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Comparative Study of Different Types of Steel Fiber over Conventional Concrete

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AbstractThis paper deals with the experimental investigation for M25 grade of concrete to study the compressive strength tensile strength flexural strength and workability of Steel fiber reinforced concrete containing 0% 1% and 2% of 3 different types of Steel fiber that is creamed Flat fiber, creamed around fiber and both in hooked fiber.
Result data obtained have been analyzed and compared with the conventional concrete (0% of Steel fiber). Relationship between the physical properties of concrete with respect to days is represented graphically. These results data clearly show that the increase in compressive strength tensile strength and flexible stand with the increase of Steel fibers while the reduced in workability with the increase in doses of Steel fibers are also plotted graphically
Keywords: Conventional concrete, Steel fiber reinforced concrete, compressive strength, tensile strength, split tensile strength, workability

I. INTRODUCTION

Concrete is the one of the major construction material that plays a vital role in the development of modern civilization throughout world. The consumption of concrete as construction materials is more than the twice of total consumption of all other building materials. The tensile strength of concrete is lower as comparison to the compressive strength. To compensate this low value of tensile strength of concrete, different size re-bar and fibers are mixed in the concrete during the mixing time of other ingredients. Since the past centuries conventionally steel bar are used in the casting of concrete. But now a day there are so many alternatives are available in the commercial market, which may be improve the hardened properties, like ductility, energy dissipation impact resistance fatigue resistance and performance of concrete.

In present experimental work, M_{25} Grade of concrete was prepared by using OPC 53 Grade, along with of three different types of Steel fiber, named Crimped round fiber, Crimped flat fiber and both end hooked fiber, Presented in Fig. 1(a),1(b) and 1(c), respectively

II. LITERATURE REVIEW

In this chapter comprehensive literature review of various researcher work carried out in field of concrete technology using several types of Steel fiber.

Hamid BehbahaniPesaran et al. [2002] Synthesis of the mechanical properties of reinforced concrete fiber reinforced concrete (SFRC), their advantage and their application. Concrete steel fiber performance (SFRC) has planted a significant improvement in bending strength and total hardness compared to conventional reinforced concrete.

P S song et al. [2006] Steel fibers were added to the fractions of volume 0.5%, 1.0%, 1.5% and 2.0%. The reinforced concrete compression strength increased to 1.5% by volume, with a 15.3% improvement over HSC.

Shrikant et.al. [2014] Study an experimental and found that 1% of steel fibers gives flexural strength of 6.46 N/mm^2 with comparison to the 5.36 N/mm^2 in normal aggregate concrete. Author also compared the properties SFRC with normal self-compacting concrete (SSC) and observed that the compressive strength, flexural strength increased 25.75%, 19.47%, respectively.

Abdul Ghaffaret al. [2014]investigated the use of hooked Steel fibers in the percentage of 0% to 5% with the interval of 0.5% by weight of the cement in normal concrete and observed that the workability of concrete significantly reduced as increase the doses of Steel fibers. The maximum increase in the percentage of compressive strength, flexural strength was 6.15% and 7.94%, respectively with the volume fraction of Steel fibers were 3% and 4% respectively

III. EXPERIMENTAL INVESTIGATION

A. Materials

The constituents materials used in this project were obtained from local source and these were Ordinary Portland cement (OPC-53), Coarseaggregate, fineaggregate, steel fibers and potable water was used for mixing and curing.

B. Cement-

Ordinary Portland cement with Trade name "DOUBLE BULL" was used conforming to IS 455 whose Physical properties are given below

Table: 3.1 Physical properties of cement

PROPERTIES	RESULTS	STANDARD LIMIT (IS 12269-1987)
Consistency	30%	----
Soundness	4 mm	< 10 mm
Initial setting time	35 min	>30 min
Final setting time	180 min	<600 min
Specific gravity	3.14	---
Fineness	3%	<10%
Compressive strength 1. 3 days 2. 7 days 3. 28 days	N/mm^2 29.09 45.15 53.17	N/mm^2 >27 >37 >53

