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Experimental Investigation on Properties of Fiber Reinforced Concrete

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Abstract: Today the concrete fiber composites are the most promising material used in construction industry. Many researchers have shown that the addition of small closely spaced and uniform dispersed fiber to concrete would act as crack arresters and would substantially improve the tensile strength and other properties of the concrete. The type of fibers which were used is steel fibers, carbon fibers, glass fibers, synthetic polymer fibers and natural fibers.

An attempt has been made to study the comparison of strengths between M50 Grade concrete mix of Polyester Fiber Reinforced Concrete to Conventional Concrete in which using Recron 3s CT2024 polyester fiber of 12 mm size, subtended into the concrete mix at dosage of 90,125 grams per cubic meter of concrete mix and subjected to mechanical strengths. In this experimental work the Conventional Concrete and Polyester Fiber Reinforced Concrete mix was designed based on Indian standards code book of IS 10262-1982(2009). For the above test the specimens are casted and cured in ordinary mineral water and tested for the time periods of 7 days, 14 days, 28 days, 90 days & 365 days respectively. The experimental tests were carried out to the behavior of Polyester Fiber Reinforced Concrete under different mechanical strengths like Compressive Strength Test for cubes, Split Tensile test for Cylinders and Flexural strength test for Beams, subjected to curing and tested at the age of 7 days, 14 days, 28 days , 90 days & 365 days respectively.

I. INTRODUCTION

Concrete technology has made a tremendous stride in the past decade. Concrete is now no longer a material consisting of cement, aggregates, water and admixtures but it is an engineered material with several new constituents performing satisfactorily under different exposure conditions. Concrete today can be tailor made for specific applications and it contains different materials like micro silica, colloidal silica and many other binders, filler and pozzolanic materials. The development of specifying a concrete according to its performance requirements rather than constituents and ingredients has opened innumerable opportunities for producers and users to design concrete to suit to their specific requirements. The type of concrete that is designed to a specific application is known as high performance concrete. ACI defines high performance concrete [HPC] as "concrete that meets special performance and uniformity requirements that cannot always be obtained by using conventional ingredients, normal mixing procedure and typical curing practices." HPC should have at least one outstanding property viz. compressive strength, high workability enhance resistance to chemical or mechanical stresses, lower permeability, high durability etc..

II. MATERIALS USED

A. Material Ingredients For Concrete

The materials used for CVC and PFCVC are coarse aggregate, fine aggregate, cement, chemical admixture (super plasticizer), polyester fiber (Recron 3s CT2024-12 mm).

B. Aggregates

The coarse aggregate chosen as per IS: 383-1970 for CVC and PFCVC is typically angular in shape and is well graded, and gradually decrease in maximum size than that of typical conventional concrete which have maximum size of aggregate greater than 40 mm or more. In general, angular and small aggregate particles aid in the flow ability and deformability of the concrete as aiding in the prevention of segregation. Gradation is an important factor in choosing the coarse aggregate, especially in typical uses of FCVC where reinforcement may be highly congested or the form work has small dimensions. Gap-graded coarse aggregate promotes segregation to a greater degree than well-graded coarse aggregate. The maximum size of coarse aggregate used in this project is 12.5 mm and the sizes of coarse aggregate used are 10mm, 12.5mm and 20 mm respectively.

The normal fine aggregates are suitable for CVC and FCVC. Both crushed and stone fines, Siliceous and calcareous sands can be used. The amount of fines less than 0.125 mm is to be considered as powder. The fine aggregate used in this project is brought from Godavari river basin which is graded in zone III and is confirmed to zone II as per IS: 383-1970 and the aggregate passing from 900 μ sieve size were used in entire project.

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C. Cement

All types of cements conforming to BIS are suitable. Selection of the type of cement will depend on the overall requirements for the concrete, such as strength, durability, etc, C2A content higher than 10% may cause problems of poor workability retention. The typical content of cement is 350-450 Kg/m³ as per SP: 23-1982. As per IS: 456-2000, more than 500 Kg/m³ cement can increase the shrinkage. Less than 350 Kg/m³ may only be suitable with the inclusion of other fine filler, such as fly ash, pozzolanic etc. the cement used in this project is of Bhavya 53 grade OPC cement.

