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Experimental Investigation on Silica Fume Based Concrete of M25 Grade

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Abstract: ***The usage of Nano-materials in concrete is gaining increasing attention in the constructions industry. Studies have shown that concrete containing nanoparticles demonstrated increased strength, durability. The use of large quantity of cement produces increasing CO_2 emissions and also consequents the greenhouse effect. The use of Nano materials like Silica fume reduce the cement content in the concrete mix and hence the greenhouse effect. In the present paper, the influence of Silica fume on mechanical properties of concrete is studied by replacing the cement with various percentages of Silica fume replacement with cement. Experimental investigations are conducted with Silica fume as a partial replacement for cement in the range of 0%, 3%, 6%, 9%, 12%, 15% concrete of grade M25 Grade of concrete. The optimum dosage of replacement of Silica fume was found to be 3%, beyond which the results for the mechanical properties are found to be not encouraging The cubes, beams, cylinders were casted and cured and tested after 7 days, 28 days respectively with partial replacement of silica fume with 0%, 3%, 6%, 9%, 12%, 15% respectively .conplast sp430 used as super plasticizer. The optimum dosage of replacement of Silica fume was found to be 12%, beyond which the results for the mechanical properties are found to be not encouraging .The results of the tests are analyzed, discussed and presented.***

Keywords: Concrete, Silica fume, compressive strength, Flexural strength, split tensile strength, Optimum dosages of Silica fume.

I. INTRODUCTION

These days the world is experiencing the construction of very influencing and demanding structures, the world inclined towards the concrete jungle, and the high rise skyscrapers are becoming predominant structures in society. The central constituents in the typical concrete are Portland cement the process that is being used in the construction industry for the production of cement releases large footprints of carbon dioxide which give rise to an increase in the earth's surface to resist the above harmful effects to the environment, to the initiation of Avant grade materials and construction procedures. The innovative pozzolanic materials such as silica fume. the material like pozzolanic was introduced a partial replacement to the cement reduces the unconstrained usage of cement this study if for the development of high usage of The cost increased in buying concrete, and basic ingredients are quite high. Sand, coarse aggregate, and cement are basic ingredients in the study. To make the experiment economically, alternatives or replacement are used.one of the best alternative is silica fume in this production. Silica fume popularly called micro silica, it is non-crystalline. Amorphous material. It is the diehard thin powder formed as a by-product of silicon and ferrosilicon alloy. And comprises spherical partial with a norm partial diameter of 150 mm.the particles of silica fume are extremely small. Each partial minimal, being less than 1um. Silica fume is a bit lighter than Portland cement with a specific gravity of 2.2. By mixing silica fume to the concrete mix, the density would differ. SF in concrete increase both mechanical and durable characteristics of concrete. By using silica fume along with complaint sp430 it is relatively easier to obtain compressive strengths. Compare to conventional concrete, SF gives more workability. The main aim of this present work is to find the effect of partial replacement of SF on the strengths for both mechanical and durable characteristics of concrete. The percent levels i.e. 0%,3%,6%,9%and15% are considered for partial replacing OPC cement with silica fume along with sulphonated naphalene based superplasticizer (conplast sp 430). For M25 grade of concrete is initially designed without any replacement.

II. LITERATURES

POTHULA RAJESH1 and K.VAMSI KRISHNA..... , al (2018) investigated the improvement of concrete by partial replacement of Opc 53grade of cement with silica fume. They studied on M25grade concrete with partial replacement of cement by silica fume with varying levels 0%, 10%, 20%and 30% by weight of cement. A detailed experimental study in Compressive strength (cubes), split tensile strength (cylinders), flexural strength (beams) at age of 7, 28, and 56day was carried out. Results Show the third proportion of 20% is a significant strength gets increases due to additional of a mineral admixture. And also it is decreasing the strength after the fourth proportion.

R. M. MADHANASREE, A. JOE Paulson.., al (2016) Examine the study of silica fume replaced concrete with a superplasticizer. The experimental program comprised the four levels of silica fume content (silica fume replaced concrete) at 0%, 12.5%, 13%and 13.5% with superplasticizer. The study it has been observed that maximum compressive strength (both cubes and cylinders) is noted for 13% replacement of cement with SF (for M30, M35, M40 grade of co concrete) and the values are higher than those of specimens.

