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Experimental Study on Glass Fibre Reinforced Concrete with Partial Replacement of Cement by Rice Husk Ash and Fine Aggregate by Copper Slag and Quarry Dust

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***Abstract:** Glass Fibre reinforced concrete is a composite material consisting of cement, fine aggregate, coarse aggregates and fibres. Glass fibers are used as reinforcement for concrete. It improves the tensile strength of concrete and resistance to cracking in concrete. It has many advantages such as light weight, fire resistance, good appearance and strength. Rice Husk Ash possess high pozzolanic activities and very suitable as partial replacement of cement in concrete. By using rice husk ash in concrete, it provides many advantages, such as improved strength and durability properties and reduced carbon-dioxide emissions. The function of Fine Aggregate is to assist in producing workability and voids are filled to attain uniformity in mixture. The river beds are most common source of fine aggregate. In order to limit the usage of Fine aggregate the construction projects that use Quarry Dust and copper slag have proven to be cheaper than those that depend wholly on sand. The dust come at cheaper cost and lesser. To reduce the consumption of river sand we are replacing Quarry dust at 15% and copper slag at 15% as a partial replacement of fine aggregate.*

In this present study the concrete is casted for a design mix of M30 grade with a partial replacement of cement with Rice Husk Ash at varying percentages i.e., 5%, 10%, 15% and Glass FIBREs were added at 0.25% by weight of cement. The experimental test results demonstrate considerable changes in compressive strength, flexural strength, split tensile strength of specimen at 7 and 28 days with addition of alkali resistant glass Fibers. From the test results it was observed that 10% replacement of Rice husk ash, 15% quarry dust,15 % copper slag & 0.25% of glass fibers showed the maximum compressive, tensile & flexural strength when compared to conventional M30 grade concrete.

***Keywords:** Alkali resistance glass fibres, Rice Husk Ash, Copper Slag, Quarry Dust, Compressive strength, Split tensile strength and Flexural strength.*

I. INTRODUCTION

Concrete is the most important construction material and used in world wide. Concrete has several properties like high compressive strength, stiffness and durability under usual environmental factors. At the same time frail in tension. The production of ordinary Portland cement produces approximately 8% of the total greenhouse gases emitted to the atmosphere. In order to substitute cement, waste materials produced from industries can be utilized. By using rice husk ash in concrete, we can improve the reduce heat of hydration and permeability of the concrete.

Utilization of industrial waste by-products in concrete has attracted attention all around the world due to the rise of environmental consciousness. The function of the fine aggregate is to help in producing workability and uniformity in the mixture. Now-a-days the natural river sand has become scarce and very costly. Glass fibres were added at a percentage of 0.25% by weight of cement. Rice husk ash was used to replace ordinary Portland cement at 5%, 10%, and 15%. Quarry dust and copper slag was used as partial replacement of fine aggregate by 30%. Tests were conducted on cubes, cylinders and prisms are casted to study the compressive, split tensile and flexural strength of conventional M30 grade concrete and also for Glass fibre reinforced M30 grade concrete made of Rice husk ash, quarry dust and copper slag and the results were compared with that of conventional concrete. Workability studies were done for concrete with Glass Fibres and Rice Husk Ash, Quarry Dust & Copper Slag and compared with that of the conventional M30 grade concrete.

II. EXPERIMENTAL WORK

A. Materials Used

1) *Ordinary Portland Cement (OPC):* The cement used for this study is Ordinary Portland Cement 53-grade conforming to IS: 12269-1987.

Table 1: Physical Properties Of OPC

Specific Gravity	Fineness Modulus	Normal Consistency	Initial Setting time	final Setting time
3.15	8%	30%	30 minutes	600 minutes

2) *Rice Husk Ash:* The Rice Husk Ash has good pozzolanic material when used as a partial substitute for cement. By using it provides several advantages, such as improved strength and durability properties and environmental benefits related to the disposal of waste materials and to reduce CO2 emissions

Table 2: Physical Properties Of RHA

Specific Gravity	Fineness Modulus	Normal Consistency	Initial Setting time	final Setting time
1.97	10%	31.5%	43 minutes	256 minutes

