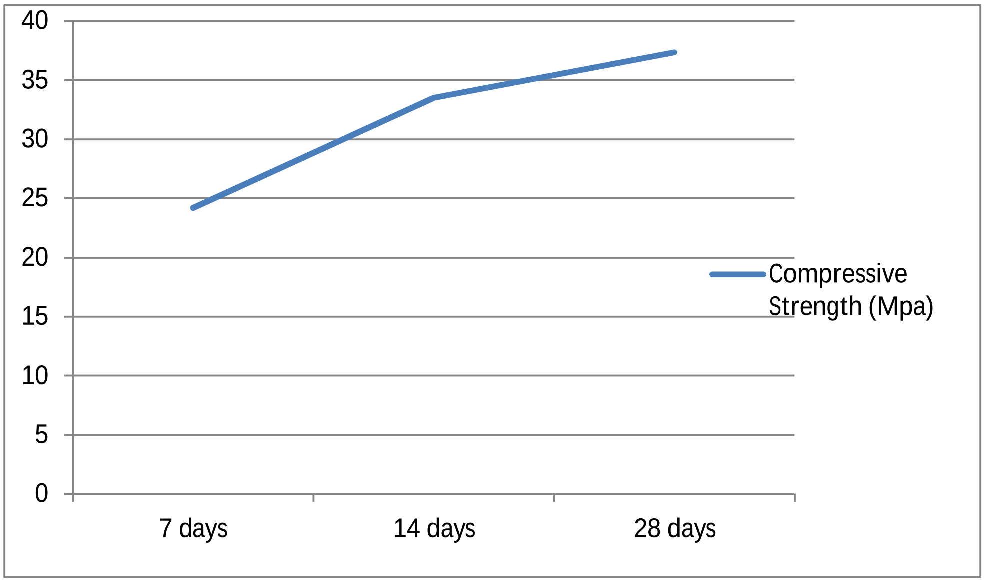
Compressive strength (14days) = 790 x 1000/150 x 150
= 35.1 Mpa

Compressive strength (28days) = 880 x 1000/150 x 150
= 39.1 Mpa

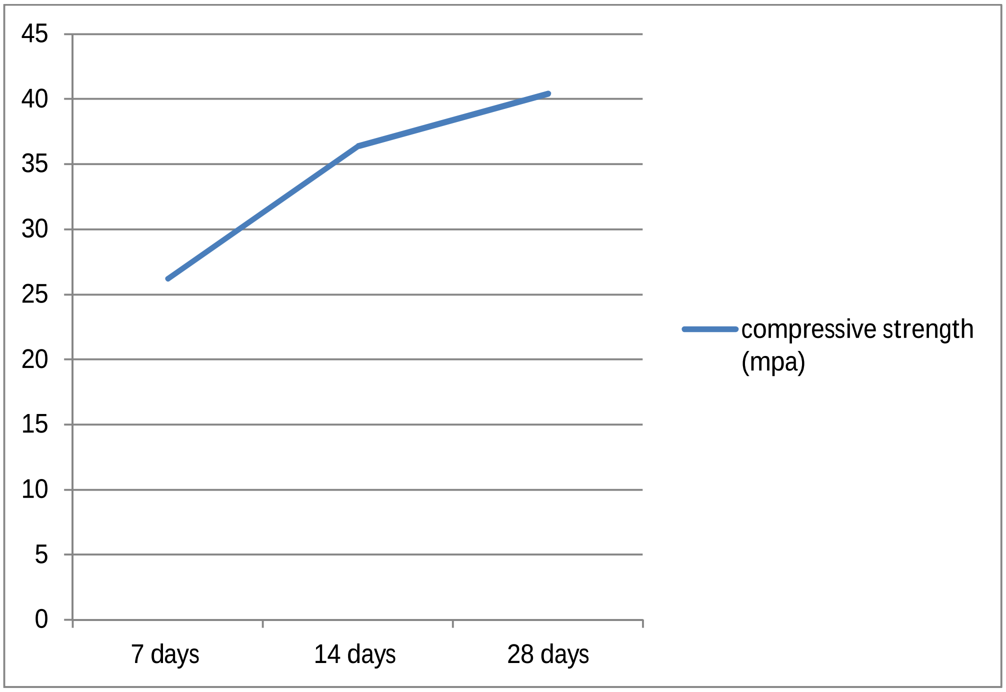
Compression test machine

Result : For M30 grade :