PRABHULAL CHOUHAN, SAGAR JAMLEet...,al(2017) conducted their research on silica fume as partial replacement of cement and tested for compressive strength of concrete for 7,14 and 28days.they have concluded that 15% of replacement of cement by SF the maximum compressive strength has been increased and also workability of concrete decreases gradually.

T.SHANMUGAPRIYA, DR.R.N.UMA..., (2013)

Write a review paper on experimental investigation on silica fume as partial replacement of cement in high performance concrete.M60 Grade of concrete with water cement ratio as 0.32 and percentage replacement was 2.5%, 5%, 7.5%and12.5%. The optimum percentage of silica found to be at 28days of compressive strength 7.5% cement replacement by silica fume at age levels (i.e., 7, 14, and 28).

III. METHODOLOGY

1) Step 1: Literature Study
2) Step 2: Material Collection
3) Step 3: Tests on Materials

Physical properties of materials

a) Cement
b) Fine Aggregate
c) Coarse Aggregate
d) Silica fume
e) Superplasticizer (conplast sp 430)
4) Step 4: Preparation of design mix for M25 grade
5) Step 5: casting of specimens
6) Step 6: curing of specimens for 7,28days
7) Step 7: Testing of specimens
a) Compression test on cubes
b) Tensile test on cylinder
c) Modulus of rupture test on prism
8) Step 8: Result and conclusion

A. Cementitious Material Used

1) Cement: Cement is binding material that binds the fine and coarse aggregate together and sets and gets hardened gaining the strength of the concrete. The important OPC Grades of cement are a result of the component used in the production of Cement. In this experimental work we have selected the OPC 53 grade of concrete as per IS: 12269-1987(9). Ultratech cement one of the best brand for building material, as per IS: 12269-2013. It is used in this study.opc (ordinary Portland cement) it gives the high strength to the structures because of its finest size particle distribution structure.

Table.1 Physical properties of cement

Properties	Observed Values	Requirements of IS12269-2013
Specific Gravity	3.15	-
Initial Setting Time (min)	29.8	Minimum 30
Final Setting Time (min)	540	Maximum 600
Consistency of cement	28%	22-30%(IS 40311988 part 4)

2) *Fine Aggregate:* Fine aggregates is the main component in concrete which pass through 4.75 mm IS sieve. As per IS: 383-1970 code referred, the river sand used for construction. This invention as fine aggregate confirmed to the grade of zone 3 Testing values shown in tabular form.

Table.2 Physical properties of fine aggregate

Properties	Observed Values
Specific Gravity	2.65
Fineness Modulus	2.28
Water Absorption (%)	1

3) *Coarse Aggregate:* Crushed aggregates are one of the primary ingredient in cement. For proper concrete mix, aggregates are well clean and hard, and strong particles are free of chemical are used. This chemical coating effect the detonation of concrete. 20 mm aggregates are used with the requirements of IS: 382-1970.testing values shown in tabular form.

Table.3 Physical properties of coarse aggregate

Properties	Observed Values
Specific Gravity	2.75
Bulk Density	1650kg/m³
Finess	7.54
Partial shape	Angular
Water Absorption (%)	1.25%

4) *Silica Fume:* Silica fume also referred to condensed Silica or silica dust or Micro silica. The pozzolanic material is also generally called as silica fume. This ultra-fine powder is called as a by production of Elementa silicon. A partial replacement of micro silica in concrete, it fills the spaces between cement grains. It is basically naturally occurring product, not chemically manufactured. Micro silica reduce the cracking and it gives the durable structure.

Table.4 Physical properties of silica fume

Properties	Observed Values
Specific Gravity	2.2
Density	0.76gm/cc
Appearance	White colour powder
Finess modulus	20000m²/kgg
Bulk modulus	240kg/m³

Table.5 Physical properties of silica fume

Properties	Observed Values
Sio_2	90-96%
Al_2O_3	0.6-3%
Fe_2O_3	0.3-0.3%
MgO	0.4-1.5%
CaO	0.1-0.6%
Na_2O	0.3-0.7%
K_2O	0.004-1.0%
C	0.5-1.4%
S	0.1-2.5%

5) *Superplasticizer:* Complast SP430 (sulfonated naphthalene) super plasticizer also known as high range water reducer. Complast SP430 its color disappears, when used in water. For M25 grade of concrete to choose the complast sp430. This superplasticizer suitable for 53 Grade of (OPC) cement.

