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An Experimental Investigation on Strength of Concrete with Combination of Sisal and Steel Fiber

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Abstract: ***In conventional concrete, micro crack develop before structure is loaded because of dry Shrinkage and other cause of volume change. When the structure is loaded, the micro cracks Open up and propagate because of development of such micro-cracks, results in inelastic Deformation in concrete. Concrete is strong in compression and weak in tension, in order to overcome this weakness fiber is mixed with concrete. fiber reinforced concrete is Cementing concrete reinforced mixture with more or less randomly distributed small fibers. In this research work two fibers named Sisal fibers and steel fibers are being taken and combination of the fibers is used in concrete. The present work is carried out to evaluate the Compressive as well as tensile strength of concrete using the combination of sisal (0%,0.5%,1%,1.5%,2%) and steel fibers(0%,0.5%,1%,1.5%,2%) with different proportion. By using different fiber content, effects on strength of the concrete specimen for various combinations is study and find the optimum fiber content for best result. For the study of effect of combination of steel and sisal fibers, M20 concrete mix design is used.***

Keywords: Sisal, Steel

I. INTRODUCTION

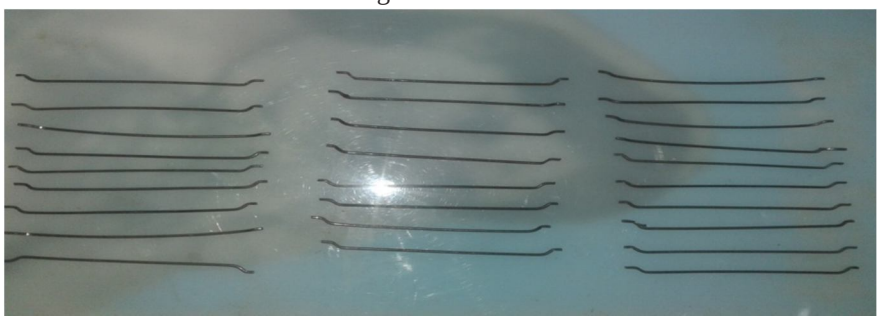
Plain concrete possesses a very low tensile strength, limited ductility and little resistance to cracking. Internal micro cracks are inherently present in the concrete and its poor tensile strength is due to the propagation of such micro cracks, eventually leading to brittle fracture of the concrete. In the past, attempts have been made to impart improvement in tensile properties of concrete members by way of using conventional reinforced steel bars and also by applying restraining techniques. Although both these methods provide tensile strength to the concrete members, they however, do not increase the inherent tensile strength of concrete itself. In plain concrete and similar brittle materials, structural cracks (micro-cracks) develop even before loading, particularly due to drying shrinkage or other causes of volume change. The width of these initial cracks seldom exceeds a few microns, but their other two dimensions may be of higher magnitude.

Fiber is a natural or synthetic string. Fibers are a class of hair like material that is continuous illuminated or are in discrete elongated pieces, similar to pieces of thread. To overcome the weakness of concrete, fibers is used in concrete. It has been recognized that the addition of small, closely spaced and uniformly dispersed fibers to concrete would act as crack arrester and would substantially improve its static and dynamic properties. This type of concrete is known as Fiber Reinforced Concrete. Fiber reinforced concrete can be defined as a composite material consisting of mixtures of cement, mortar or concrete and discontinuous, discrete, uniformly dispersed suitable fibers. Continuous meshes, woven fabrics and long wires or rods are not considered to be discrete fibers. Although every type of fiber has been tried out in cement and concrete, not all of them can be effectively and economically used. Each type of fiber has its characteristic properties and limitations. From last few decades natural fibers used in concrete to improve the strength of the concrete. In this experiment natural fiber named sisal is used with steel fibers. In this experiment sisal fibers and steel fibers use and behavior of concrete is evaluate for different tests.