Table: 3.2. Physical property of Natural coarse aggregate and fine aggregate

Properties	Fine aggregate	Coarse aggregate
Specific gravity	2.59	2.8
Bulk density (loose) gm/cc	1.575	1.650
Bulk density (compacted)gm/cc	1.630	1.909
Water absorption (%)	0.8	0.7
Surface moisture content (%)	0 .6	Nil
Fineness modulus (%)	3.02	7.38
Flakiness index (%)		13.6
Elongation index (%)		18.4

C. Steel fiber

Physical and Chemical properties given as per company

Table: 3.3 Properties of crimped round & both end hook fiber

Length of fiber (L)	50 mm
Aspect ratio	50
Diameter (d)	1.0mm
Tensile Strength	Minimum 1100 Mpa
Appearance and Form	Clear, bright and undulated along the length
ASTM Specification	ASTM A820 Type I or Type II
Material Type	Short pieces of round wire of low carbon steel, cold drawn.

Table: 3.4 Properties of crimped flat steel fiber

Length of fiber (L)	50 mm
Equivalent diameter (d)	0.85 to 1.25 mm
Tensile Strength	Minimum 1100 Mpa
Appearance and Form	Clear, bright and undulated along the length
ASTM Specification	ASTM A820 Type I or Type II
Material Type	Short pieces of flat wire of low carbon steel, cold drawn.

0Table: 3.5 Properties of steel fibers Chemical

Chemical composition of mild steel wire	Percentage
Carbon	0.065
(Manganese) Mn	0.510
(Silica) Si	0.133
(Phosphorous) P	0.023
(Sulphur) S	0.013

D. Mix Proportion

To investigate the various physical properties of concrete with the addition of Steel fibers firstly conventional concrete was prepared for an M25 grade of concrete and cubes, beams and cylinders were casted with water cement ratio of 0.48to investigate the properties of the compressive strength, flexuralstrength and split tensile strength of concrete. After that the various types of Steel fibers that is creamed round fiber, both end hooked fiber and creamed Flat fiber were added in the percentage of 1% and 2% of the weight of the cement and again this experiments way repeated to check the variation of physical strength with the addition of Steel fibers. After this experimental work the various results data that was obtained on the addition of Steel fibers is now compared with the conventional concrete check which type of Steel fibersgave best result among the three used Steel fibers.

IV. RESULT AND DISCUSSION

The Variation of various of physical properties of concrete with the addition of three types of steel fibers are examined and it is compared with conventional concrete. The various Parameters like compressive strength, flexural strength, split tensile strength were tested and plotted in the tabular and graphical from below.

Here, comparison is done in the two ways. In first, I compared the Steel fiber reinforced concrete with the conventional concrete and in another case, I compared the variation in strength of Steel fiber reinforced concrete(SFRC) with different types of addition of the Steel fiber.

A. Comparison of Steel Fiber Reinforced Concrete and Conventional Concrete

1) Compressive Strength Test: In this test firstly, I prepared a cube of conventional concrete of dimension 150 mm X 150 mm X 150 mm and the compressive strength was analyzed after 7 and 28 days of curing. After that the three different types of Steel fibers separatelyAdded with the percentage of 1% and 2% of the weight of the cement. I got that on addition of Steel fibers in concrete compressive strength of the concrete increased as compared to the conventional concrete.

Conv.- Conventional

S_1 1% both end hooked fiber
S_2 1% crimped flat fiber
S_3 1% crimped round fiber
S_4 2% both end hooked
S_5 2% crimped flat fiber
S_6 2% crimped round fiber