Table-3: Chemical properties of Cement & Rice husk Ash

S.No	Constituent	Cement(%)	Rice Husk Ash(%)	Test method
1	SiO2	18.91	23.5	IS:4032-1968
2	Al2O3	4.51	4.90	
3	Fe2O3	4.94	0.95	
4	K2O	0.43	1.4	
5	CaO	66.67	67.3	
6	MgO	1.52	1.81	
7	Na3O	0.12	1.2	
8	P2O5	1.05	1.72	

3) *Glass Fibre*: Glass fiber most popular of the synthetics, are chemically inert, hydrophobic and lightweight. They are produced as continuous cylindrical monofilaments that can be chopped to specified length or cut as films and tapes and formed into fine fibrils of rectangular cross section. Glass fibres reduce plastic shrinkage cracking and subsidence cracking over steel reinforcement.

Table 4: Physical Properties of Glass Fibers

S.NO	PROPERTIES	REMARKS
1.	Type	Alkali Resistant Glass Fiber
2.	Length	12mm
3.	Colour	Brilliant White
4.	Aspect Ratio	53.85

4) *Fine Aggregate:* Natural river sand of size 4.75 mm sieve conforming to zone II of IS 383:1970 was used as a fine aggregate. Table shows the test results of basic properties of fine aggregates.

Table 8: Physical properties of Fine aggregate

Specific Gravity	Fineness Modulus	Bulk Density	Void Ratio
2.42	3.79%	1.753gm/cc	0.20

5) *Quarry Dust:* Quarry dust is the by -product produced during the production of Coarse aggregate. In quarrying activities, the rock has been crushed into various sizes; during the process the dust generated is called quarry dust and it is formed as waste

Table 5: Physical properties of Quarry dust

Specific Gravity	Fineness Modulus	Bulk Density	Void Ratio
2.78	2.54	1.82gm/cc	0.25

6) *Copper Slag:* Copper slag is by product of copper extraction by smelting. Large amount of Copper slag is generated as waste worldwide during the copper smelting process. By using copper slag in concrete, we can reduce the usage of natural resources and increase the workability of concrete.

Table 6: Physical properties of Copper slag

Specific Gravity	Fineness Modulus	Bulk Density	Void Ratio
3.1	3.9%	2.119gm/cc	0.37

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Table 7- Chemical properties of Fine aggregate, Quarry dust, Copper slag

S.NO	Constituent	Fine aggregate	Quarry dust	Copper slag	Test method
1	SiO2	82.37	65.73	34.4	IS:2386-1963
2	Al2O3	8.23	19.31	3.4	
3	Fe2O3	1.39	5.27	5.6	
4	K2O	1.81	2.26	0.72	
5	CaO	2.73	3.64	0.5	
6	MgO	1.47	2.16	3.2	
7	Na3O	1.63	-	0.57	
8	P2O5	0.31	0.35	0.3	

7) *Coarse Aggregate:* Coarse aggregate are stones that are retained on 4.75 mm sieve, all natural aggregates originated from bed rocks. The grading of coarse aggregates should be as per IS 383-1970. In this project 20mm nominal size of aggregates was used.

Table 9: Physical properties of coarse aggregate

S.NO	PROPERTIES	VALUES
1.	Specific gravity	2.7
2.	Fineness modulus	6.53%
3.	Water Adsorption Test	5%
4.	Shape	Angular

8. Water

The amount of water in concrete controls many fresh and hardened properties of concrete including workability compressive strength, permeability and water tightness, durability and weathering, drying shrinkage and potential for cracking. For this reasons limiting and controlling the amount of water in concrete is important for both constructability and service life.

The water used in present investigation for mixing and curing is portable water with pH = 7.0.

9. Mix Proportion

The steps involved in the design of concrete mix has been taken as per IS: 10262-2009 and IS456-2000.