Plant Fibers - Sisal (Agave sisalana) Sisal is a hard fiber extracted from the leaves of sisal plants which are perennial succulents that grow best in hot and dry areas.Sisal is an environmentally friendly fiber as it is biodegradable and almost no pesticides or fertilizers are used in its cultivation. Sisal is composed many chemical composition. Cellulose is the main component of sisal fibers.


Fig.1 Sisal Fiber Agave Sisalana

Steel fiber is one of the most commonly used fibers. Generally, round fibers are used. The Diameter may vary from 0.25 to 0.75 mm. The steel fiber is likely to get rusted and lose some of its strengths. But investigations have shown that the rusting of the fibers takes place only at the surface. Use of steel fiber makes significant improvements in flexural, impact and fatigue Strength of concrete. It has been extensively used in various types of structures, particularly for overlays of roads, airfield pavements and bridge decks. Thin shells and plates have also been constructed using steel fibers.



Hooked end steel fiber

II. MATERIAL USED IN EXPERIMENT

A. *Cement*

Ordinary Portland cement (OPC) of grade 53 conforming to IS 12269-2013 is used

B. *Fine Aggregate*

The fine aggregate used was locally available river sand conforming to IS:383-2016.the fine aggregate was tested for its physical requirements such as gradation, specific gravity etc. zone of the F.A is zone II and SP.GR is 2.70

C. *Coarse Aggregate*

The crushed coarse aggregate obtained from local crushing plant is used. size of the coarse aggregate used in experiment is 10mm to 20mm conforming to IS: 383-2016. Specific gravity of C.A is 2.74 tested in accordance with IS: 2386.

D. *Water*

Portable water is used for experiment work.

E. *Sisal Fiber*

Sisal fiber cut into small length for used of experiment work. length of the sisal fiber is 15 to 20mm throughout the experiment work.

F. *Steel Fiber*

Hooked end Steel fiber with aspect ratio 72 is used throughout the experiment work.

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III. OBJECTIVE

Using the combination of steel and sisal fiber as reinforcing material to improve the strength of concrete and achieve the optimum value content of fibers to get maximum strength of concrete. Steel fibers are use in different proportion 0.5%,1%,1.5%,2% by weight of concrete and sisal fibers are used in different proportion 0.5%,1%,1.5%,2% by weight of cement and investigate strength properties of concrete by performing various tests. compressive strength (7 & 28Days), split tensile strength (28 Days),flexural strength (28 Days)

IV. EXPERIMENTAL METHOLOGY

A. Concrete Mix design

In this experiment study different mixes with different fiber combination are designed for M20 grade of concrete as per IS: 10262-2009.

B. Preparation and Testing of Specimen

Based on different mixes, cubes(150mm x 150mm x 150mm) for compression test, cylinder (300mm x 150mm) for split tensile test and prism (500mm x 100mm x 100mm) for flexure test were casted for each mix. A set of 3 specimens as a average has been prepare for each mix and each test and cured.

Table 1
Detail of mixing

Identification mark	Sisal fiber(%)	Steel fiber(%)
Mix 1	0	0
Mix 2	0	0.5
Mix 3	0	1.0
Mix 4	0	1.5
Mix 5	0	2
Mix 6	0.5	0
Mix 7	0.5	0.5
Mix 8	0.5	1.0
Mix 9	0.5	1.5
Mix 10	0.5	2
Mix 11	1.0	1..0
Mix 12	1.0	0.5
Mix 13	1.0	1.0
Mix 14	1.0	1.5
Mix 15	1.0	2
Mix 16	1.5	0
Mix 17	1.5	0.5
Mix 18	1.5	1.0
Mix 19	1.5	1.5
Mix 20	1.5	2
Mix 21	2.0	0
Mix 22	2.0	0.5
Mix 23	2.0	1.0
Mix 24	2.0	1.5
Mix 25	2.0	2

