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Experimental Study of Light Weight Concrete Using Natural Fiber

Singh Manindra Kumar[1] , Chandraul Kirti[2] , Saxena Anil Kumar[3] , Arora T. R.[4]
[1] M.Tech. Student, [2] M.Tech. Student, [3] Associate Professor, [4]Head Of Department
[1,2,3,4]Lakshmi Narayan College of Technology, Department of Civil, Bhopal

Abstract *- The overall goal of this research is to investigate the behavioural study of natural fibre in concrete structure. The coir fibre recently attracted an interest as a sustainable fibre composite material, due to some specific mechanical property which can be compared to artificial fibre. The Coir fibre is treated using natural latex before using in concreteso that it is not be affected by moisture content presented in concrete. In this experimental study of 28 days the compressive strength and tensile strength are carried out using different coir fibre length of 6mm, 12mm and 19mm of different percentage as15%, 25% and 35% with water cement ratio 0.5.Encouragement should be given for the use of natural fibres which are locally available materials, in the field of civil engineering.*
Key words: Coir Fibre, Composite Materials, slump value, compressive and tensile strength.

I. INTRODUCTION

COIR is a versatile natural fiber extracted from monocarp tissue, or husk of the coconut fruit. Generally fiber is of golden colour when cleaned after removing from coconut husk; and hence the name "The Golden Fiber". Coir is the fibrous husk of the coconut shell. Being tough and naturally resistant to seawater, the coir protects the fruit enough to survive months floating on ocean currents to be washed up on a sandy shore where it may sprout and grow into a tree, if it has enough fresh water, because all the other nutrients it needs have been carried along with the seed. These characteristics make the fibers quite useful in floor and outdoor mats, aquarium filters, cordage and rope, and garden mulch. A coconut harvest occurs once in 45 days. From 1000 coconuts it would be possible to extract 10 kg of coir. Among vegetable fibers, coir has one of the highest concentrations of lignin, making it stronger but less flexible than cotton and unsuitable for dyeing. The tensile strength of coir is low compared to abaca, but it has good resistance to microbial action and salt water damage and needs no chemical treatment.

A. Production And Trade

The coir industry is fully developed only in India and Sri Lanka, but economically important in Brazil, Indonesia, the Philippines and Vietnam. Coconuts are typically grown by small-scale farmers, who use local mills for fiber extraction. Globally around 650 000 tones of coir are produced annually, mainly in India and Sri Lanka. India and Sri Lanka are also the main exporters, followed by Thailand, Indonesia, Malaysia, Vietnam, and the Philippines. Around 80 percent of the coir produced is exported in the form of raw fiber. Smaller quantities are exported as yarn, mats, matting and rugs. Total world coir fiber production is 250,000 tones. The coir fiber industry is particularly important in some areas of the developing world. India, mainly the coastal region of Kerala State, produces 60% of the total world supply of white coir fiber. Sri Lanka produces 36% of the total world brown fiber output. Over 50% of the coir fiber produced annually throughout the world is consumed in the countries of origin, mainly India.

Table1. Physical properties of Coir Waste

Electrical conductivity(milliohms/cm	0.4-1
Ph	5.5-6.1
Porosity	82%
Bulk density (Kg/m)	70-80
Macro pores(Airspaces)	16 -20%
Micro pores (Water holding)	63-70%

Table2.Nutrient content in raw coir waste:-

Composition	Content
Nitrogen	0.26%
Organic carbon	29%
C: N ratio	100:01:00
Lignin	31%
Cellulose	27%
Hemicellulose	47%
Potassium	0.78%
Phosphorus	0.01%
Iron (ppm)	0.07
Reducing sugar	4%

II. MATERIAL AND METHODOLOGY

A. *Ordinary Portland Cement*

Ordinary Portland Cement confirming the requirements of IS: 1489 (Part1)-1991.is used for the present experimental work. OPC 43 Grade cement is used.