Table 10: Mix Proportion

CEMENT	FINE AGGREGATE	COARSE AGGREGATRE	W/C ratio
350kg/m^3	591.35kgs	1351.72kgs	140lit
1	1.68	3.86	0.4

Table 11- Quantities of materials

Mix proportions	**Cement (kg)**	**FA (kg)**	**CA (kg)**	**RHA (kg)**	**CS (kg)**	**QD (kg)**	**Water (lts)**	**SP (ml)**	**GF**
5% RHA+0.25%GF+ 15%CS+15%QD	34.599	42.5	138.6	1.82	9.12	9.12	14.2	291	91 gm
10% RHA+0.25%GF+ 15%CS+15%QD	32.778	42.5	138.6	3.64	9.12	9.12	14.2	291	91 gm
15% RHA+0.25%GF+ 15%CS+15%QD	30.952	42.5	138.6	5.46	9.12	9.12	14.2	291	91 gm

10. Casting Of Cubes, Cylinders, Beams

For every percentage level of fiber cubes, cylinders, beams specimens were casted calculating 7 days and 28 days strengths. Compaction was done by means of vibration and stored in water till 7 and 28 days for testing. All specimens were de moulded after 24 hours

III. RESULTS AND DISCUSSIONS

A. Workability

The measured slump values of rise husk ash and Glass Fibers with water/cement ratio 0.4 are 20mm for M30 mix. It is observed that slump values increase with increase in percentage of rise husk ash ,glass Fiber, Quarry dust and Copperslag for the same w/c ratio concrete does not give adequate workability with increase of Glass Fiber, It is increased by adding of rise husk ash. Increased fineness require greater amount of water for the mix ingradients to closer packing,Result in decresed workability of the mix. The above slump value corresponds to low degree of workability as per IS: 456-2000

Table 12 : Slump Cone Values

S.NO	GRADE	WORKABILITY(mm)
1	M30 (CONVENTIONAL)	59
2	M30 (5%RHA+0.25%GF+15%CS+15%QD)	61
3	M30 (10%RHA+0.25%GF+15%CS+15%QD)	60
4	M30 (15%RHA+0.25%GF+15%CS+15%QD)	62

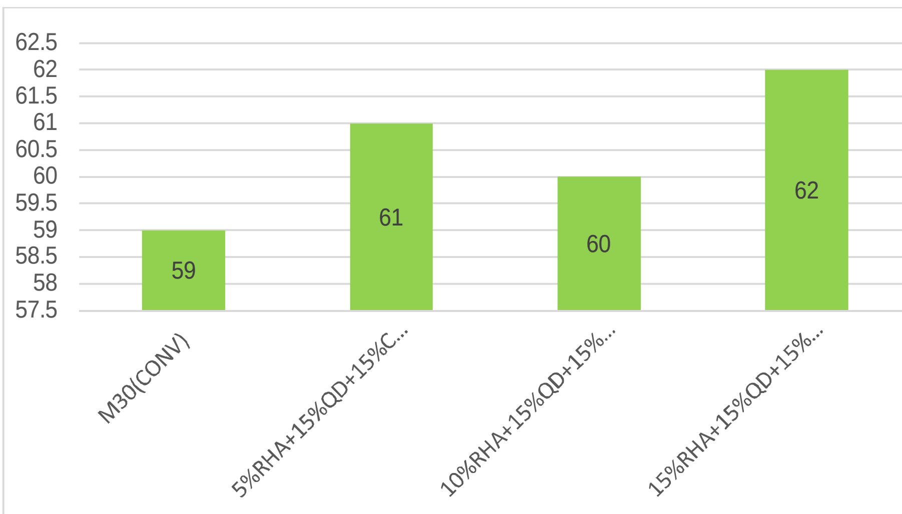

Fig 5- Comparision of Slump cone values for Conventional and Glass Fiber Reinforced Concrete.

B. Compressive Test on Cubes

Comparision of Compressive strength of ordinary concrete with replacement concrete of 0.25% glass fibres, 5%, 10%, 15% Rice Husk Ash and 15% Quarry Dust & 15% Copper slag:

Table 13: Indicating various values of Compressive strength

Grade of concrete & % of Replacement	Compresive strength(N/mm^2) at 7 days	Compresive strength(N/mm^2) at 28 days
M30 (CONVENTIONAL CONCRETE)	20.3	38.28
M30(5%RHA,15%Quarrydust,15%Copperslag, 0.25%Glass fibers)	30.27	40.27
M30(10%RHA ,15%Quarry dust,15%Copper slag, 0.25%Glass fibers)	30.45	44.33
M30(15%RHA,15%Quarry dust,15%Copper slag, 0.25%Glass fibers)	25.32	38.06