V. RESULT AND DISCUSSION

A. *Fresh Concrete Properties*

Table 2
Fresh concrete properties

Identification mark	Sisal fiber(%)	Steel fiber(%)	Slump (mm)
Mix 1	0	0	70
Mix 2	0	0.5	68
Mix 3	0	1.0	67
Mix 4	0	1.5	64
Mix 5	0	2	61
Mix 6	0.5	0	68
Mix 7	0.5	0.5	65
Mix 8	0.5	1.0	64
Mix 9	0.5	1.5	63
Mix 10	0.5	2	60
Mix 11	1.0	0.0	67
Mix 12	1.0	0.5	65
Mix 13	1.0	1.0	63
Mix 14	1.0	1.5	61
Mix 15	1.0	2	59
Mix 16	1.5	0	66
Mix 17	1.5	0.5	64
Mix 18	1.5	1.0	63
Mix 19	1.5	1.5	59
Mix 20	1.5	2	56
Mix 21	2.0	0	59
Mix 22	2.0	0.5	56
Mix 23	2.0	1.0	55
Mix 24	2.0	1.5	53
Mix 25	2.0	2	48

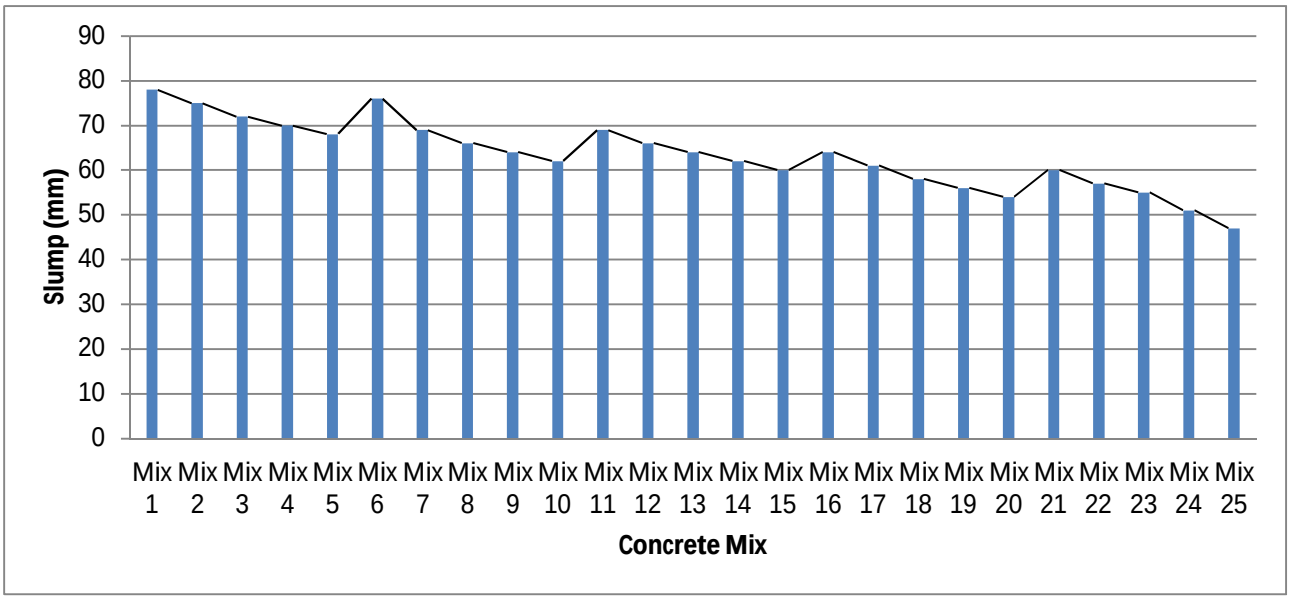

Fig.4Slump Test Result

B. Harden Concrete Properties

Hardened properties of M20 grade of concrete are shown in Table 3.