B. *Natural Fiber: Coconut Coir*

Coconut Shell is cut in length of 6mm, 12mm and 19mm, then soaked for 12 hours before use. Polypropylene fiber cut in the same length as coir fiber. The fibers added by volume of cement in various percentages. Fiber is added in concrete as reinforcement in various percentages such as 15%, 25% and 35% of cement.

C. *Fine Aggregate*

Fine aggregate was purchased which satisfied the required properties of fine aggregate required for experimental work and the sand conforms to zone II as per the specifications of IS 383:1970.

D. *Coarse Aggregate*

Crushed granite of 20 mm maximum size has been used as coarse aggregate. The sieve analysis of combined aggregates confirms to the specifications of IS 383: 1970 for graded aggregates.

E. *Water*

Combining water with a cementitious material forms a cement paste by the process of hydration. The cement paste glues the aggregate together, fills voids within it, and makes it flow more freely.

III. METHODOLOGY

The light weight reinforced concrete is prepared by using natural fibers. The Natural fiber which is used is coconut coir. The coir fiber is obtained from the temples of 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: 1.51: 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.

IV. TESTING

Strength of concrete is done to determine the various properties of concrete when coir fiber is used as reinforcement by volume of cement. The coconut coir is socked for 12hours before use and Material properties are found. Compressive and tensile

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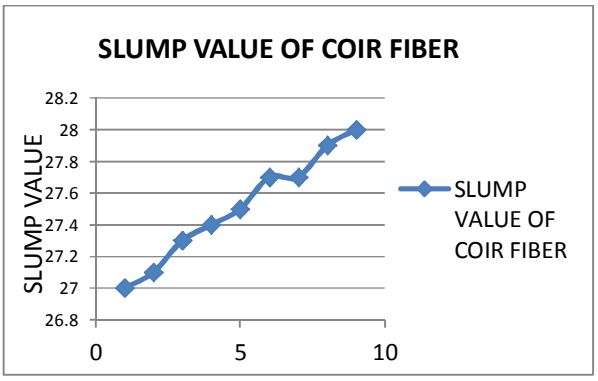
Strength properties were analyzed by conducting compressive strength test as per IS: 516 - 1959 and tensile strength test as per IS: 5816 – 1999 on 7th, 14th and 28th day. The strength property of concrete reinforced with coconut coir is analysed. The strength property of concrete is improved by fiber reinforcement.

V. RESULTS AND DISCUSSION

A. *Slump Cone (Workability Test)*

Table 3. Slump cone value Of Coir Fiber.

	N1	N2	N3	N4	N5	N6	N7	N8	N9
Slump Value	27.0	27.1	27.3	27.4	27.5	27.7	27.7	27.9	28.0
Slump	3.00	2.90	2.70	2.60	2.50	2.30	2.30	2.10	2.00



Graph1. Slump cone value of coir fiber

B. *Compressive strength test:*

Name	Ratio Of Coir Fiber	Size	AMOUNT(Kg/m3)				7 Day Kg/m2	14Day Kg/m2	28Day Kg/m2
			Cement	Sand	Aggr.	PP fiber			
N1	15 %	6 mm	384.35	580.4	1176.1	57.65	16.8	18.6	32.4
N2	25 %	6 mm	384.35	580.4	1176.1	96.1	16.9	18.8	33.7
N3	35 %	6 mm	384.35	580.4	1176.1	134.5	17.4	19.3	33.9
N4	15 %	12 mm	384.35	580.4	1176.1	57.65	17.3	18.5	34.3
N5	25 %	12 mm	384.35	580.4	1176.1	96.1	17.5	19.2	34.9
N6	35 %	12 mm	384.35	580.4	1176.1	134.5	17.8	19.8	35.2
N7	15 %	19 mm	384.35	580.4	1176.1	57.65	18.4	20.4	35.3
N8	25 %	19 mm	384.35	580.4	1176.1	96.1	18.8	20.7	35.4
N9	35 %	19 mm	384.35	580.4	1176.1	134.5	19.7	21.2	35.9

Table.4 Compressive Strength Test Of Coir Fiber.