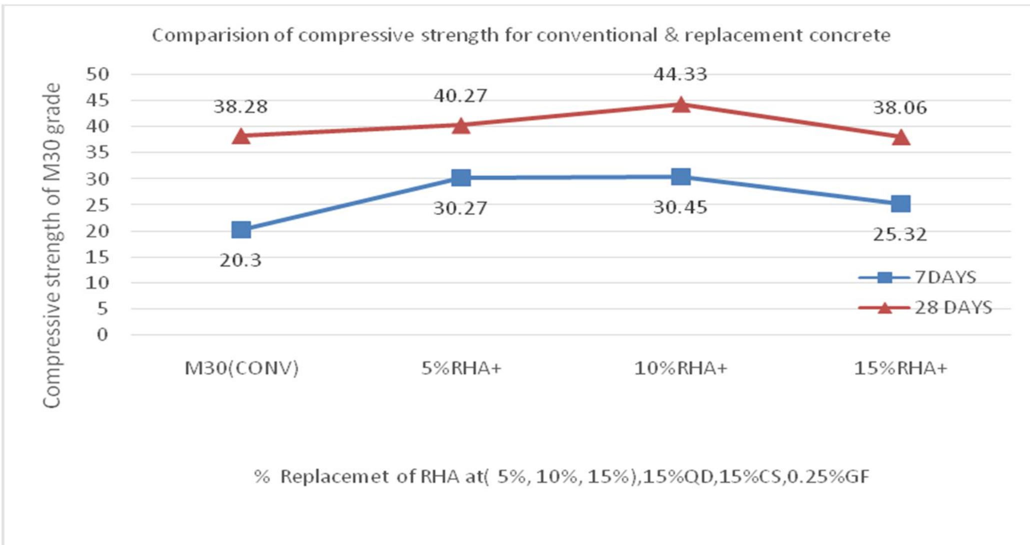

Chart 1: Compressive strength of Glass fiber reinforced concrete

C. Split Tensile Strength On Cylinders

Comparision of Split Tensile Strength of concrete with Glass Fibre (0.25%) & varying percentages of Rice Husk Ash (5%,10%,15%), Copper slag (15%), Quarry dust (15%)

Table-14: Indicating various values of Split tensile strength

Grade of Concrete & % of replacements	Split tensile strength(N/mm^2) at 7 days	Split tensile strength(N/mm^2) at 28 days
M30(CONVENTIONAL CONCRETE)	2.23	3.77
M30(5%RHA,15%Quarry dust,15%Copperslag, 0.25%Glass fibers)	3.3	4.36
M30(10%RHA,15%Quarry dust,15%Copperslag, 0.25%Glass fibers)	3.83	5.42
M30(15%RHA,,15%Quarry dust,15%Copperslag, 0.25%Glass fibers)	2.75	3.83

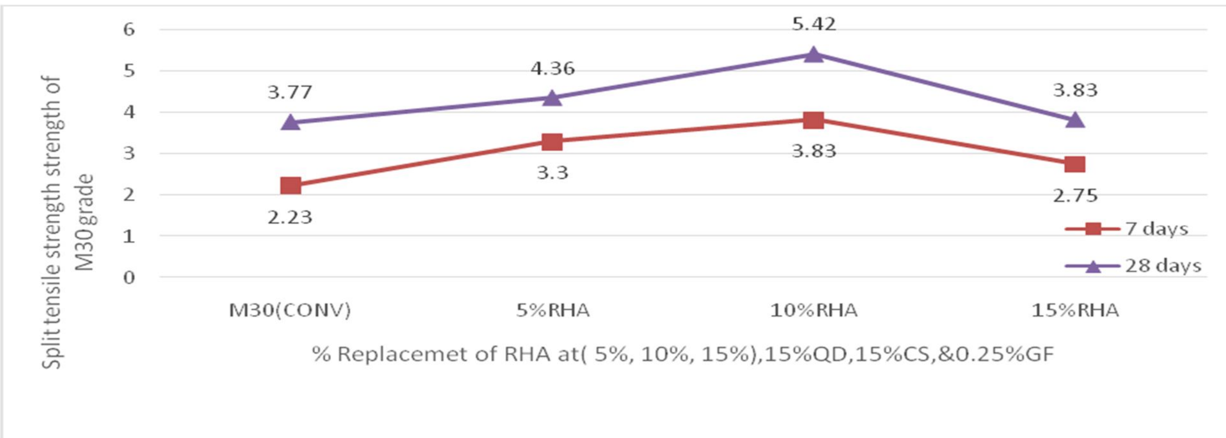

Chart-2: Split tensile strength of Glass fiber reinforced concrete

D. Flexural Strength On Prisms

Comparison of Flexural Strength of concrete with addition of Glass Fibre at (0.25%) & varying percentages of Rice Husk Ash (5%,10%,15%), Copper slag (15%), Quarry dust (15%)