Table 3

Identification mark	Sisal fiber(%)	Steel fiber(%)	Compressive strength (N/mm^2)		Split tensile strength (N/mm^2)	Flexure strength (N/mm^2
			7 Days	28 Days	28 Days	28 Days
Mix 1	0	0	18.90	28.67	2.84	3.69
Mix 2	0	0.5	19.9	30.39	2.93	4.53
Mix 3	0	1.0	20.92	32.64	3.07	5.16
Mix 4	0	1.5	21.81	36.12	3.32	5.39
Mix 5	0	2	22.86	39.75	3.51	5.95
Mix 6	0.5	0	18.86	29.84	2.84	3.85
Mix 7	0.5	0.5	19.82	32.19	3.04	4.68
Mix 8	0.5	1.0	20.33	34.59	3.22	5.33
Mix 9	0.5	1.5	21.01	37.79	3.51	5.84
Mix 10	0.5	2	21.6	41.73	3.98	6.37
Mix 11	1.0	0.0	19.01	30.41	2.90	3.91
Mix 12	1.0	0.5	19.90	33.01	3.24	5.91
Mix 13	1.0	1.0	21.10	35.70	3.43	5.60
Mix 14	1.0	1.5	22.78	39.27	3.71	5.97
Mix 15	1.0	2	23.4	42.99	4.10	6.47
Mix 16	1.5	0	19.39	32.15	2.96	4.24
Mix 17	1.5	0.5	20.10	34.04	3.35	5.01
Mix 18	1.5	1.0	20.80	36.79	3.62	5.85
Mix 19	1.5	1.5	21.56	39.99	3.86	6.19
Mix 20	1.5	2	22.06	43.26	4.21	6.49
Mix 21	2.0	0	18.74	31.5	2.77	3.72
Mix 22	2.0	0.5	19.59	33.33	3.15	4.81
Mix 23	2.0	1.0	19.90	35.85	3.49	5.57
Mix 24	2.0	1.5	20.64	38.93	3.63	6.00
Mix 25	2.0	2	21.20	41.63	3.77	6.45

C. Compressive Strength Test

It has been seen that compressive strength of concrete increase up to 50% as compared to conventional concrete for combination of 1.5% sisal and 2% steel..

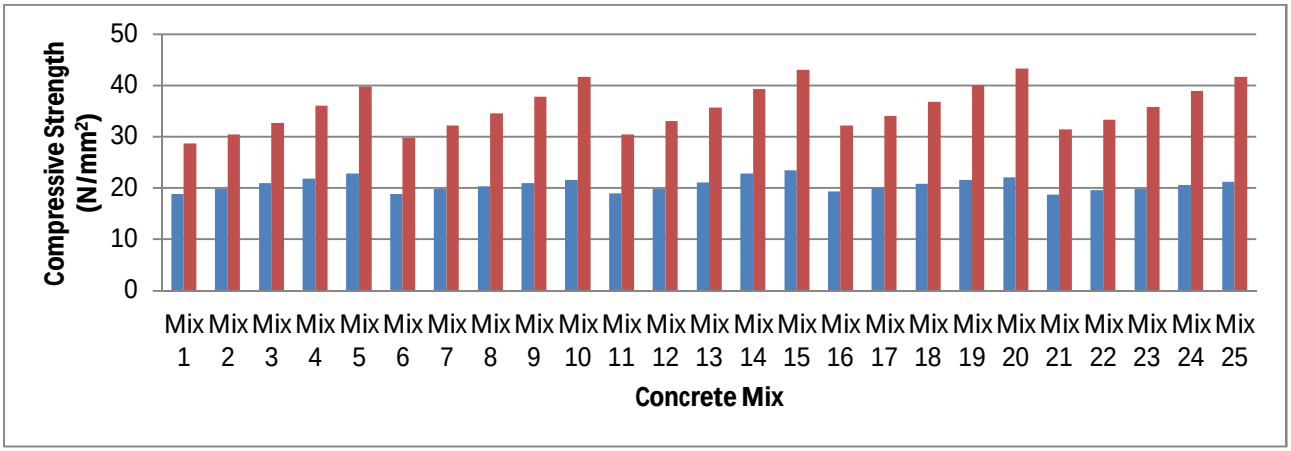

Fig.5 Compressive strength Test Results of concrete Mix at 7&28 Days

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D. Spilt Tensile Test

It has been observed that split tensile of concrete increase up to 48.23% as compared to conventional concrete for combination 1.5% sisal fiber and 2% steel fiber.