D. Super Plasticizer

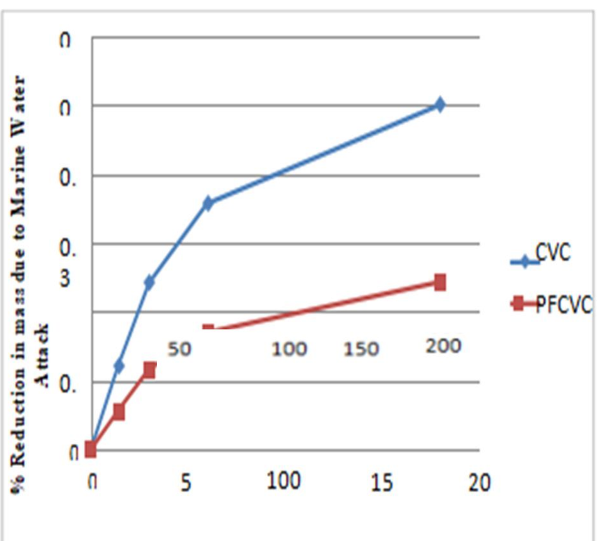
Super plasticizer is a chemical compound used to increase the workability without adding more water i.e. spreads the given water in the concrete throughout the concrete mix resulting to form a uniform mix. Super plasticizer improves better surface expose of aggregates to cement gel. It acts as a lubricant among the materials. Generally in order to increase the workability the water content is to be increased provided a corresponding quantity of cement is also added to keep the water-cement ratio constant, so that the strength remains same. The dosage of admixture should be within limits of (0%- 2.5%). The super plasticizer used in this project is of Conplast SP 430 in a dosage of variation from 1.8% to 2% for better results.

E. Polyester Fiber [RECRON 3'S CT2024]

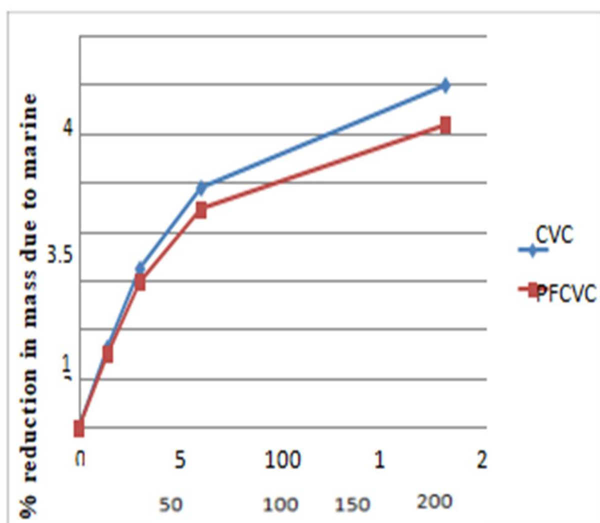
Recron 3s is a polyester fiber which was used in the concrete mix based on its advantages as follows.

1) Reduces cracks during at plastic and hardening stages.
2) Reduces seepage and protects steel in concrete from corroding and walls from damping
3) Protects corners in precast slabs and concrete flooring. Increases abrasion resistance by over 40% thereby increasing. Life of roads, walkways, floors. Also reduces pitting of the floor.
4) Rebound loss reduced by 50 – 70%.
5) Results in saving of expensive mortar, cement and sand.
6) Time taken for plastering is reduced and work is completed faster.
7) Marginal increase in flexural, compressive strength based on mix design has been observed.
8) Considerable reduction in cracks during plastic and hardening stage.

