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Experimental Study of Light Weight Concrete Using PP Fiber

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Abstract - Concrete is acknowledged to be a relatively brittle material when subjected to normal stresses and impact loads, where tensile strength is approximately just one tenth of its compressive strength. the addition of steel reinforcement significantly increases the strength of concrete, the development of micro cracks must be controlled to produce concrete with homogenous tensile properties. The introduction of fibres is brought in as a solution to develop concrete with enhanced compressive and tensile strength, which is a new form of binder that could combine Portland cement in bonding with cement matrices. The influence of polypropylene fiber improves the performance characteristics of the lightweight cement composites. Fiber may be used in two different lengths 6mm , 12mm and 19mm and fiber proportions can be taken as 15%, 25% and 35% by cement weight in the mixture design. Hardened concrete properties can be evaluated at 7, 14 and 28-day by testing compressive strength and tensile strength with w/c ratio 0.5%. The use of fiber makes the concrete light weight and low cost material. , Fibre Reinforced Concrete have wide variety of usages in structures such as heavy-duty pavements, Airfields, industrial floor, water retaining and hydraulic structures, parking structure decks, water and waste water treatment plants, pipes, precast roof and wall panels, and the techniques of shotcrete application.
Keywords: PP fiber, cement composite, concrete, slump value, compressive strength and tensile strength.

I. INTRODUCTION

Concrete is a brittle material with low tensile strength and low strain capacity that result in low resistance to cracking. To improve such properties, fibre reinforced concrete (FRC) has been developed. Fibres are intended to improve tensile strength, flexural strength, toughness and impact strength, to change failure mode by means of improving post-cracking ductility, and to control cracking. Tensile strength of the, related more to the stress at which matrix develops a macro-crack, will not differ much for most conventional fibre reinforced cementitious materials. Several fibre materials in various sizes and shapes have been developed for use in FRC. Among these fibres, the polypropylene has been one of the most successful commercial applications. The common forms of these fibres are smooth-monofilament and have triangular shape. Polypropylene fibres have some unique properties that make them suitable for reinforcement in concrete. The fibres have a low density, are chemically inert and non corrosive.

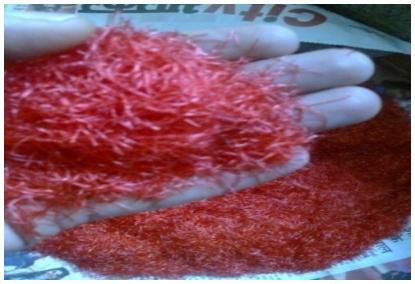

Fig1. Polypropylene Fiber

The primary objectives of this investigation were to determine the benefits of using polypropylene fibre reinforced concrete (PFRC).

To determine the properties of the fresh concrete mixtures using fiber.
To investigate and compare the properties of hardened concrete for control and various PFRC mixes.
Observe the difference between failure patterns of plain and PFRC specimens.

A. Properties Of Polyp Ropylene Fibers

Polypropylene is in the polyolefin family of chemicals. Chemically inert, it will not rust, corrode or rot, and it will not absorb water. Little or no flame spread on the surface of polypropylene fiber reinforced panels was reported in laboratory tests. Reference 2 indicates that a fire will leave such concrete with an additional porosity equal to the volume of the fibers incorporated in the mix. Fibrillated polypropylene fibers now on the market have the following properties. Fiber diameter 88 denier or 10,000 denier* (4.5 mils or 49.5)

Density	55 pounds per cubic foot
Specific gravity	0.91
Young's modulus of elasticity	500,000-700,000 psi
Tensile strength	70,000-110,000 psi
Elongation at break	10-15 percent

II. MATERIAL AND METHODOLOGY

The ingredients of concrete are cement sand and aggregate with water. In the present experiment OPC 43 Grade cement is used, Ordinary Portland Cement confirming the requirements of IS: 1489 (Part1)-1991. The sand of zone III as per the specifications of IS 383:1970 is used. The crushed granite aggregate of graded 20mm size are collected and sieved as per specifications of IS 383: 1970 for graded aggregates.