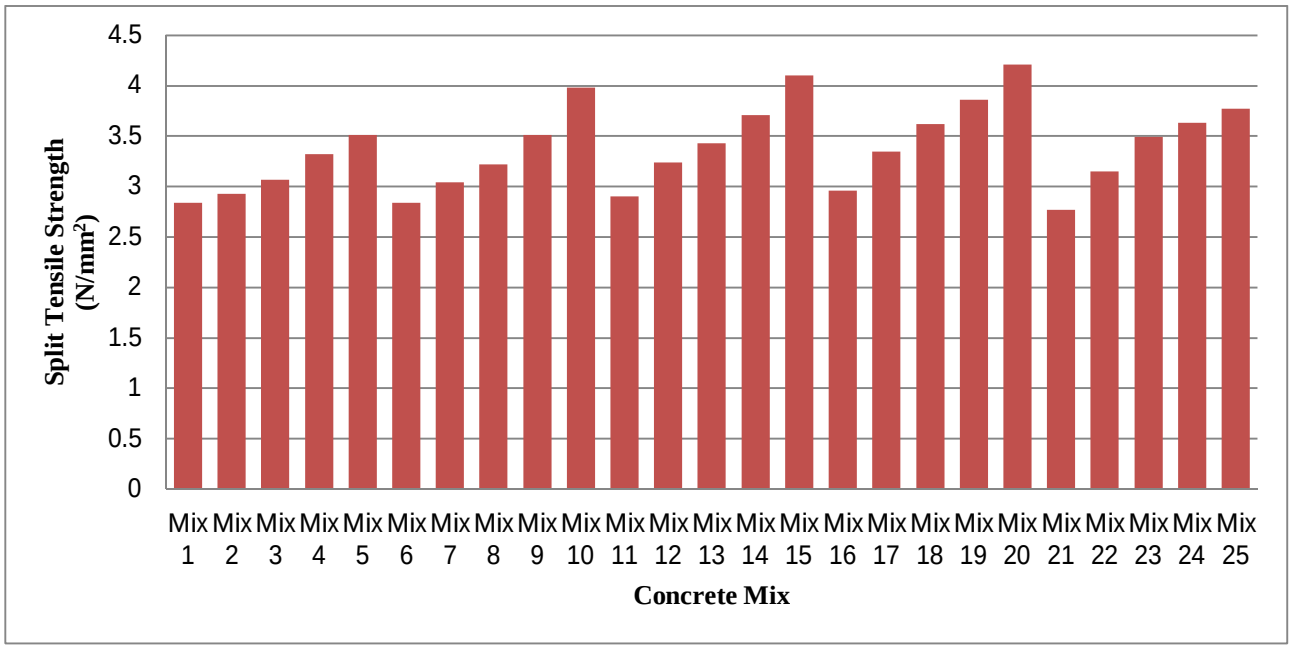

Fig.6 Split Tensile Strength Test Results at 28 Days

E. Flexural Strength Test

It has been observed that split tensile of concrete increase up to 75.88% as compared to conventional concrete for combination 1.5% sisal fiber and 2% steel fiber.