Table-15: Flexural strength

Grade of concrete & % of replacements	Flexural strength(N/mm^2) at 7 days	Flexural strength strength(N/mm^2) at 28 days
M30(CONVENTIONAL CONCRETE)	2.33	3.9
M30(5%RHA,15%Quarry dust,15%Copperslag, 0.25%Glass fibers)	4.25	5.12
M30(10%RHA,15%Quarry dust,15%Copperslag, 0.25%Glass fibers)	4.54	5.45
M30(15%RHA,,15%Quarry dust,15%Copperslag, 0.25%Glass fibers)	4.06	4.83

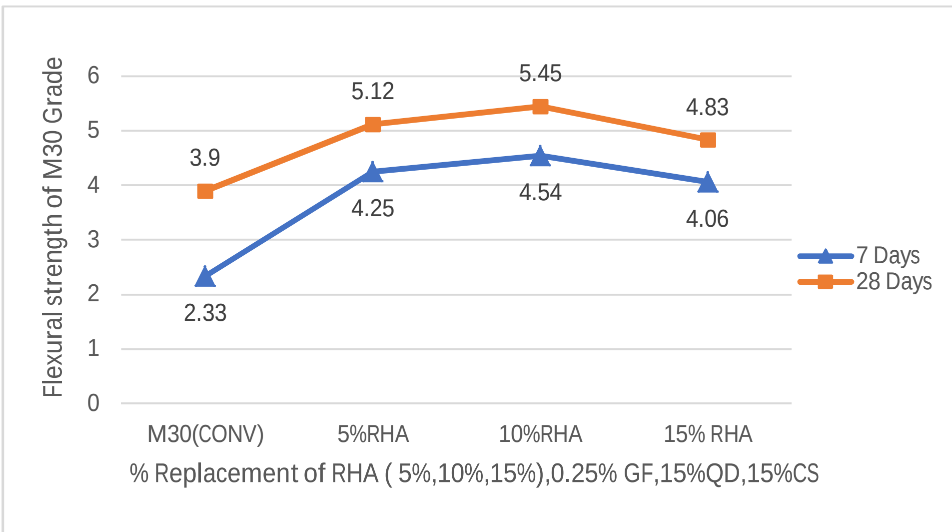

Chart3: Flexural strength of Glass fiber reinforced concrete

IV. CONCLUSIONS

The study was conducted to evaluate the strength parameters of Glass Fiber Reinforced conventional M30 grade concrete. The following conclusions are from the study:

A. The materials used in the present study were tested to find out the physical and chemicals properties of Cement, Fine aggregate, Coarse aggregate, Rice Husk Ash, Copper slag and Quarry Dust.
B. Glass fibers were added in order of 0.25% by weight of cement, Rice Husk Ash was used as a partial replacement for ordinary Portland cement by 5%,10%,15% by weight of cement proportions. Quarry Dust at 15% and copper slag at 15% was used as partially replaced for fine aggregate.
C. The optimum results were shown at 5% and 10% replacement of Rice Husk Ash and Glass fibers at 0.25% by weight of cement and Copper Slag (15%) & Quarry dust (15%).
D. The compressive strength of M30 grade concrete when cement is replaced by rice husk ash at 10%, quarry dust (15%) and copper slag (15%) and Glass fibers at 0.25%. There is maximum increase in compressive strength of concrete up to 15.6% compared to M30 grade conventional concrete, and later the strength has been gradually decreased by 13.5% compared to M30 grade concrete

E. The split tensile strength of M30 grade concrete increased with the addition of 0.25% Glass fibers and at replacement of 10% Rice Husk Ash, Quarry dust 1(5%) and copper slag (15%). There is maximum increase in tensile strength of concrete up to 43.7% compared to M30 grade conventional concrete, and later the strength has been gradually decreased by 42.1%.