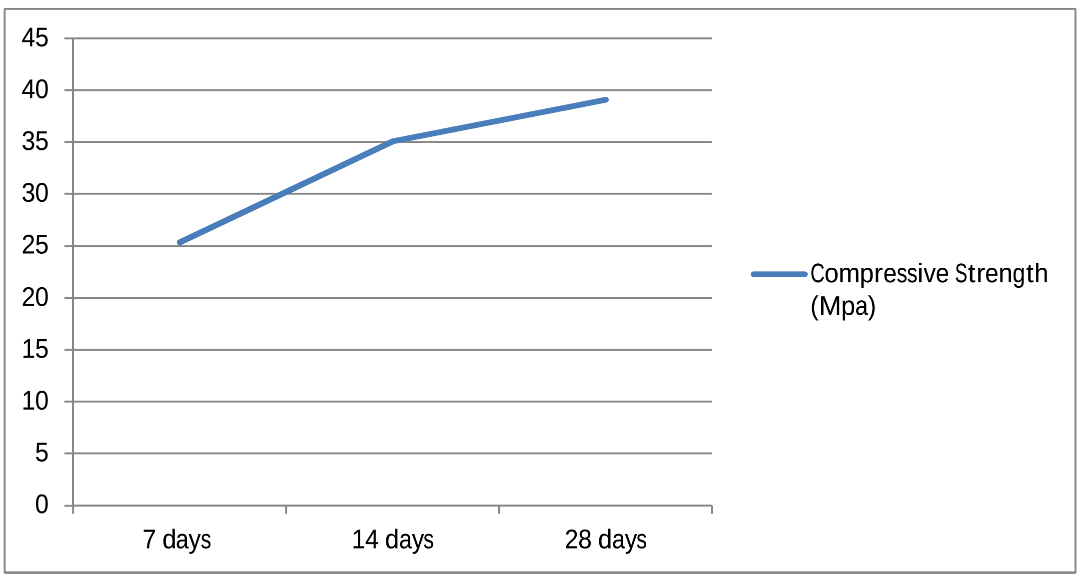
Day	Zone I	Zone II	Zone III
7	24.22 Mpa	26.22 Mpa	25.33 Mpa
14	33.50 Mpa	36.4 Mpa	35.10 Mpa
28	37.33 Mpa	40.4 Mpa	39.10 Mpa



Graph indicating Compressive Strength for Zone I (M30)



Graph indicating Compressive Strength for Zone II (M30)



Graph indicating Compressive Strength for Zone III (M30)

2) For M40 grade Compressive load is given below :

a) Zone I

P = 660 KN (7 days) ; P = 920 KN (14 days) ; P = 1020 KN (28 days).

Compressive strength (7days) = 660 x 1000/150 x 150
= 29.33 Mpa

Compressive strength (14days) = 920 x 1000/150 x 150
= 40.88 Mpa

Compressive strength (28days) = 1020 x 1000/150 x 150
= 45.33 Mpa

b) Zone II

P = 720 KN (7 days) ; P = 995 KN (14 days) ; P = 1110 KN (28 days).

Compressive strength (7days) = 720 x 1000/150 x 150
= 32 Mpa

Compressive strength (14days) = 995 x 1000/150 x 150
= 44.22 Mpa

Compressive strength (28days) = 1110 x 1000/150 x 150
= 49.3 Mpa

c) Zone III

P = 705 KN (7 days) ; P = 970 KN (14 days) ; P = 1080 KN (28 days).