Table.6 Physical Properties of Super Plasticizer

Properties	Observed Values
Specific gravity	1.20
Chloride content	Nil as per IS 456
Air entrainment	Approximately 1% additional air is entrained
Appearance	Brown liquid

IV. EXPERIMENTAL INVESTIGATION

A. *Compressive Strength*

Cubical moulds are used for testing the compressive strength of the designed concrete mix. The standard size of cube specimens is two types. We used in the project is 15cm×15cm×15cm is used for concrete testing. The initial work is to cast specimens using conventional of OPC 53garde of concrete. The partial replacement of compressed silica is incorporated in concrete with levels of0 %, 3 %, 6 %, 9 %, 12 %, 15 % by weight of ordinary Portland cement. The cubes are cast by using of concrete mixer. After 24 hours these cubical moulds are demoulded from moulds and the test specimens are placed under water curing for 7, 28 days. The specimens after respective days of water curing (7days, and 28days) are tested by compressive testing machine or tested in UTM machine. Below the tabular column shows the average compressive strength of conventional ordinary Portland concrete and micro silica incorporated concrete for 3, 7 days.

B. *Split Tensile Strength*

A split cylinder test is used to determine the tensile strength of concrete. The dimensions of the cylindrical specimen of diameter 15 cm(150 mm) and height 30 cm(300 mm). As per IS: 10086-1982. The test specimens (split cylinder test), should be stored in a place, free from vibration and at room temperature of 27°+/-2 °C for a complete day of 24 hours. After this period, specimens are dispatched from the moulds and specimens are obtained after specified period of 7 and 28 days of clean water curing. The splitting strength test is conducted after the most usual being 7and 28days. The failure load values are recorded, by using of UTM test machine. The results obtained from the silica fumes incorporated concrete is found to higher hat conventional concrete.

C. *Flexural Strength*

Test beam size is 50 cm×10 cm×10 cm has been casted as per IS: 516-1959 to obtain the bend strength of concrete. The age of 7 and 28days of micro silica continuously increased with respect of the controlled concrete and it reaches the maximum value. High performance of (OPC) cement with partial replacement of 12% cement by micro silica shows the greater flexural strength than conventional concrete.

V. RESULTS AND CONCLUSION

A. *Compressive Test*

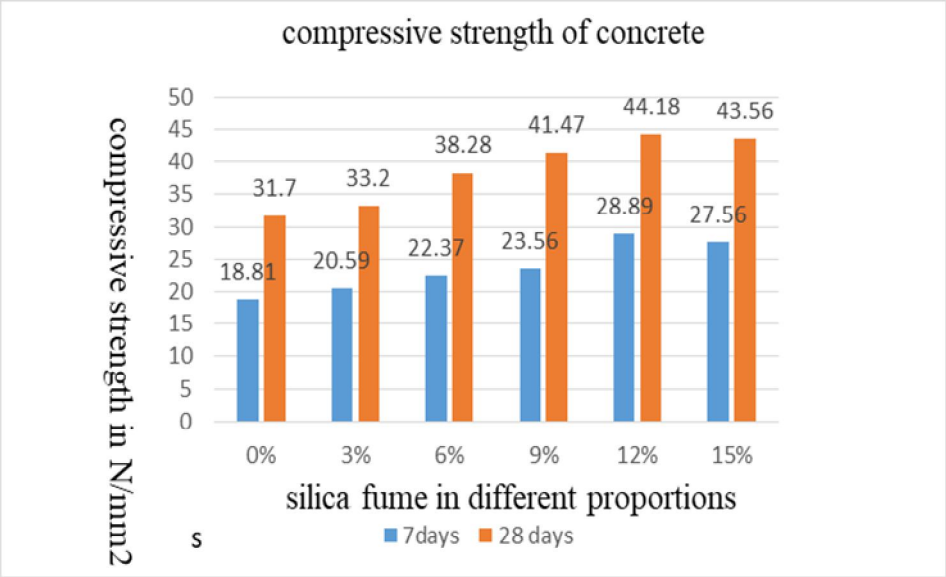
Table 7: compressive Strength for 7days for different proportions of silica