Table 4 shows the variation of compressive strength of conventional, coir fibrous concrete against age of curing. From the figure it is observed that, all the three mixes exhibit increase in strength over the curing age period. Among all the mixes, coir fibrous concrete mix possesses the highest strength at all the ages. The conventional concrete specimen shows a compressive strength of 30.64 MPa at 28 days curing. The coir fiber concrete specimens show higher compressive strength when in longer fiber and more percentage of fiber as shown in table4.

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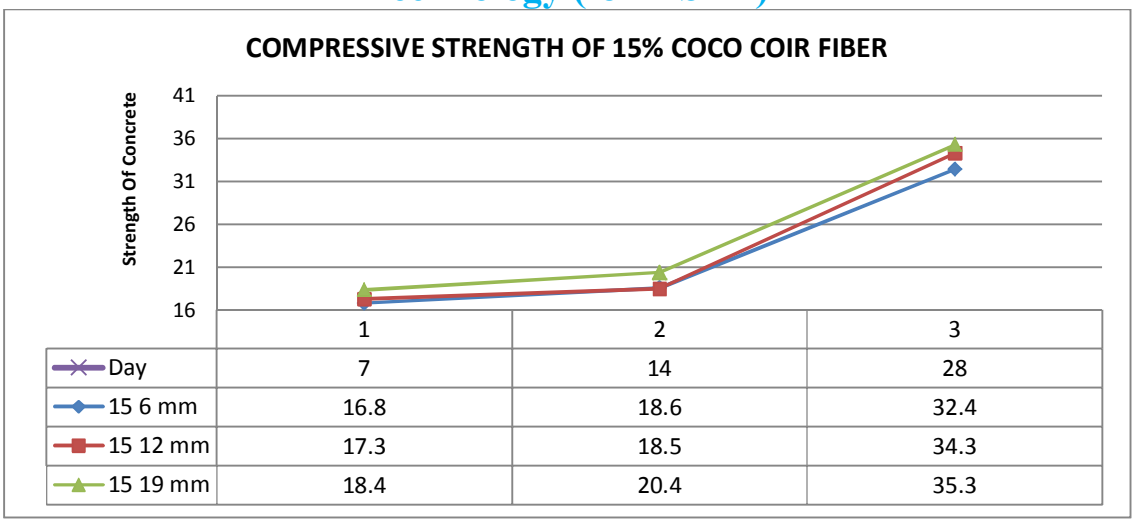
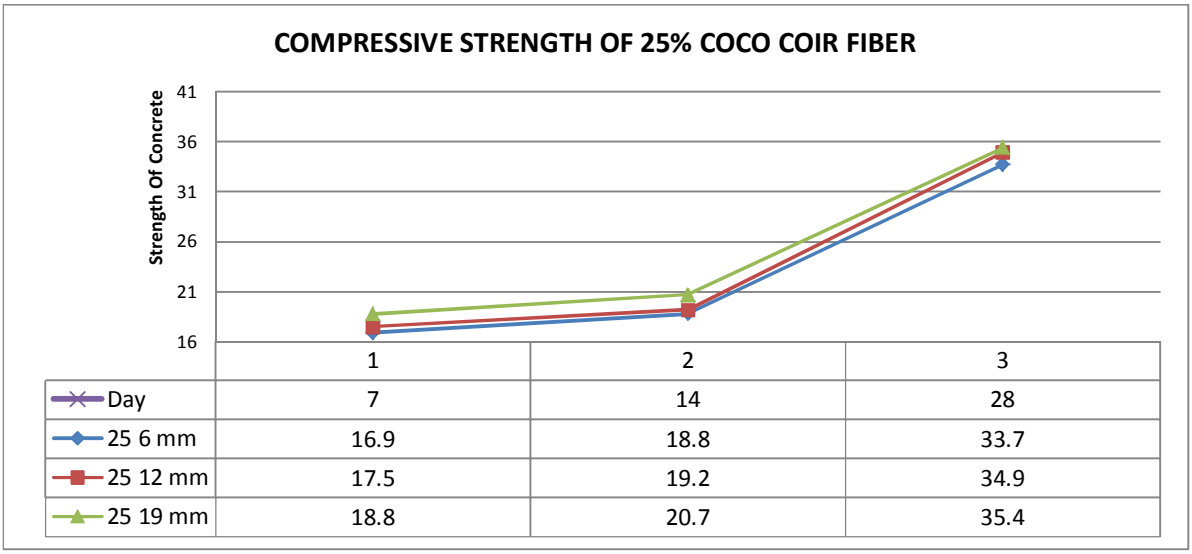