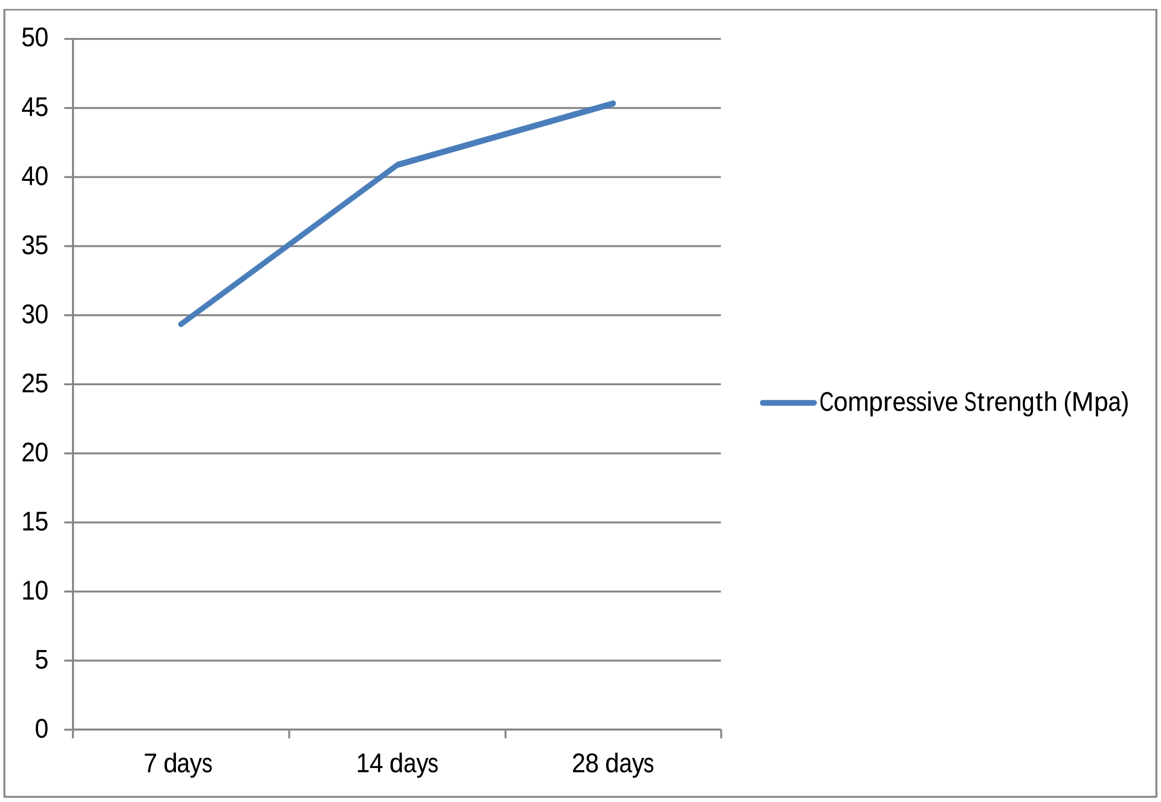
Compressive strength (7days) = 705 x 1000/150 x 150
= 31.33 Mpa

Compressive strength (14days) = 970 x 1000/150 x 150
= 43.11 Mpa

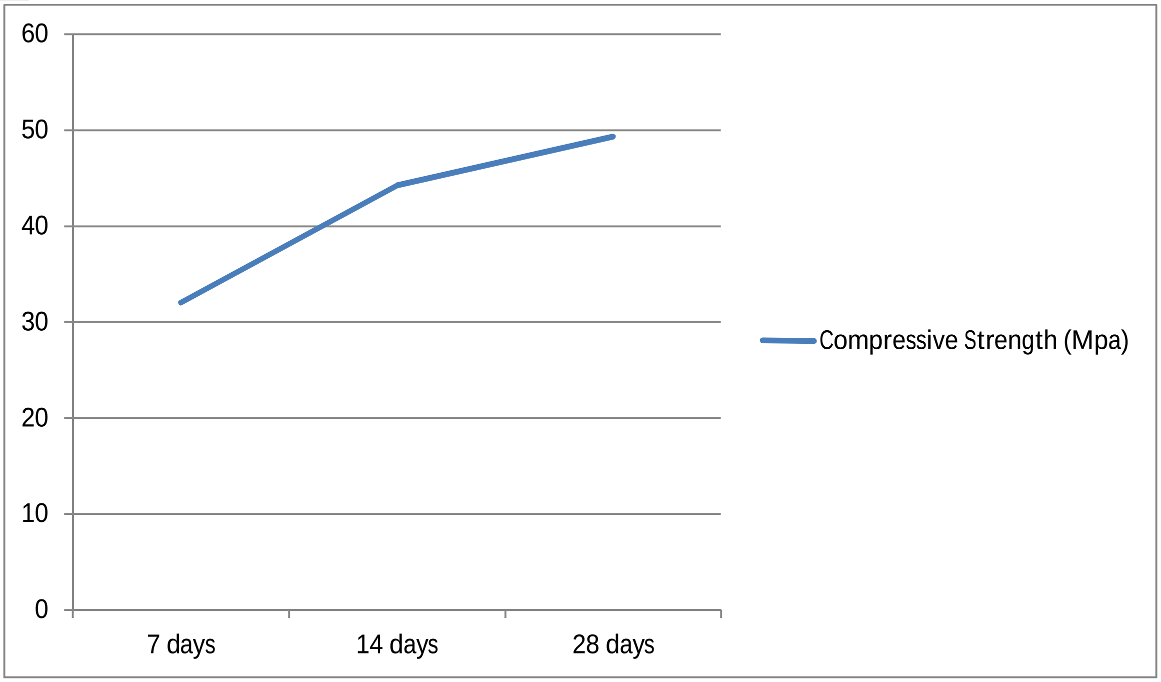
Compressive strength (28days) = 1080 x 1000/150 x 150
= 48 Mp