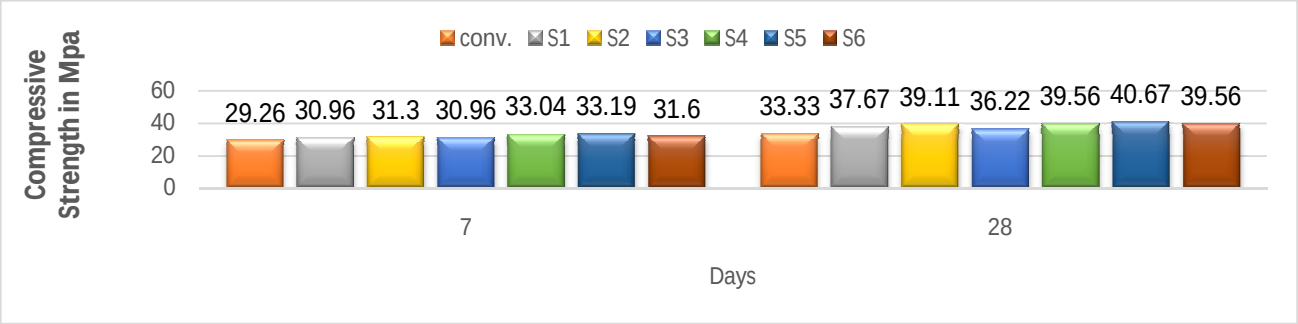

Fig: 4.1. Compressive Strength of conv. and SFRC concrete at 7and 28 days

Compressive strength in Mpa	7days		28day	
Conventional concrete 0% fiber	29.26		33.33	
Fiber	1%	2%	1%	2%
Both end hooked fiber	30.96	33.04	37.67	39.56
Crimped flat fiber	31.30	33.19	39.11	40.67
Crimped round fiber	30.96	31.60	36.22	39.56

Table: 4.1 Compressive strength at 7 and 28 days

2) *Split Tensile Strength :*In this test cylinder of dimension 300mm X150mm is prepared of conventional concrete and the Split Tensilestrength was analyzed after 7 and 28 days of curing. After that the three different types of Steel fibers separately added in the similar manner as in Compressive Strength Test with the percentage of 1% and 2% of the weight of the cement. I got that on addition of Steel fibers in concrete compressive strength of the concrete increased as compared to the conventional concrete. The reason of increase in strength is due to fact that steel fibers in concrete acts as a composite material leads to improvement of bond between ingredients.

The test results have been plotted on graphical and tabular form.

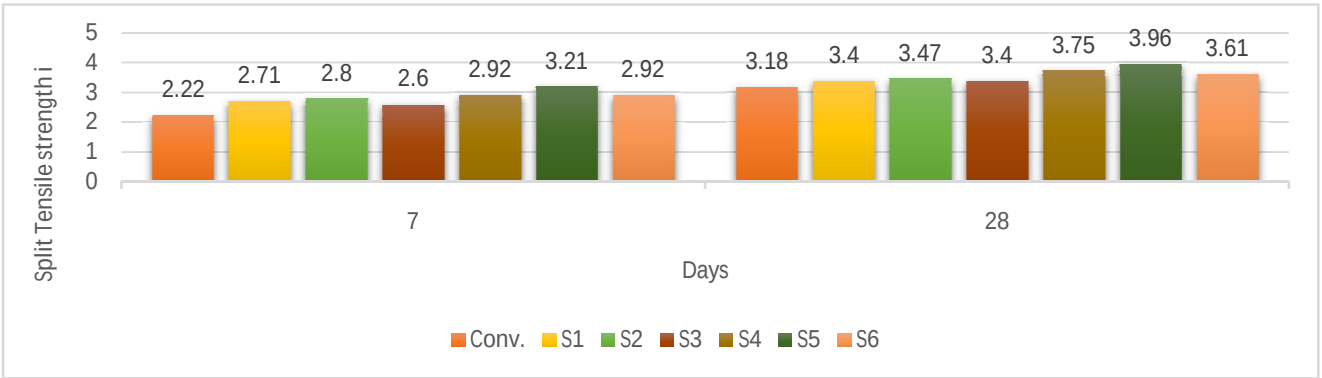

Fig: 4.2.SSplit Tensile strength of conv. and SFRC concrete at 7and 28 days

tensile strength in Mpa	7days		28day	
Conventional concrete 0% fiber	2.22		3.18	
Fiber	1%	2%	1%	2%
Both end hooked fiber	2.71	2.92	3.40	3.75
Crimped flat fiber	2.80	3.21	3.47	3.96
Crimped flat fiber	2.80	3.21	3.47	3.96