F. The flexural strength of M30 grade concrete increased with the addition of 0.25% Glass fibers and at replacement of 10% Rice Husk Ash, Quarry dust 1(5%) and copper slag (15%). There is maximum increase in tensile strength of concrete up to 39.7% compared to M30 grade conventional concrete, and later the strength has been gradually decreased by 15.86%.

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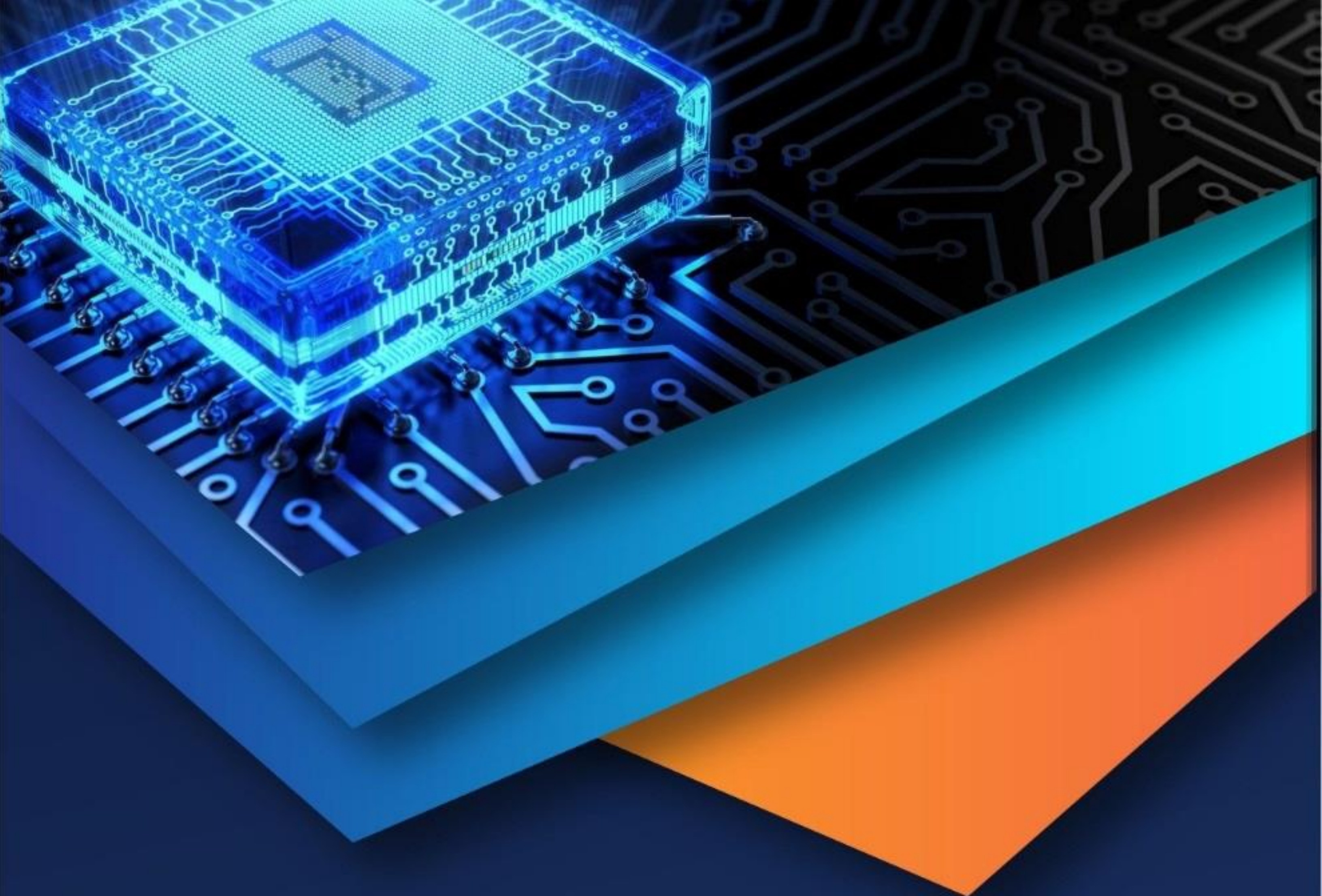

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