A. Polypropylene Fibers

The principal reason for incorporating polypropylene fibers into a cement matrix is to increase the toughness and tensile strength, and improve the cracking deformation characteristics of the resultant composite. In order for fiber reinforced concrete (FRC) to be a viable construction material, it must be able to compete economically with existing reinforcing systems.

B. Methodology

The light weight reinforced concrete is prepared by using artificial fibers synthetic fiber which is used is polypropylene. The coir fiber is obtained from the Rewa city. These fibers are used in three sizes 6mm, 12mm and 19mm.. The ratio M20 concrete is obtained from mix design that is 1: 1.5: 3.06. The concrete is prepared in the same reaction. The fibers are added by value of cement in 15%, 25%, 35%, the W/C ratio is kept as 0.5. Now the moulds are ready and put it in a tank for curing the compaction & tension test are performed on 7^{th} , 14^{th} , & 28^{th} days.

III. TESTING

Testing of concrete is done to determine the various properties of concrete when it is reinforced with PP fiber. Strength properties were analyzed by conducting compressive strength test as per IS: 516 - 1959 and tensile strength test as per IS: 5816 – 1999 on 7^{th}, 14^{th} and 28^{th} day. The strength property of PP reinforced fiber concrete is obtained. The strength and cracks resistance property of concrete is improved by the addition PP fiber in concrete.

IV. RESULTS AND DISCUSSION

A. Slump Cone (Workability Test)

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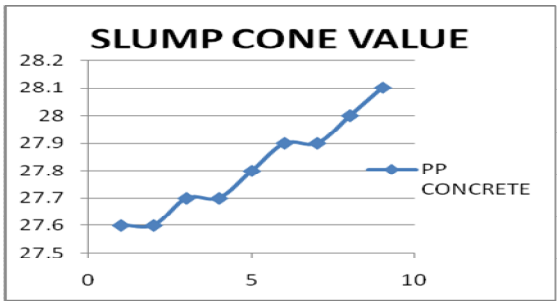
Table 1. slump cone value of PP fiber

	P1	P2	P3	P4	P5	P6	P7	P8	P9
Slump Value	27.6	27.6	27.8	27.4	27.6	27.8	27.7	27.9	28.2
Slump	2.40	2.40	2.20	2.60	2.40	2.20	2.30	2.10	1.80



Graph1. Slump cone value of PP fiber

B. Compressive strength test:

As it is evident from Table 2, an enhancement in compressive strength compared to control sample occurs for the PP fiber concrete for all sizes 19mm, 12 mm and 6 mm fiber lengths. Also an increase in the fiber content has direct effect on compressive strength. The fiber length of 19 mm showed better performance compared to 6 mm and 12 mm. It can be seen, however, that the difference in performance of the PP fiber concrete with introducing more percentage of fibers in the specimen such as 15%, 25% and 35%. The performance of polypropylene fibers in the concrete mixture can be attributing to generation a good cohesion with other aggregates which enhances mechanical properties of the LWC. This could be as a result of good distribution of fiber in LWC, table 2. higher compressive strength of LWC specimens is 30.9 KN/mm2. From the compressive test results, it could be clearly found that PP fibers have no significant effect on compressive strength of concrete at 7 days and 14 days of curing. However, 28 days of curing the samples shows significant change in comparison with control specimen.