Day	1	2	3
	7	14	28
15 6 mm	16.8	18.6	32.4
15 12 mm	17.3	18.5	34.3
15 19 mm	18.4	20.4	35.3

Graph2. Compressive strength of 15% coir fiber

From the graph 2 that for controlled cube, the compressive strength of 15% of PP fiber reinforced concrete with size of 19mm gives better result, its strength is increases from 18.4 N/mm2 at 7 day to 35.3 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 30N/mm2 for grade M30 concrete as shown in Graph 2**.**



Day	1	2	3
	7	14	28
25 6 mm	16.9	18.8	33.7
25 12 mm	17.5	19.2	34.9
25 19 mm	18.8	20.7	35.4

Graph3. Compressive strength of 25% coir 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 18.8 N/mm2 at 7 day to 35.4 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 30N/mm2 for grade M30 concrete as shown in Graph 3**.**

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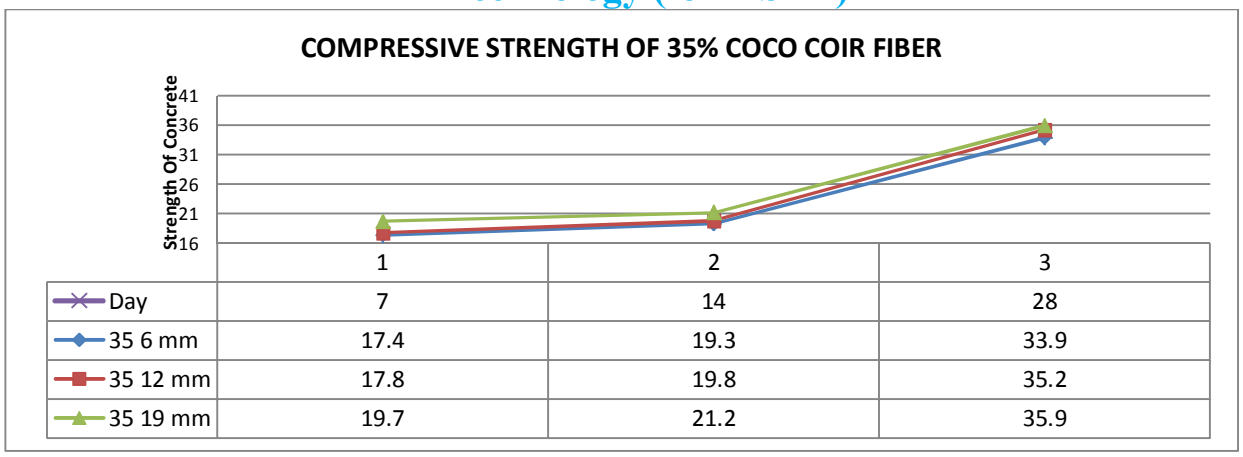