Table: 4.2 Split tensile strength at 7and 28 day

3) Flexural Strength Test

In this test Beams of dimension 500mm X100mm X 100mm is prepared of conventional concrete and the Flexural Strength Test was analyzed after 7 and 28 days of curing. After that the three different types of Steel fibers separately added in concrete with the percentage of 1% and 2% of the weight of the cement. I got that on addition of Steel fibers in concrete compressive strength of the concrete increased as compared to the conventional concrete. The reason of increase in strength is due to fact that steel fibers in concrete acts as a composite material leads to improvement of bond between ingredients

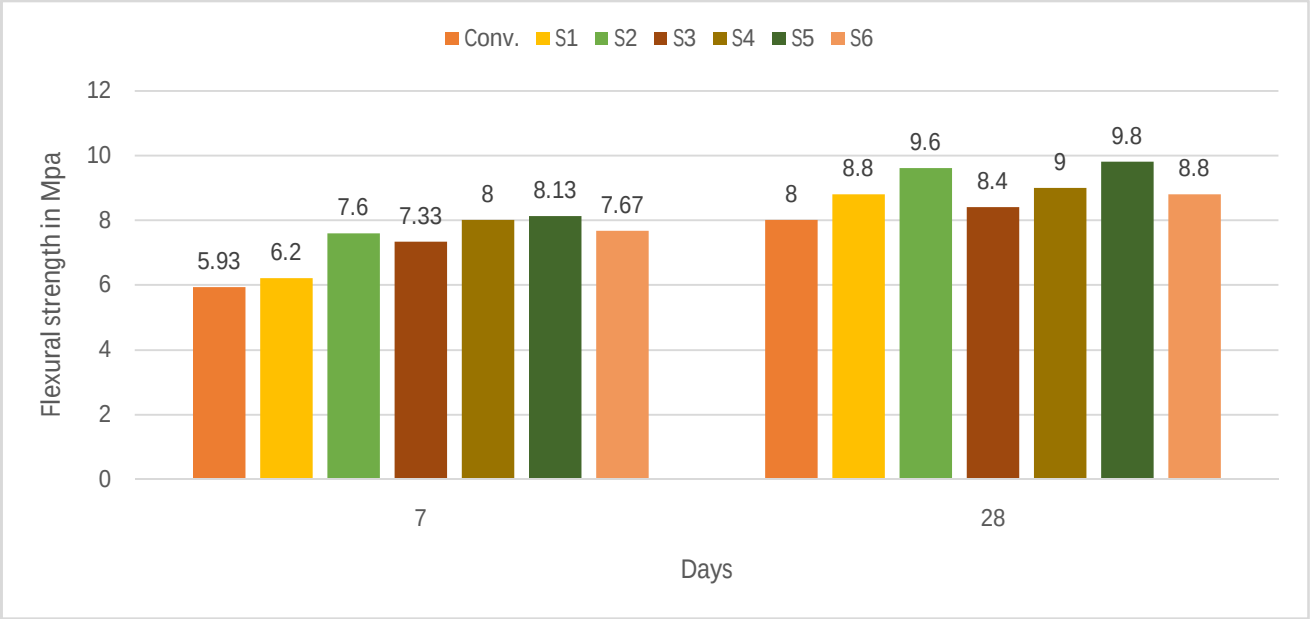

Fig: 4.3 Flexural strength of conv. and SFRC concrete at 7and 28 days

Table: 4.3 Flexural strength at 7 and 28 days

flexural strength in Mpa	7days		28day	
Conventional concrete 0% fiber	5.93		8.00	
Fiber	1%	2%	1%	2%
Both end hooked fiber	6.20	8.00	8.80	9.00
Crimped flat fiber	7.60	8.13	9.60	9.80
Crimped round fiber	7.33	7.67	8.40	8.80

B. Comparison of Strength of Concrete with different types of steel fiber

1) Compressive Strength Test: On addition of different types of Steel fiber with different doses of 1% and 2% of the weight of the cement, I got that the 2% of each type of the three used Steel fibers gives more compressive strength as compared to the 1% of same type of Steel fibers. Another thing is that among the three used Steel fiber the creamed flatfibers gave maximum percentage increase that is about 17% and 22% in compressive strength at 1% and 2% of Steel fiber respectively.