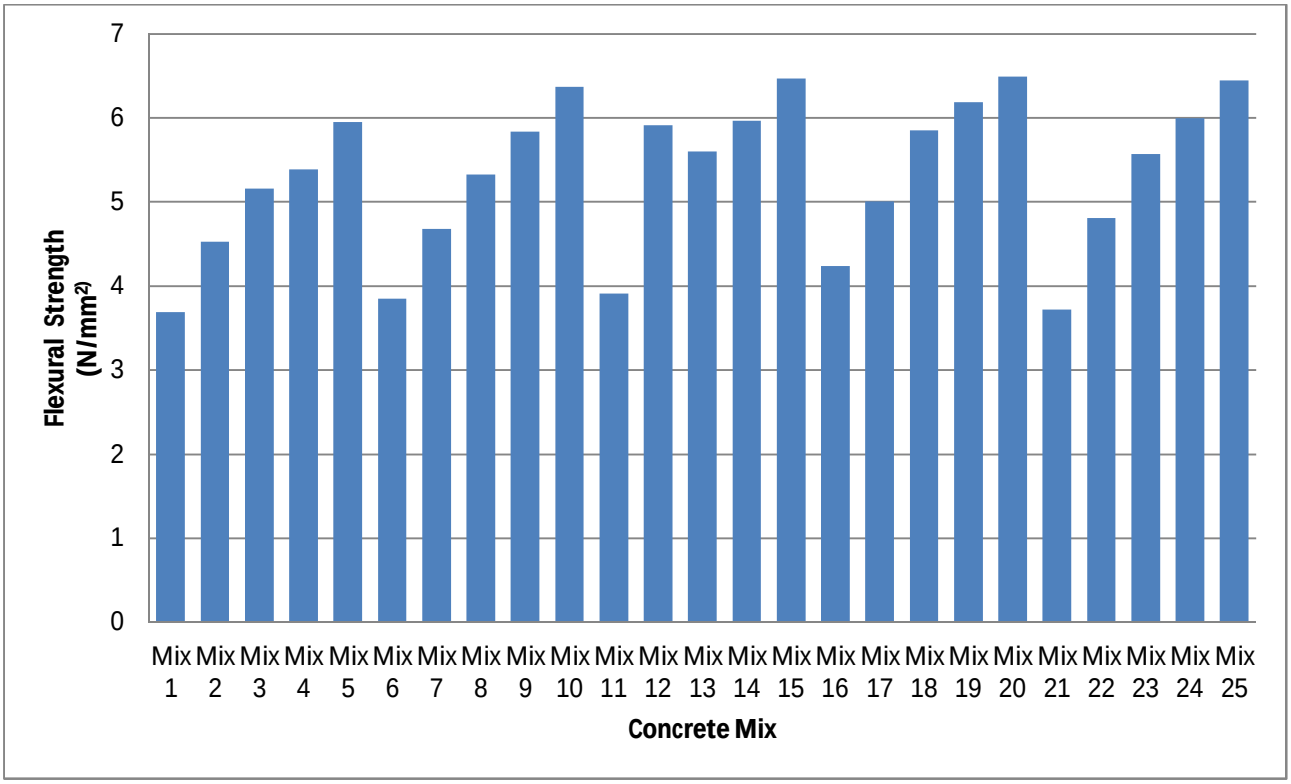

Fig.7 Flexure Strength Test Results at 28 Days

VI. CONCLUSION

Concrete is strong in compression zone and weak in tension zone. To improve the properties of concrete in tension zone, in present research work M20 grade concrete is use with combination of sisal and steel fiber in different proportion. Different tests were performed like compressive test, split tensile test, And flexure test to evaluate the behavior of concrete. After performing the experiment following conclusion can be drawn….

A. From results,it can be concluded that compressive strength of the concrete increase 50%, split tension strength of concrete increase 48.23%, flexural strength of concrete increase 75.88% for fiber content 1.5% sisal and 2% steel as compare to conventional concrete at 28 days.further increase the content of fibers strength of concrete is reduce.

B. It has been obsrved during the experiment,steel fiber does not affect the workability much more but sisal fiber affect the workability.it has been seen that increaseing the content the sisal fiber workability decrease.to increase the workability at high content of sisal fiber superplasticizer is used.

C. It has been seen from the experiment performed behaviour of concrete, use of sisal and steel fiber in concrete,it improve the properties of concrete mainly in tension zone,in which concrete is weak. Further increaseing fiber content it seems that strength of the concrete is decrease.sisal fiber is natural type fiber,using this fiber in concrete we can achive the concept of GO GREEN BUILDING,and encourage the enviourment friendly construction activities.experimental results seems that use of fibers in structural members,amount of reinforcement bars canbe reduce,due to this overall weight of the structure is reduce without any compromis with quality of concrete.