Percentage of silica fume	Sample-1		Sample-2		Sample-3		Average strength
	Load (KN)	Strength (KN/mm^2)	Load (KN)	Strength (KN/mm^2)	Load (KN)	Strength (KN/mm^2)	
0%	400	17.78	450	20.00	420	18.67	18.81
3%	440	19.56	460	20.44	490	21.78	20.59
6%	520	23.11	500	22.22	490	21.78	22.37
9%	540	24.00	550	24.44	500	22.22	23.56
12%	600	26.67	650	28.89	700	31.11	28.89
15%	650	28.89	600	26.67	610	27.11	27.56

Table 8: compressive Strength for 28days for different proportions of silica

Percentage of silica fume	Sample-1		Sample-2		Sample-3		Average strength
	Load (KN)	Strength (KN/mm^2)	Load (KN)	Strength (KN/mm^2)	Load (KN)	Strength (KN/mm^2)	
0%	700	31.11	750	33.33	690	30.67	31.70
3%	740	32.89	720	32.00	781	34.71	33.20
6%	844	37.51	850	37.78	890	39.56	38.28
9%	950	42.22	919	40.89	930	41.33	41.47
12%	1000	44.44	972	43.20	1010	44.89	44.18
15%	1000	44.44	1040	46.22	900	40.00	43.56

Figure 5: compressive strength for all proportion replacement for 7,28 days



B. Split Tensile Strength

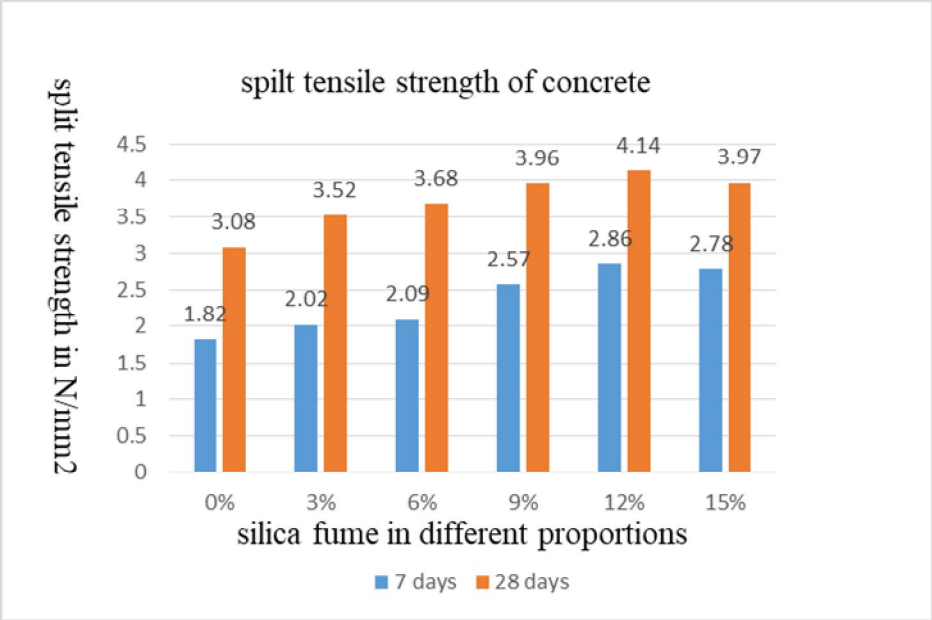
Table 9: Split Tensile Strength for 7 days for different proportions of silica

Percentage of silica fume	Sample-1		Sample-2		Sample-3		Average strength
	Load (KN)	Strength (KN/mm^2)	Load (KN)	Strength (KN/mm^2)	Load (KN)	Strength (KN/mm^2)	
0%	130	1.84	120	1.70	135	1.54	1.82
3%	145	2.05	135	1.91	148	2.09	2.02
6%	140	1.98	160	2.26	144	2.04	2.09
9%	230	2.69	175	2.48	180	2.55	2.57
12%	208	2.94	193	2.73	205	2.90	2.86
15%	205	2.90	200	2.83	185	2.62	2.78