III. COMPARISION OF RESULTS



Graph 1 Comparative Results of % Reduction in Mass for Cube Specimens [150 X 150 X 150] Under Marine Water Attack



Graph 2 Comparative Results of % Reduction in Mass for cylinder Specimens [150mmϕX300mm H] Under Marine Water Attack

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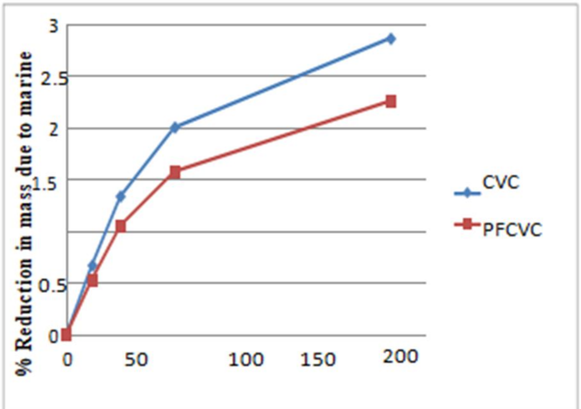
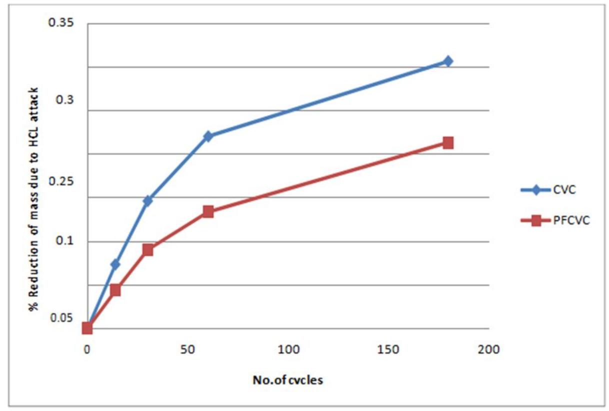
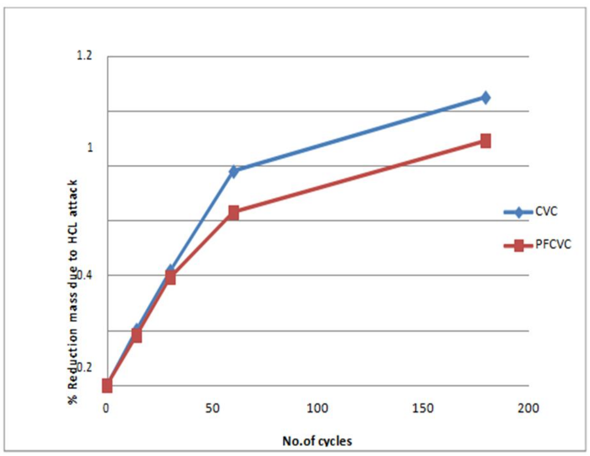


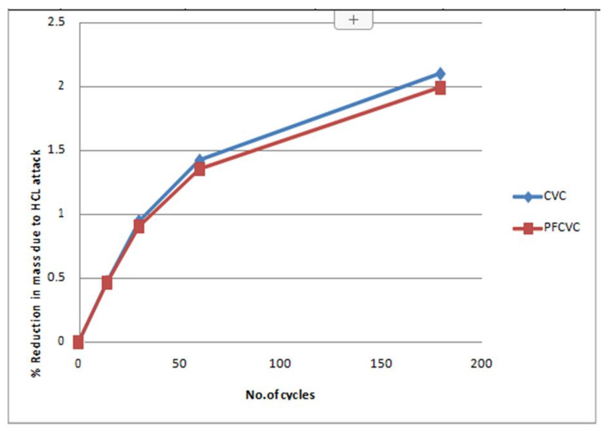
Graph 3 Comparative Results of % Reduction in Mass for Beam Specimens [100 X 100 X 500]Under Marine Water Attack