Table 2. Compressive Strength Test Of PP Fiber

Name	Ratio Of PP Fiber	Size	AMOUNT(Kg/m3)				7Day Kg/m2	14Day Kg/m2	28Day Kg/m2
			Cement	Sand	Aggr.	PP fiber			
P1	15 %	6 mm	384.35	580.4	1176.1	57.65	16.7	18.4	33.1
P2	25 %	6 mm	384.35	580.4	1176.1	96.1	16.9	18.7	33.5
P3	35 %	6 mm	384.35	580.4	1176.1	134.5	17.2	19.1	33.7
P4	15 %	12 mm	384.35	580.4	1176.1	57.65	17.2	18.8	34.8
P5	25 %	12 mm	384.35	580.4	1176.1	96.1	18.3	19.1	36.3
P6	35 %	12 mm	384.35	580.4	1176.1	134.5	18.8	19.7	37.2
P7	15 %	19 mm	384.35	580.4	1176.1	57.65	18.5	20.2	48.4
P8	25 %	19 mm	384.35	580.4	1176.1	96.1	18.9	20.8	39.7
P9	35 %	19 mm	384.35	580.4	1176.1	134.5	19.6	21.4	40.9

The result of the compressive strength of concrete cubes show that the compressive strength increases as percentages of fiber increased. Addition of 35% of fiber of 19 mm length gives better result than other length and percentages. However, the compressive strength increased as the no. Of days of curing increased for each percentage PP fiber reinforcement. It is seen from Table 2 that for controlled cube, the compressive strength increases from 19.6 N/mm2 at 7 day to 40.09 N/mm2 at 28days. The strength was above the specified value of 40N/mm2 for grade M40 concrete as shown in Graph 2.

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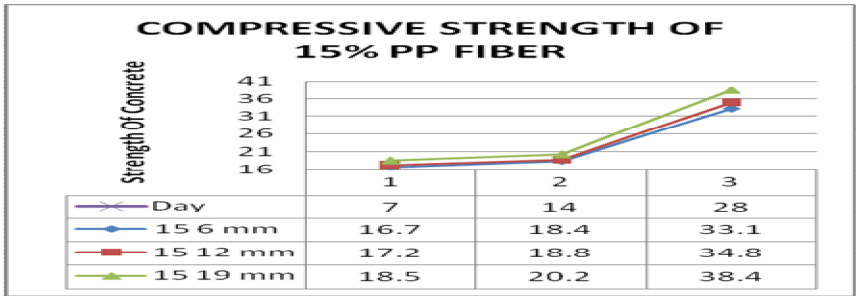
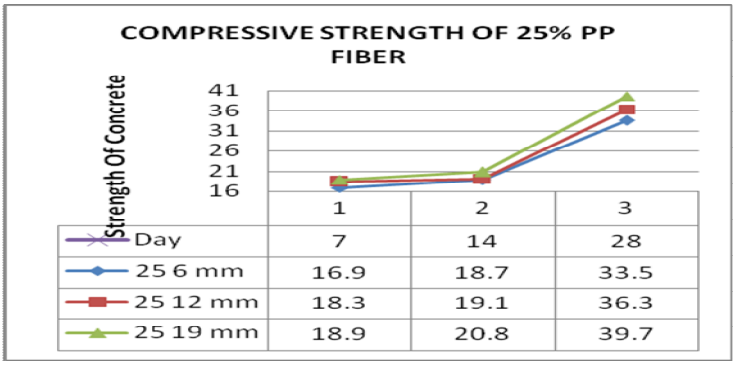


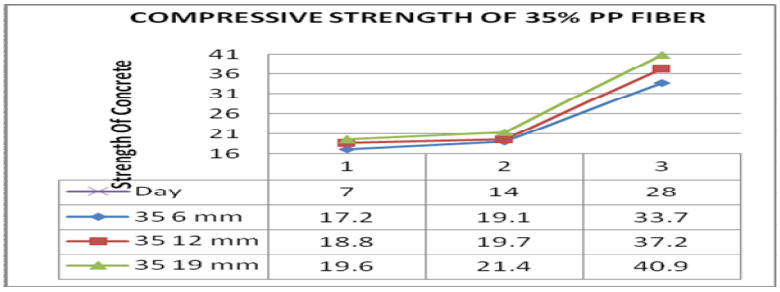
Graph2. Compressive strength of 15% PP fiber

It is seen from graph 2 that for controlled cube, the compressive strength of 15% of PP fiber reinforced concrete gives better result, its strength is increases from 18.5 N/mm2 at 7 day to 38.4 N/mm2 at 28days. The compressive strength increased as the no. Of days of curing increased for each percentage and size of fiber. The strength was above the specified value of 25N/mm2 for grade M25 concrete as shown in Graph 2.