Graph4. Compressive strength of 35% coir fiber

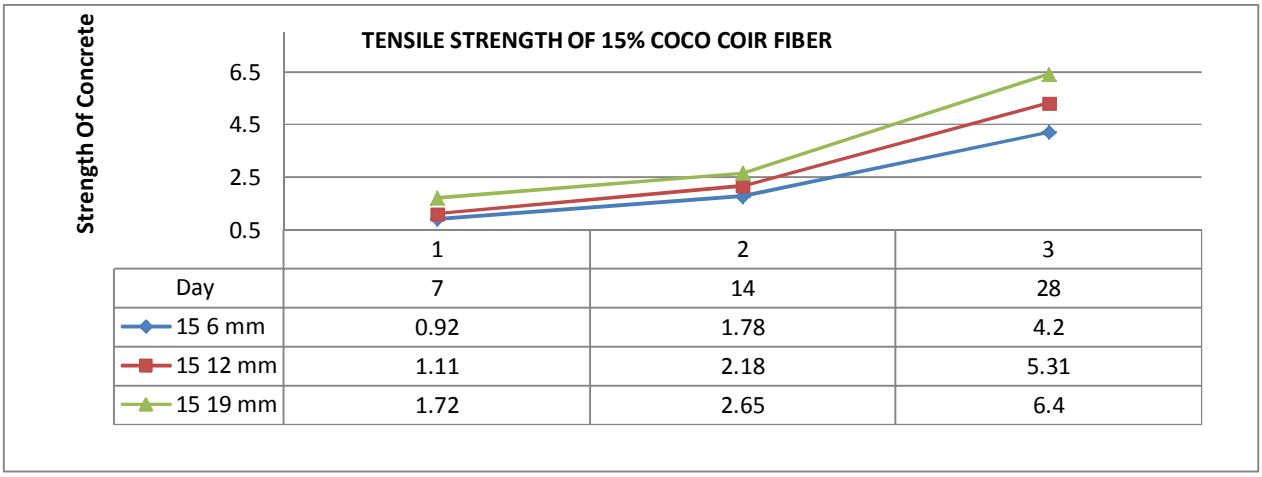
From the graph4 that for controlled cube, the compressive strength of 35% of PP fiber reinforced concrete with size of 19mm gives better result, its strength is increases from 19.7 N/mm2 at 7 day to 35.7 N/mm2 at 28days. The compressive strength increased as the no. Of days of curing increased for each percentage and size of fiber. The strength was above the specified value of 30N/mm2 for grade M30 concrete as shown in Graph 4.

C. Tensile strength test:

Table 5.Tensile Strength Test Of Coir Fiber.

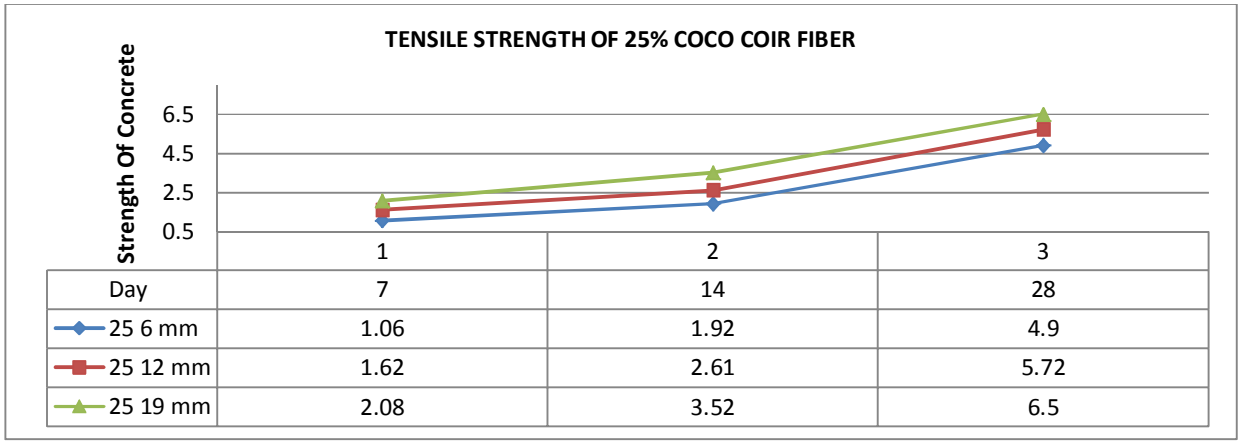
Name	Ratio Of Coir Fiber	Size	7 Day	14 Day	28 Day
N1	15 %	6 mm	0.92	1.78	4.2
N2	25 %	6 mm	1.06	1.92	4.9
N3	35 %	6 mm	1.13	2.07	5.6
N4	15 %	12 mm	1.11	2.18	5.31
N5	25 %	12 mm	1.62	2.61	5.72
N6	35 %	12 mm	1.79	2.80	6.32
N7	15 %	19 mm	1.72	2.65	6.4
N8	25 %	19 mm	2.08	3.52	6.5
N9	35 %	19 mm	2.56	3.91	6.9