Table 10: Split Tensile Strength for 28 days for different proportions of silica

Percentage of silica fume	Sample-1		Sample-2		Sample-3		Average strength
	Load (KN)	Strength (KN/mm^2)	Load (KN)	Strength (KN/mm^2)	Load (KN)	Strength (KN/mm^2)	
0%	215	3.04	220	3.11	218	3.09	3.08
3%	260	3.68	240	3.40	246	3.48	3.52
6%	265	3,75	273	3.86	243	3.44	3.68
9%	270	3.82	290	4.10	279	3.95	3.96
12%	298	4.22	300	4.25	280	3.96	4.14
15%	271	3.84	290	4.10	280	3.96	3.97

Figure 5: split tensile strength for all proportion replacement for 7,28 days



C. Flexural Strength Of Modulus Test

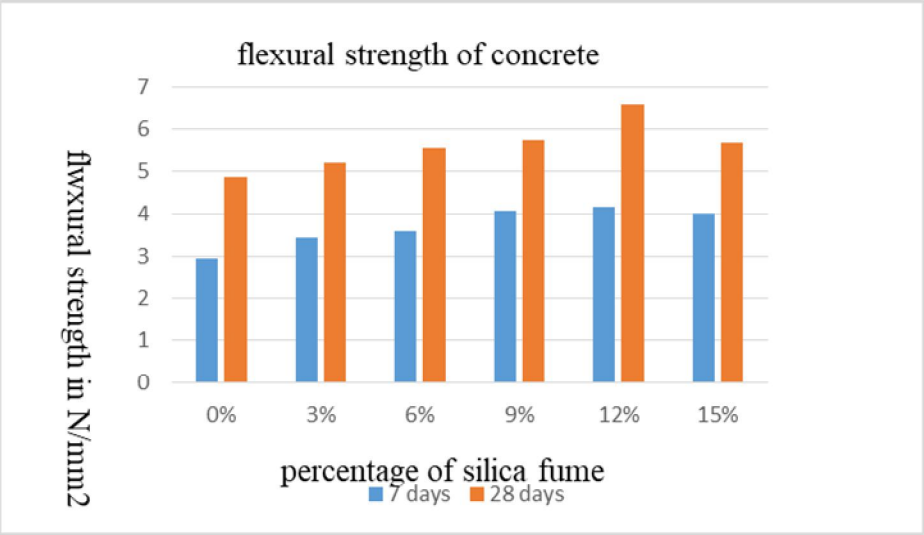
Table 11: Flexural strength of modulus test for 7days for different proportions of silica

Percentage of silica fume	Sample-1		Sample-2		Sample-3		Average strength
	Load (KN)	Strength (KN/mm^2)	Load (KN)	Strength (KN/mm^2)	Load (KN)	Strength (KN/mm^2)	
0%	6	3	5	2.5	6.75	3.375	2.96
3%	7.1	3.55	6.5	3.25	7	3.5	3.43
6%	7.2	3.6	7	3.5	7.3	3.65	3.58
9%	8.1	4.05	8.4	4.2	7.9	3.95	4.07
12%	8.2	4.1	8	4	8.7	4.35	4.15
15%	9	4.5	7	3.5	8	4	4.00

Table 12: Flexural strength of modulus test for 28days for different proportions of silica

Percentage of silica fume	Sample-1		Sample-2		Sample-3		Average strength
	Load (KN)	Strength (KN/mm^2)	Load (KN)	Strength (KN/mm^2)	Load (KN)	Strength (KN/mm^2)	
0%	7.66	3.83	10	5	11.5	5.75	4.86
3%	11	5.5	10	5	10.2	5.1	5.20
6%	10.9	5.45	11.1	5.55	11.3	5.65	5.55
9%	12	6	11.5	5.75	11	5.5	5.75
12%	14	7	13	6.5	12.5	6.25	6.58
15%	10	5	13	6.5	11	5.5	5.67

Figure 6: flexural strength of modulus for all proportion replacement for 7,28 days



VI. CONCLUSION

It is concluded that the silica fume is a well-established, extremely Pozzlani material suitable for use in concrete, with less cement. From this study it has been observed the maximum strength (cube and beam & the cylinder) is noticed for 12% of replacement of cement with SF values are high then compare to normal concrete. Beyond 12 %there is a decrease in compressive strength, split tensile and Flexure strength of concrete.