Result : For M40 grade

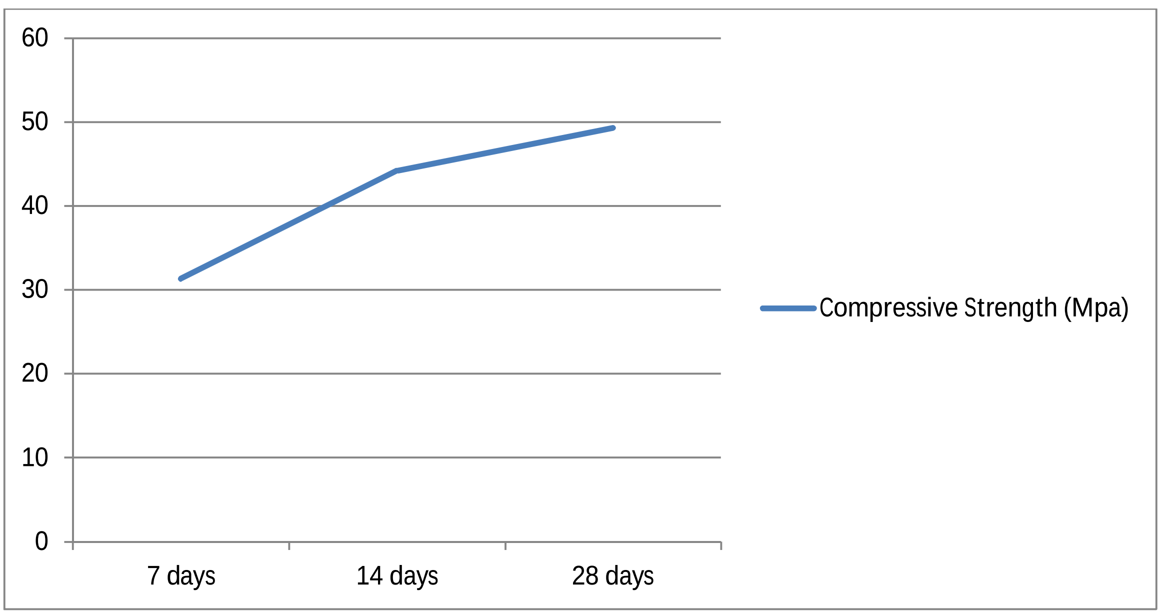
Day	Zone I	Zone II	Zone III
7	29.33 Mpa	32 Mpa	31.33 Mpa
14	40.88 Mpa	44.22 Mpa	43.11Mpa
28	45.33Mpa	49.33 Mpa	48 Mpa



Graph indicating Compressive Strength for Zone I (M40)



Graph indicating Compressive Strength for Zone II (M40)



Graph indicating Compressive Strength for Zone III (M40)

III. CONCLUSION

Fineness Modulus of Sand affects Compressive strength of Concrete. Sand, with higher FM, results in higher strength of concrete. It is evident that overall concrete mix is becoming economical if we use sand with higher FM. The results indicate that with the increase in FM, workability gets affected considerably.