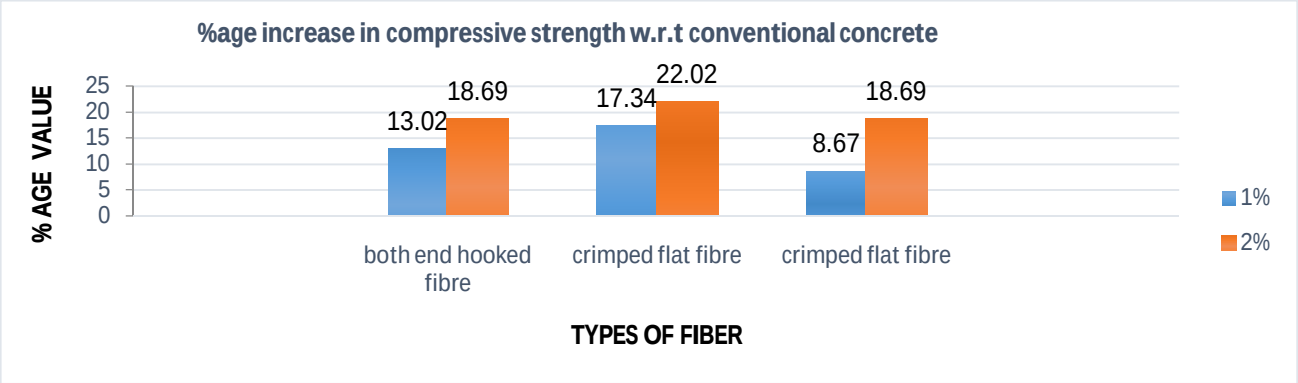

Fig: 4.5 Compression of compressive strength w.r.t to conv. Concrete

Table: 4.4 compression of compressive strength in (%)

Increase compressive strength w.r.t to conv. concrete in (%)	Both end hooked fiber		Crimped flat fiber		Crimped round fiber	
	1%	2%	1%	2%	1%	2%
	13.02	18.69	17.34	22.02	8.67	18.09

2) *Split tensile Strength:* In the case of split tensile strength, again I saw that 2% of the used Steel fibers gave more strength as compared to 1% of the same Steel fiber. The percentage increase in split tensile strength at 1% and 2% off crimped flat fiber dosage gave maximum percentage increase in strength as compared to the other two used Steel fibers.