Graph3. Compressive strength of 25% PP fiber

From the graph 3 that for controlled cube, the compressive strength of 25% of PP fiber reinforced concrete with size of 19mm gives better result, its strength is increases from 18.9 N/mm2 at 7 day to 39.7 N/mm2 at 28days. The compressive strength increased as the no. Of days of curing increased for each percentage and size of fiber. The strength was above the specified value of 35N/mm2 for grade M35 concrete.



Graph4. Compressive strength of 35% PP fiber

From the graph 4 that for controlled cube, the compressive strength of 35% of PP fiber reinforced concrete with size of 19mm gives better result, its strength is increases from 19.6 N/mm2 at 7 day to 40.9 N/mm2 at 28days. The compressive strength increased as the no. Of days of curing increased for each percentage and size of fiber. The strength was above the specified value of 40N/mm2 for grade M40 concrete as shown in Graph 4**.**

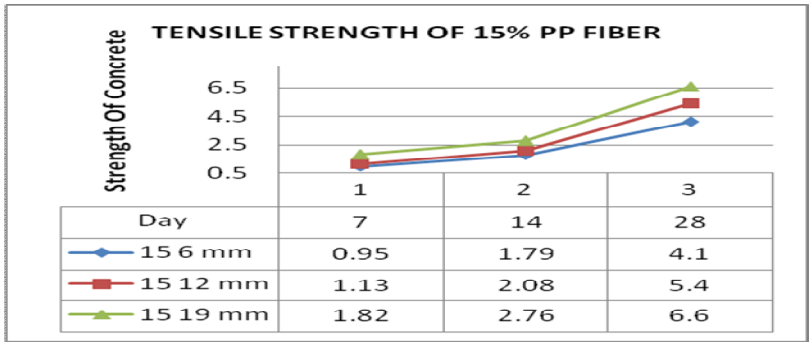
C. Tensile strength test:

Split tensile strengths of PP fiber concretes were found to be higher compared to reference concrete. it can be observed that the

fiber concrete specimens containing longer PP fiber show the best split tensile strength among all concretes. Enhancement in split tensile strength is expected with increasing the fiber proportion since the plane of failure is well defined (diametric). The higher the number of fibers bridging on the diametrical 'splitting' crack, the higher would be the split` tensile strength. Short length fiber reinforced specimens possibly owing to their short fiber lengths, did not perform as longer fiber.