VII. ACKNOWLEDGEMENT

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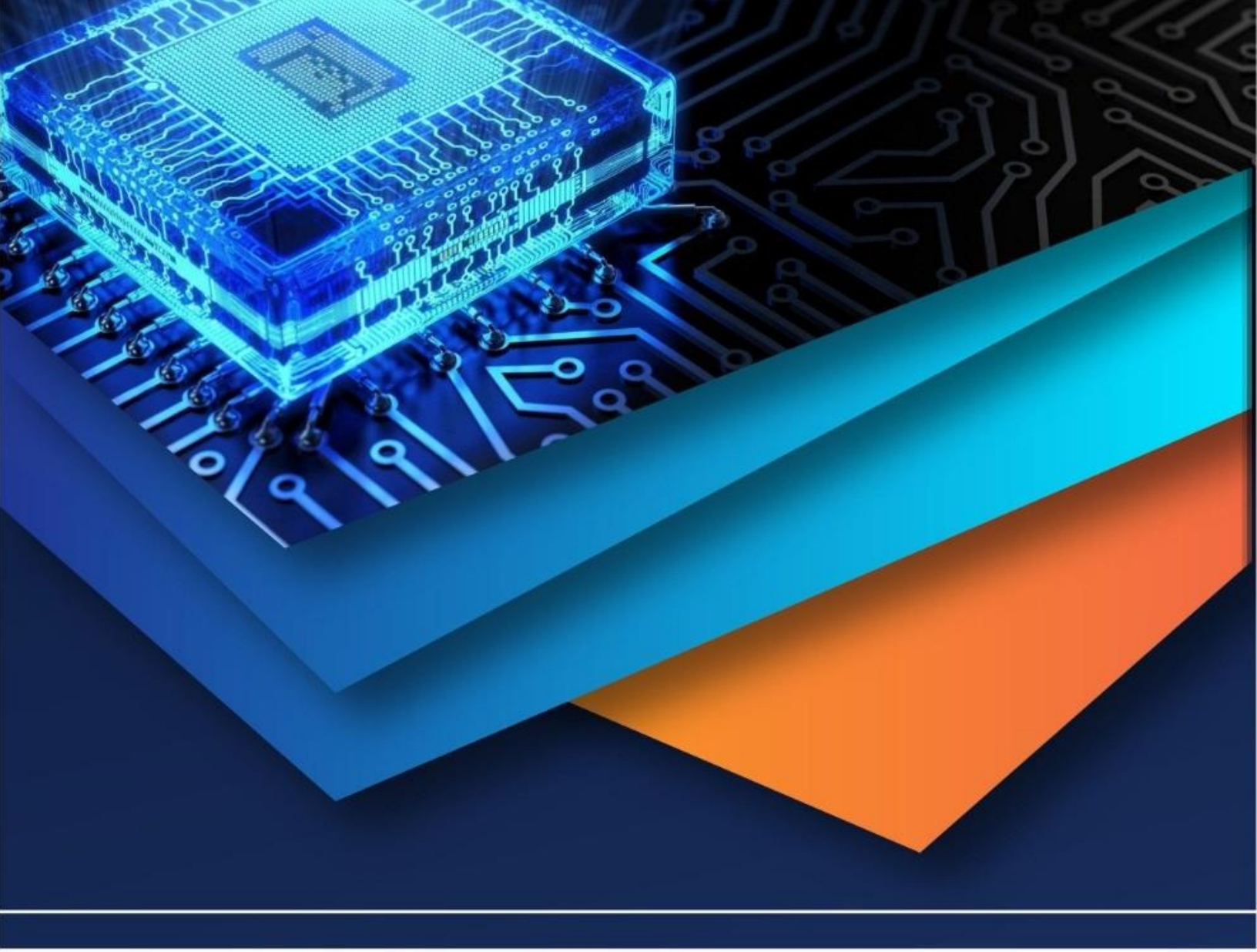

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