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 1.72 N/mm2 at 7 day to 6.4 N/mm2 at 28days.



Graph5. Tesile strength of 15% coir fiber

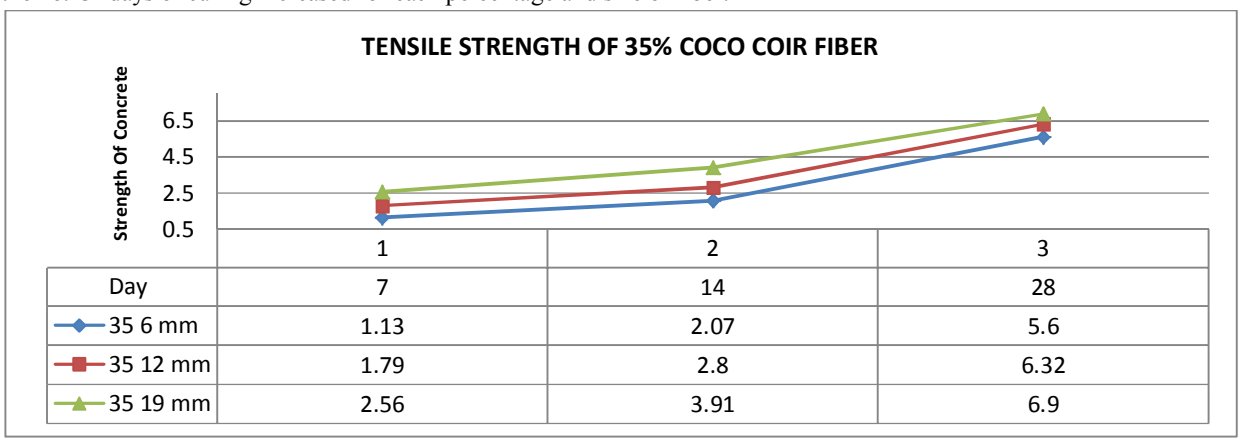
The compressive strength increased as the no. Of days of curing increased for each percentage and size of fiber.



	1	2	3
Day	7	14	28
25 6 mm	1.06	1.92	4.9
25 12 mm	1.62	2.61	5.72
25 19 mm	2.08	3.52	6.5

Graph6. Tensile strength of 25% coir 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 2.08 N/mm2 at 7 day to 6.5 N/mm2 at 28days. The compressive strength increased as the no. Of days of curing increased for each percentage and size of fiber.



	1	2	3
Day	7	14	28
35 6 mm	1.13	2.07	5.6
35 12 mm	1.79	2.8	6.32
35 19 mm	2.56	3.91	6.9

Graph7. Tensile strength of 35% coir fiber

From the graph7 that for controlled cube, the tensile strength of 35% of PP fiber reinforced concrete with size of 19mm are increases from 2.56 N/mm2 at 7 day to 6.9 N/mm2 at 28days. The compressive strength increased as the no. Of days of curing increased for each percentage and size of fiber.

VI. CONCLUSIONS

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

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

C. Using coir fiber in civil construction reduces environmental pollution factor and may also bring several improvement in concrete characteristic. Coir fiber used in cement improves the resistance of concrete from sulphate attack.

D. Compressive strength of material increases with increasing fibre content. Strength enhancement ranges from 15% to 35% for FRC.