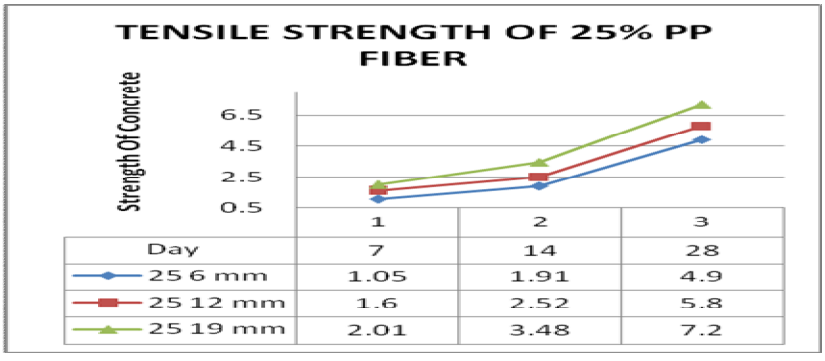
Table 3. Tensile strength of PP fiber

Name	Ratio Of PP Fiber	Size	AMOUNT(Kg/m3)				7Day Kg/m2	14Day Kg/m2	28Day Kg/m2
			Cement	Sand	Aggr.	PP fiber			
P1	15 %	6 mm	384.35	580.4	1176.1	57.65	0.95	1.79	4.1
P2	25 %	6 mm	384.35	580.4	1176.1	96.1	1.05	1.91	4.9
P3	35 %	6 mm	384.35	580.4	1176.1	134.5	1.12	2.08	5.4
P4	15 %	12 mm	384.35	580.4	1176.1	57.65	1.13	2.08	5.4
P5	25 %	12 mm	384.35	580.4	1176.1	96.1	1.6	2.52	5.8
P6	35 %	12 mm	384.35	580.4	1176.1	134.5	1.8	2.70	6.5
P7	15 %	19 mm	384.35	580.4	1176.1	57.65	1.82	2.76	6.6
P8	25 %	19 mm	384.35	580.4	1176.1	96.1	2.01	3.48	7.2
P9	35 %	19 mm	384.35	580.4	1176.1	134.5	2.64	3.93	7.7



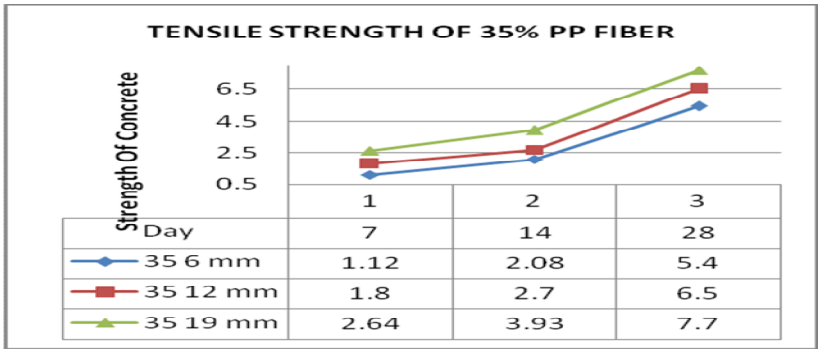
Graph5. Tensile strength of 15% PP fiber

From the graph 5 that for controlled cube, the tensile strength of 15% of PP fiber reinforced concrete with size of 19mm gives better result, its strength is increases from 1.82 N/mm2 at 7 day to 6.6 N/mm2 at 28days. The compressive strength increased as the no. Of days of curing increased for each percentage and size of fiber.



Graph6. Tensile strength of 25% PP fiber

From the graph 6 that for controlled cube, the tensile strength of 25% of PP fiber reinforced concrete with size of 19mm gives better result, its strength is increases from 2.01 N/mm2 at 7 day to 7.2 N/mm2 at 28days. The compressive strength increased as the no. Of days of curing increased for each percentage and size of fiber.



Graph7. Compressive strength of 35% PP fiber

From the graph 7 that for controlled cube, the tensile strength of 35% of PP fiber reinforced concrete with size of 19mm gives better result, its strength is increases from 2.64 N/mm2 at 7 day to 7.7 N/mm2 at 28days. The compressive strength increased as the no. Of days of curing increased for each percentage and size of fiber.

V. CONCLUSIONS

A. Use of fiber produces more closely spaced cracks and reduces crack width. Fibers bridge cracks to resist deformation.

B. Fiber addition improves ductility of concrete and its post-cracking load-carrying capacity. Polypropylene fibers reduce the water permeability, plastic, shrinkage and settlement and carbonation depth.

C. Despite its excellent properties, fibres as an enhancement of concrete are unlikely to replace steel for the vast majority of structures.

D. Polypropylene fibres dose not disperse properly in the mixing water. Addition of fibres to dry mix was found to be more practical.

E. Workability of concrete increase with increase in polypropylene fiber volume fraction.

F. Polypropylene fibers enhance the strength of concrete, without causing the well known problems, normally associated with steel fibers.