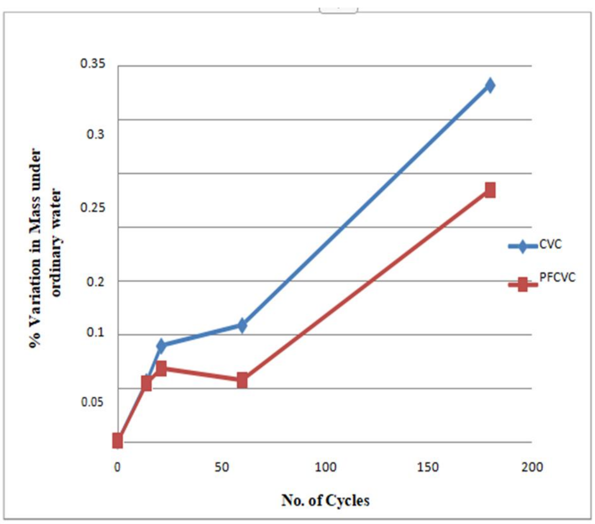
Graph 4 Comparative Results of % Reduction in Mass for Cube Specimens **[150 X 150 X 150] Under HCL Attack**



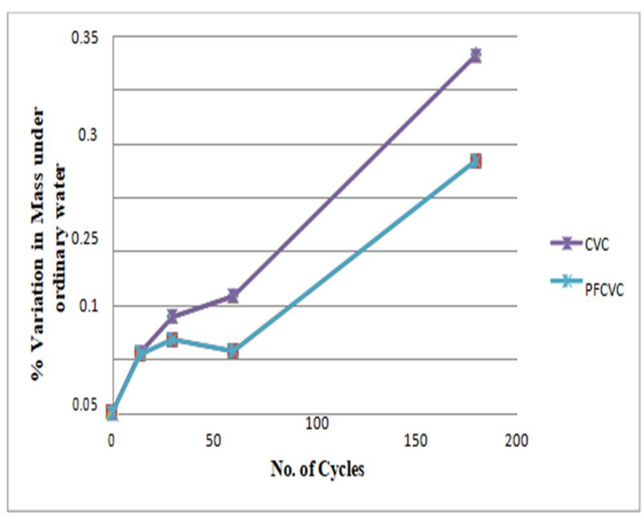
Graph 5 Comparative Results of % Reduction in Mass for Cylinder Specimens [150mmϕ X 300mm H] Under HCL attack



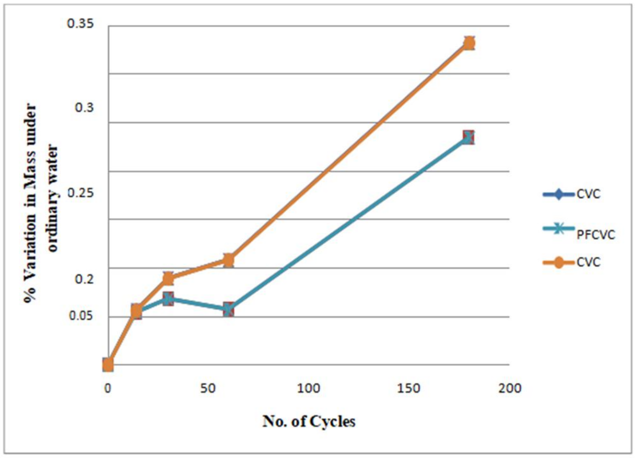
Graph 6 Comparative Results of % Reduction in Mass for Beam Specimens [100mmX100mmX500mm] Under HCL attack



Graph 7 Comparative Results of % Reduction in Mass for Cube Specimens [150 X 150 X 150] Under Ordinary Water Curing



Graph 8 Comparative Results of % Reduction in Mass for Cylindrical Specimens [150mm Ø ×300mm H] Under Ordinary Water Curing



Graph 9 Comparative Results of % Reduction in Mass for Beams Specimens [100mm ×100mm ×500mm] Under Ordinary Water Curing

Table 1 % Reduction in Mass for Cube Specimens (150 X 150 X 150) in ordinary Water:

Specimen No.	Initial Weight W1 (Kg)	% Reduction in mass after 14 cycles	% Reduction in mass after 21 cycles	% Reduction in mass after 60 cycles	% Reduction in mass after 180 cycles W2 (Kg)
CVC					
1	8.785	0.056	0.03	0.04	0.056
2	8.550	0.000	0.000	0.000	0.000
3	8.710	0.000	0.045	0.068	0.114
PFCVC					
1	8.300	0.132	0.410	0.264	0.059
2	8.430	0.011	0.020	0.040	0.059
3	8.610	0.030	0.050	0.080	0.110
% variation in mass					
1	0.485	0.076	0.038	0.225	0.003
2	0.120	0.011	0.020	0.040	0.059
3	0.100	0.030	0.005	0.012	0.004