E. Strength enhancement in splitting tensile strength due to fibre addition varies from 15% to 35%. Split tensile strength at 28days is approximately 35.9% higher conventional Concrete for Coir fiber respectively.

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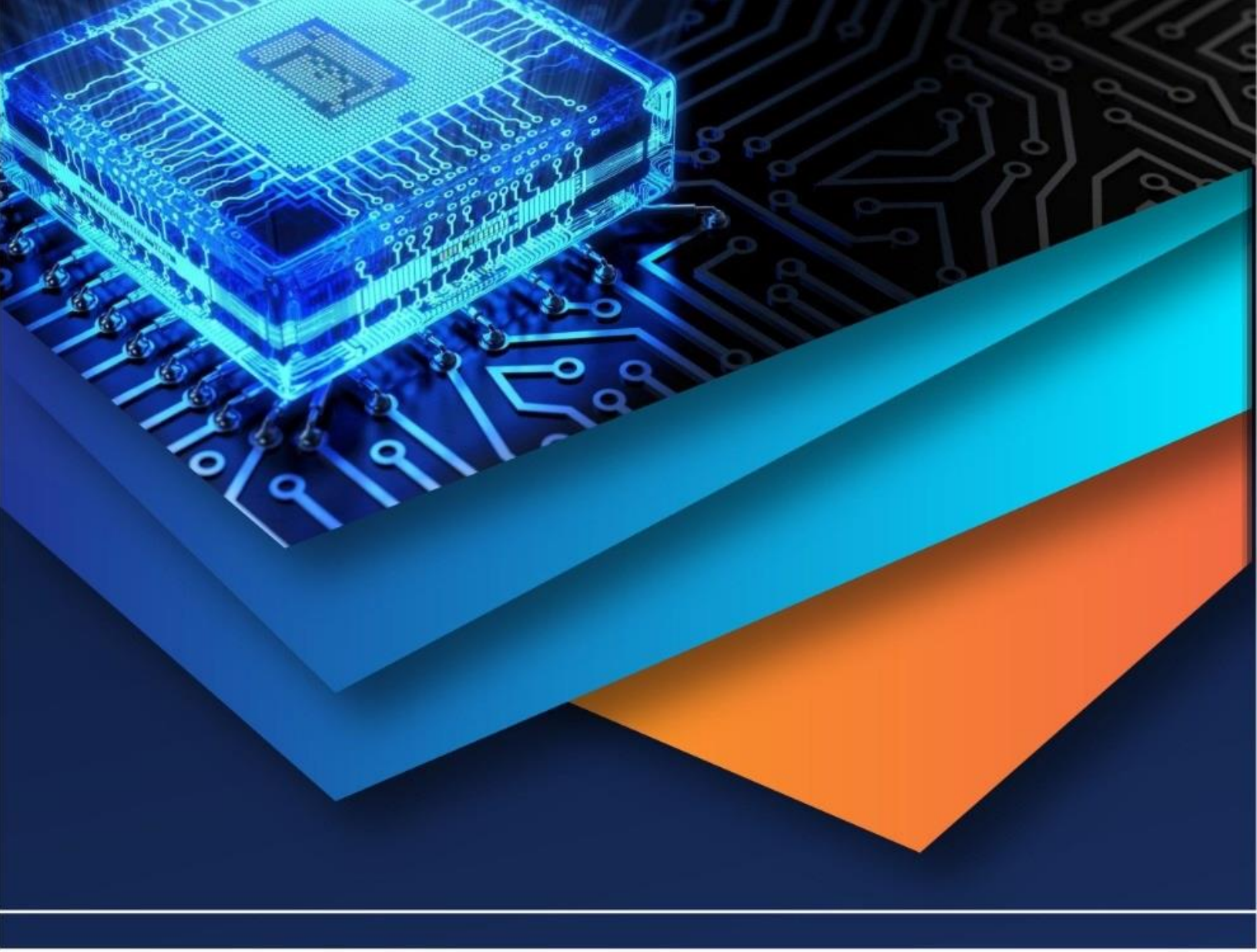

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