A. Fineness Modulus has larger impact on 28 days Compressive Strength.
B. The optimum value of strength can be taken when Fineness Modulus is about 2.7.
C. The net cost of Concrete reduces when FM of sand increases. It reduces by about 6.5% for an increase of FM from 2.0 to 3.0.

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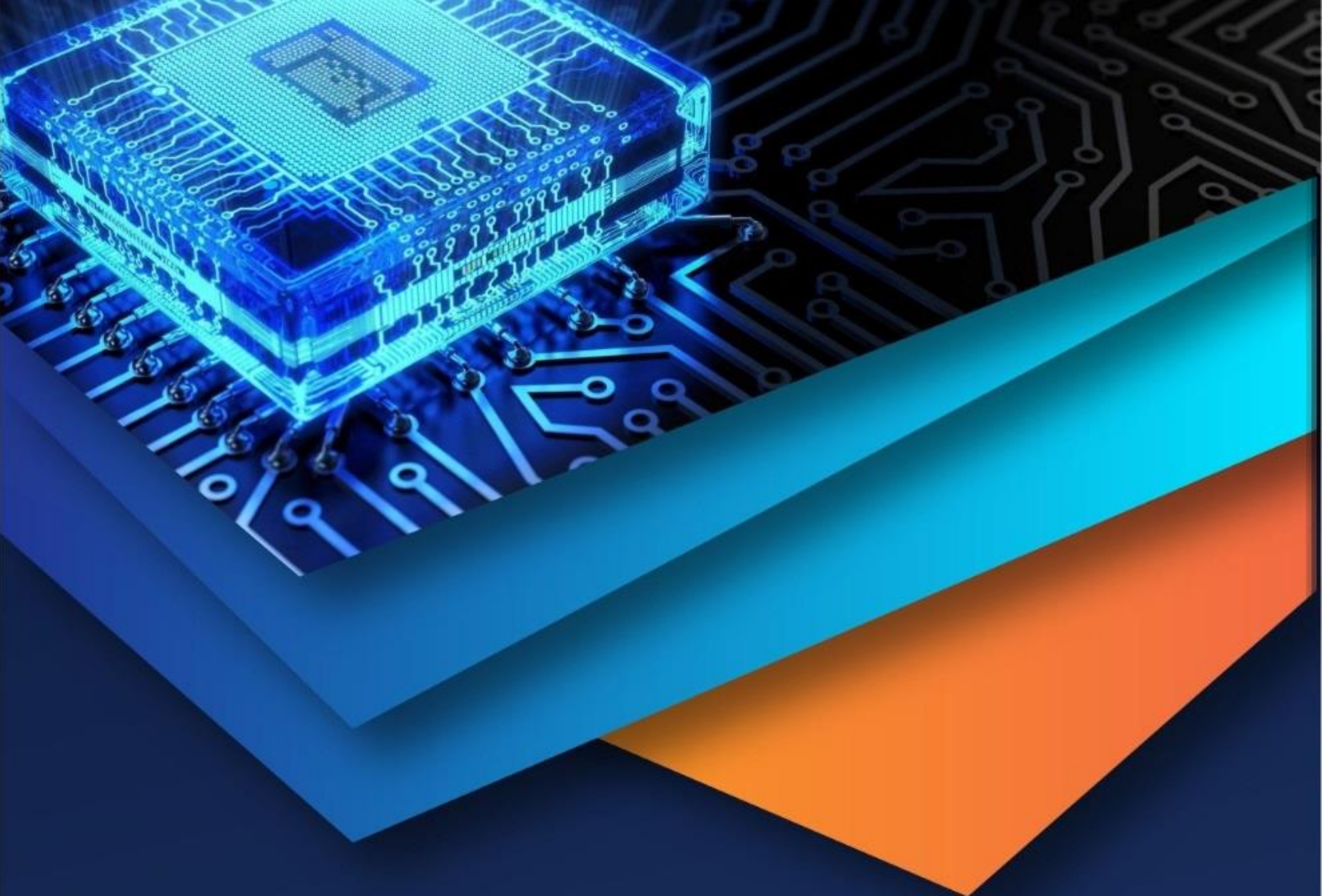

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