Table 2 % Reduction in Mass for Beam Specimens (100 X 100 X 500) in oridinary water:

Specimen No.	Initial Weight W1 (Kg)	% Reduction in mass after 14 cycles	% Reduction in mass after 21 cycles	% Reduction in mass after 60 cycles	% Reduction in mass after 180 cycles W2 (Kg)
CVC					
1	12.290	0.016	0.032	0.048	0.105
2	12.360	0.110	0.226	0.339	0.480
PFCVC					
1	12.720	0.000	0.055	0.078	0.117
2	12.680	0.560	1.127	1.687	2.405
% variation in mass					
1	0.430	0.016	0.023	0.030	0.012
2	0.320	0.450	0.901	1.348	1.925

Table 3 % Reduction in Mass for cylinder Specimens (150X300) in ordinary water:

Specimen No.	Initial Weight W1 (Kg)	% Reduction in mass after 14 cycles	% Reduction in mass after 21 cycles	% Reduction in mass after 60 cycles	% Reduction in mass after 180 cycles W2 (Kg)
CVC					
1	13.600	0.620	1.320	2.090	2.82
2	13.420	0.730	1.450	2.230	3.10
PFCVC					
1	13.290	0..000	0.030	0.052	0.075
2	13.340	0.029	0.045	0.082	0.086
% variation in mass					
1	0.310	0.620	1.290	2.038	2.745
2	0.120	0.701	1.405	2.148	3.014

Table 4 % Reduction in Mass for Cube Specimens (150 X 150 X 150) in Marine Water

Specimen No.	Initial Weight W1 (Kg)	% Reduction in mass after 14 cycles	% Reduction in mass after 21 cycles	% Reduction in mass after 60 cycles	% Reduction in mass after 180 cycles W2 (Kg)
CVC					
1	8.865	0.12	0.24	0.36	0.50
2	8.665	0.103	0.20	0.29	0.40
3	8.370	0.14	0.286	0.42	0.59
PFCVC					
1	8.885	0.06	0.13	0.20	0.28
2	8.865	0.05	0.11	0.15	0.22
3	8.480	0.058	0.11	0.16	0.23
% variation in mass					
1	0.02	0.06	0.11	0.16	0.22
2	0.2	0.053	0.09	0.14	0.18
3	0.11	0.082	0.176	0.26	0.36

Table 5 % Reduction in Mass for Beam Specimens (100 X 100 X 500) in marine water:

Specimen No.	Initial Weight W1 (Kg)	% Reduction in mass after 14 cycles	% Reduction in mass after 21 cycles	% Reduction in mass after 60 cycles	% Reduction in mass after 180 cycles W2 (Kg)
CVC					
1	12.60	0.65	1.31	1.96	2.80
2	12.36	0.67	1.35	2.03	2.91
PFCVC					
1	12.295	0.61	1.22	1.82	2.60
2	12.35	0.44	0.89	1.33	1.90
% variation in mass					
1	0.305	0.04	0.09	0.14	0.2
2	0.01	0.23	0.46	0.7	0.01

Table 6 % Reduction in Mass for cylinder Specimens (150 X 300) in marine water:

Specimen No.	Initial Weight W1 (Kg)	% Reduction in mass after 14 cycles	% Reduction in mass after 21 cycles	% Reduction in mass after 60 cycles	% Reduction in mass after 180 cycles W2 (Kg)
CVC					
1	13.75	0.83	1.66	2.49	3.56
2	13.58	0.80	1.59	2.40	3.42
PFCVC					
1	13.39	0.81	1.62	2.43	3.27
2	13.64	0.68	1.35	2.03	2.90
% variation in mass					
1	0.36	0.02	0.04	0.06	0.29
2	0.06	0.12	0.24	0.37	0.52