G. The problem of low tensile strength of concrete can be overcome by addition of polypropylene fibers to concrete.

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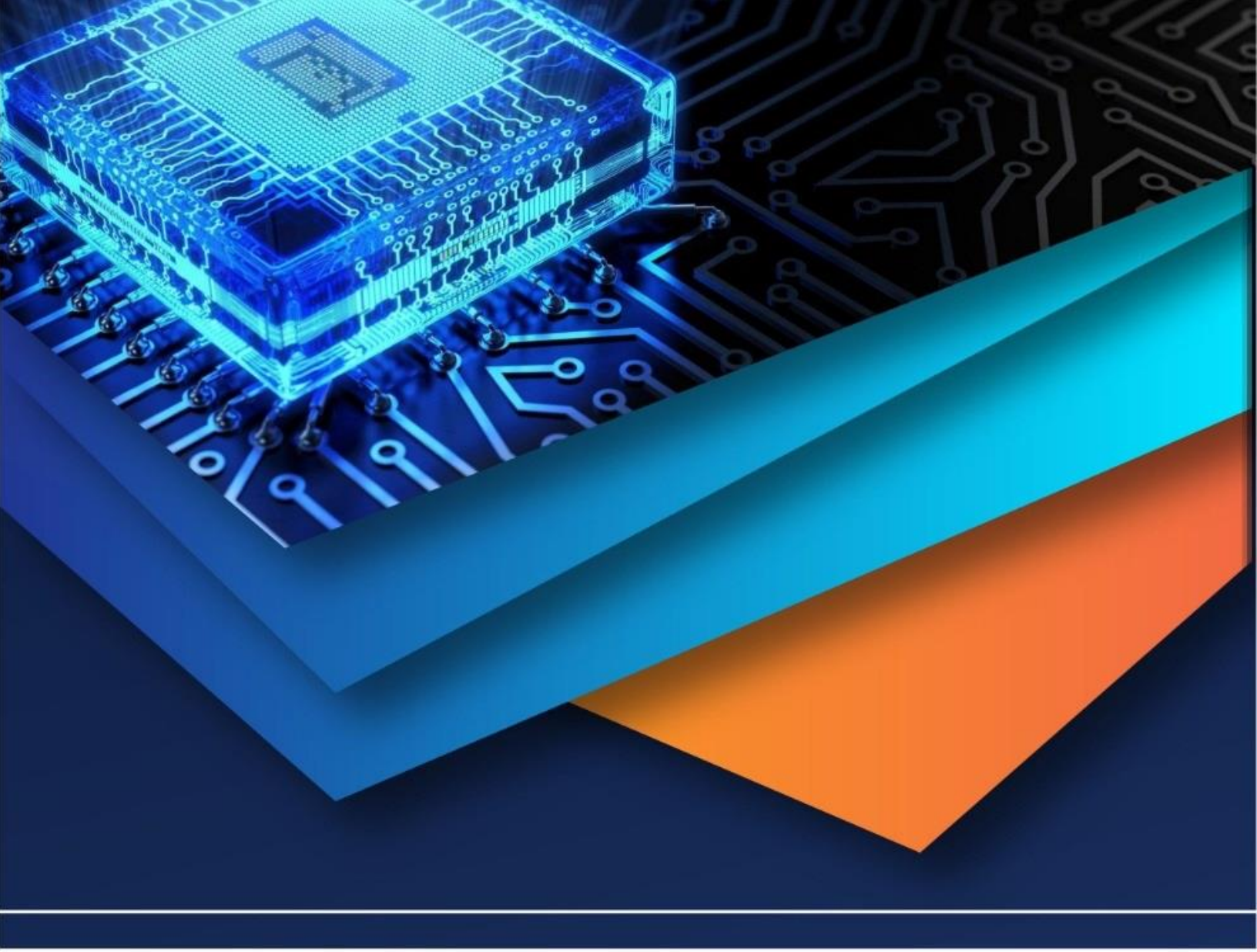

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