High strength concrete with silica fume can be effectively used in high rise buildings since high early strength is required, and construction period can be reduced. Which leads to economical and easier placement and faster construction and improves the mechanical properties of concrete.

When using silica fume in concrete, it helps to reduce the impacts on environment due to cement production process.

The maximum increase in compressive strength, split tensile strength, flexural strength are44.18N/mm²,4.14N/mm²,6.58N/mm².

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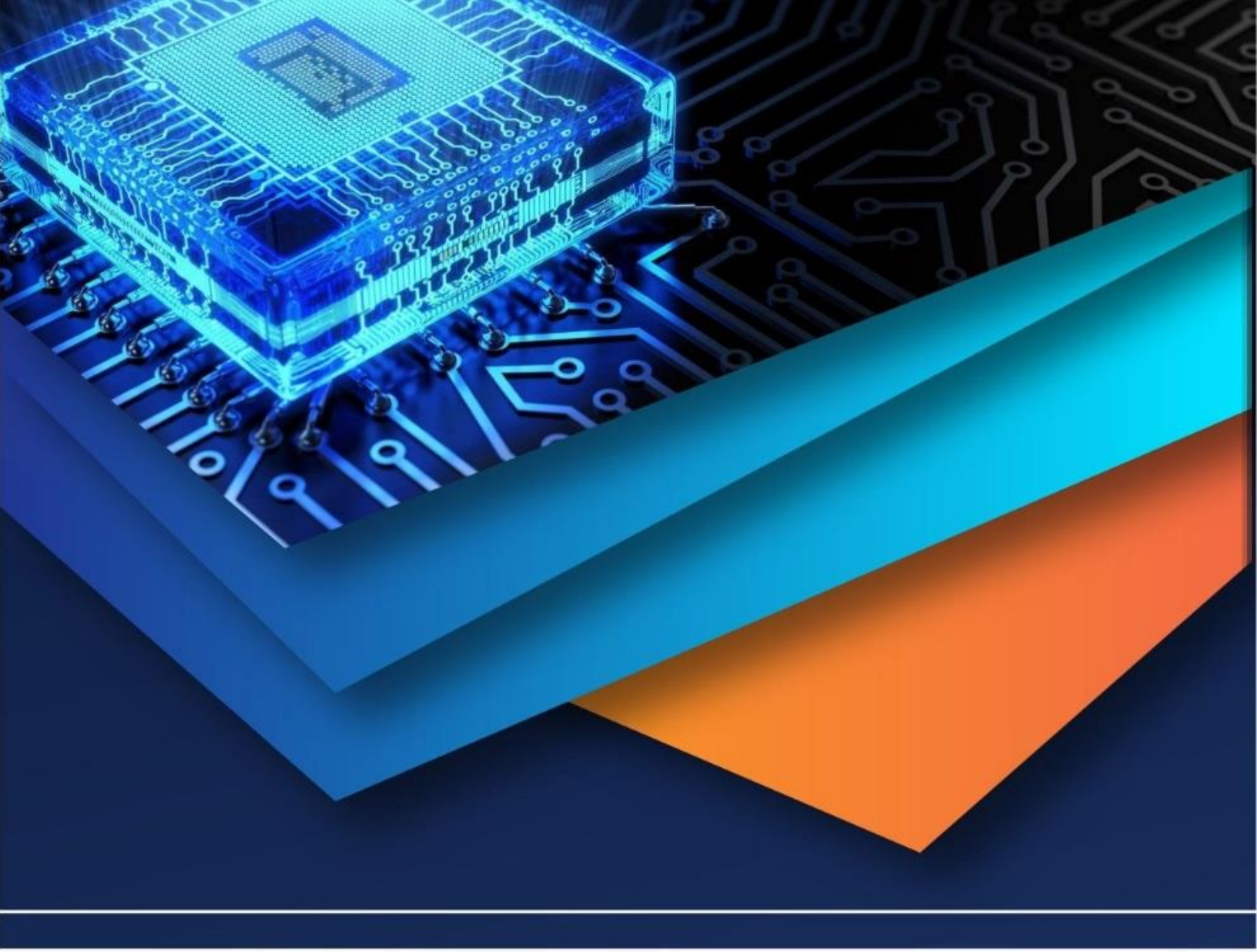

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