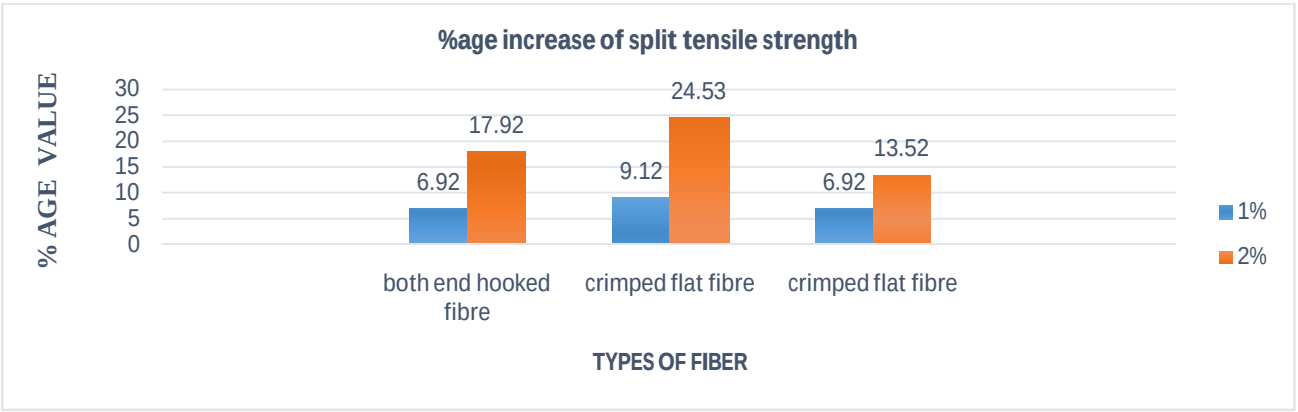

Fig: 4.5 Compression of split tensile strength w.r.t to conv. Concrete

Table: 4.5 Compression of split tensile strength in (%)

Increase tensile strength w.r.t to conv. concrete in (%)	Both end hooked fiber		Crimped flat fiber		Crimped round fiber	
	1%	2%	1%	2%	1%	2%
	6.92	17.92	9.12	24.53	6.92	13.52

3) *Flexural Strength test*

In the case of flexural strength test,the results similarly followed the above two test. It means 2% edition of this Steel fibers gives more strength as compared to 1% of the Steel fibers and among the three used Steel fibers creamed flat fibers gives maximum percentage increase then both end wood fiberAnant last cream the flat fibers.

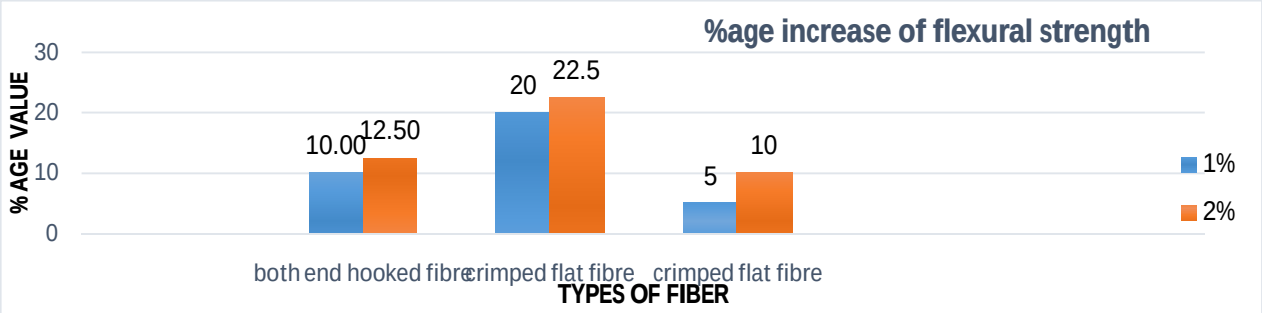

Fig: 4.7 Compression of flexural strength w.r.t to conv. Concrete

Table: 4.6 Compression of flexural strength in (%)

Increase flexural strength w.r.t to conv. concrete in (%)	Both end hooked fiber		Crimped flat fiber		Crimped round fiber	
	1%	2%	1%	2%	1%	2%
	10.00	12.50	20.00	22.50	5.00	10.00

V. RESULTS

According to this experiment work presented in this thesis results to the following conclusion.

Workability of Steel fiber reinforced concrete with the increase in percentage of fiber decreases, due to the increase in frictional resistance between various ingredients of concrete due to the mixing with steel fiber.

The various properties like compressive strength, split tensile strength and flexural strength increases due to the increase in percentage of Steel fiber from 0% to 1% and 1% to 2% due to the composite behavior of concrete.

Among all the Steel fiber used in the experiment work crimped flat fibers give the maximum result as compared to the other two fibers used.

The increase in percentage of compressive strength at 28 days with 2% addition of both end hooked fiber and crimped round fibers which is equal to the 18.6 %.

In the case of the split tensile strength test percentage increase in strength is 24.53% at 2% of crimped flat fiber give higher tensile strength test value.