Table 7 % Reduction in Mass for Cube Specimens (150 X 150 X 150) in HCL solution

Specimen No.	Initial Weight W1 (Kg)	% Reduction in mass after 14 cycles	% Reduction in mass after 21 cycles	% Reduction in mass after 60 cycles	% Reduction in mass after 180 cycles W2 (Kg)
CVC					
1	8.400	0.073	0.140	0.210	0.290
2	8.570	0.100	0.190	0.290	0.400
3	8.500	0.050	0.110	0.160	0.230
PFCVC					
1	8.575	0.030	0.050	0.080	0.180
2	8.480	0.050	0.110	0.160	0.230
3	8.865	0.050	0.110	0.160	0.225
% variation in mass					
1	0.175	0.043	0.090	0.130	0.110
2	0.090	0.050	0.080	0.130	0.170
3	0.365	0.000	0.000	0.000	0.005

Table 8 % Reduction in Mass for Beam Specimens (100 X 100 X 500) in HCL solution

Specimen No.	Initial Weight W1 (Kg)	% Reduction in mass after 14 cycles	% Reduction in mass after 21 cycles	% Reduction in mass after 60 cycles	% Reduction in mass after 180 cycles W2 (Kg)
CVC					
1	12.045	0.510	0.980	1.544	1.540
2	12.180	0.420	0.903	1.310	1.800
PFCVC					
1	12.295	0.470	0.930	1.390	1.990
2	12.420	0.490	0.980	1.470	2.100
% variation in mass					
1	0.250	0.040	0.050	0.154	0.450
2	0.240	0.070	0.077	0.160	0.300

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Table 9 % Reduction in Mass for cylinder Specimens (150X300) in HCL solution

Specimen No.	Initial Weight W1 (Kg)	% Reduction in mass after 14 cycles	% Reduction in mass after 21 cycles	% Reduction in mass after 60 cycles	% Reduction in mass after 180 cycles W2 (Kg)
CVC					
1	13.820	0.190	0.390	1.410	0.830
2	13.460	0.210	0.440	0.660	0.910
PFCVC					
1	13.390	0.230	0.500	0.760	1.080
2	13.720	0.210	0.422	0.630	0.890
% variation in mass					
1	0.430	0.040	0.110	0.650	0.250
2	0.260	0.000	0.028	0.030	0.020

IV. CONCLUSIONS

After committing various trail mixes, we have finally achieved grade CVC and PFCVC of Recron 3s CT2024 polyester fiber of 12 mm size by which satisfying all workability characteristics given by Indian standards and the mix design based on IS 10262-1982,2009.

1) From the observations it was found that nearly half of the strength is gained in 7 days and to of the strength in 14 days and increased the target mean strength in 28 days,90 days and 365 days duration which satisfies IS 456-2000.
2) It was observed that this Recron 3s CT2024 polyester fiber of 12 mm size has suddenly increased the flexural strength of Polyester fiber concrete to +15% in 28 days of curing period while comparing with the flexural strength of Conventional concrete mix due to its bonding nature.
3) Similarly the compressive strength and split tensile strength of Polyester fiber concrete has increased to +10% and +15% after 28 days of curing period
4) There is a gradual increase in compressive strength of Polyester fiber concrete upto 14 days but it has decreased its value for 28 days but still fiber has increased the compressive strength of concrete to +12%.
5) From above we can say that Polyester fiber concrete has given better results than Conventional concrete as we mentioned in our abstract of this project.
6) Wholly we have maintained good workability for both Conventional concrete and Polyester fiber concrete mix for easy placing and compacting and finally satisfied all the conditions of concrete mix to make it eligible as good construction material.
7) The Ductile Property at marine condition is negligible as the percentage reduction in weight loss is very less

A. Scope For Further Studies

1) Optimization of powder content and super plasticizer to achieve economy in construction materials.
2) Studies may be conducted with increasing cement content for the high dosage of polyster fibres into the concrete in the adopted method to achieve higher strength and durability characteristics.=
3) As the Study in this project conducted in marine and HCL Environment further Studies may be conducted on concrete specimens at different ages under different environmental conditions.