The increase in flexural strength value at 28 days in the case of 1% of both end hooked fiber is equal to the percentage increase in strength with 2% of crimped round fiber.

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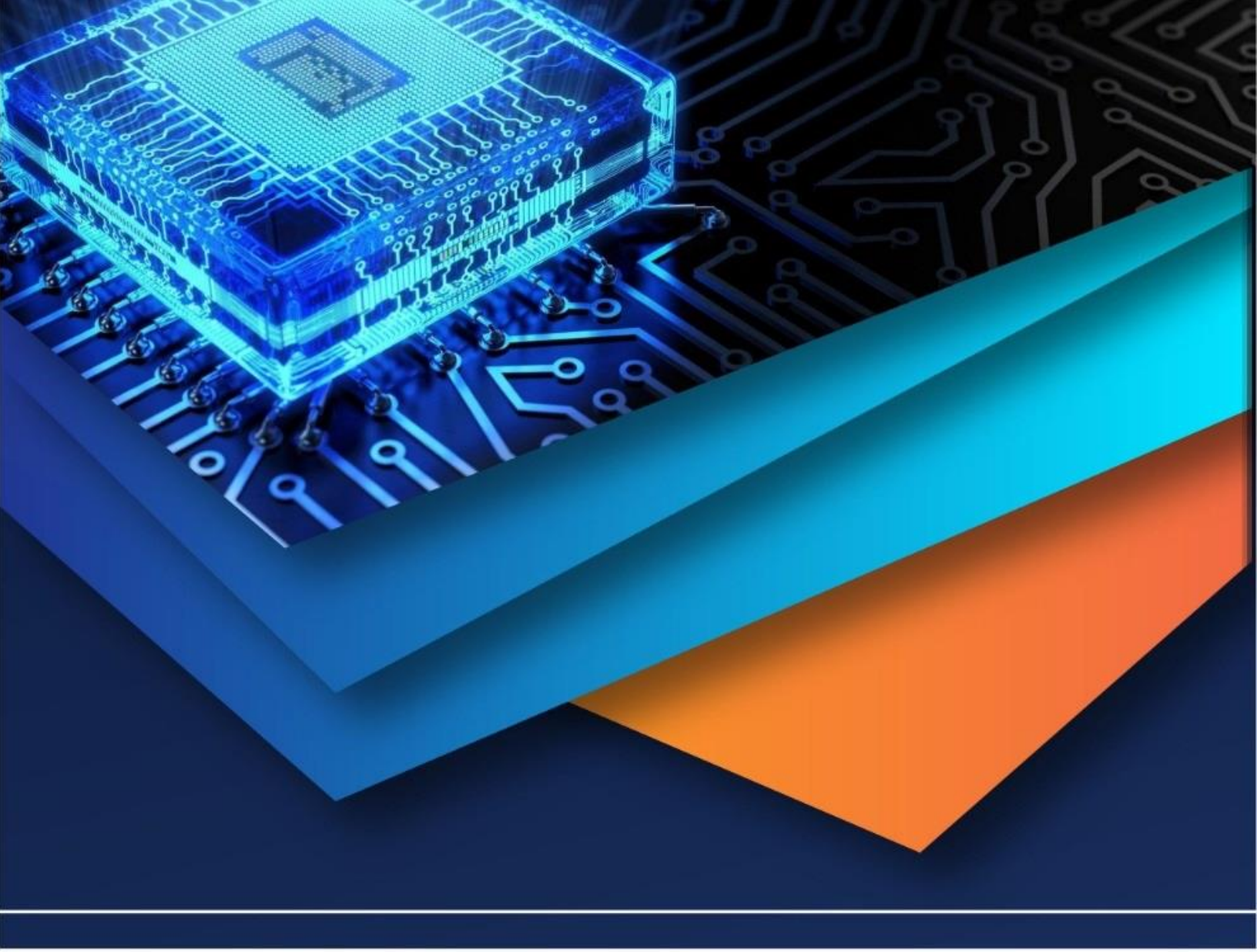

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