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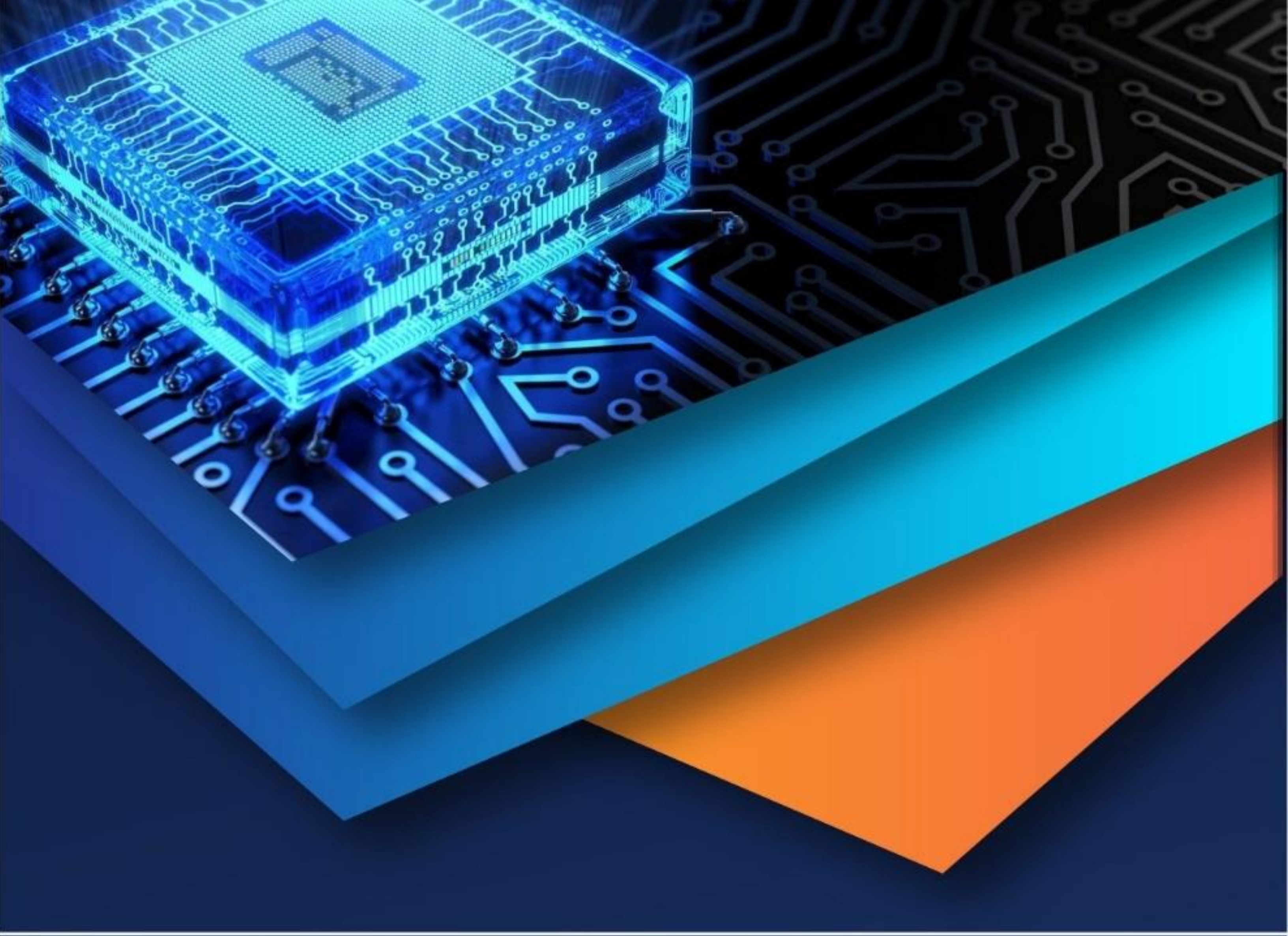

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