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Study on Mechanical Properties of Light Weight Vermiculite Concrete by Partially Replacing Cement with GGBS and Dolomite

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***Abstract:** This research aims to determine the mechanical properties of light weight vermiculite concrete of M_{30} grade by partial replacement of cement with GGBS and Dolomite In this study two different concrete mixes were prepared with partial replacement of cement with 40% of GGBS and fine aggregate with varying proportions of vermiculite of 0%,5%, 10%,15%,20% and 25% and another set of concrete mixes were prepared with partial replacement of cement with dolomite of 30% and fine aggregate with varying proportions of vermiculite of 0%,5%,10%,15%,20% and 25%.*
***Keywords:** Vermiculite Concrete, Light Weight Concrete, GGBS, Dolomite, Mechanical Properties*

I. INTRODUCTION

The construction unit is one among the greatest end user of unprocessed materials contemporary. To bear further demand it is necessary for a drastically reduce the consumption of materials in turn now lightweight concrete (LWC) is used in structures to diminish the dead load. Comprehensively. Considering the above the aggregates have been replaced with light weight aggregates like perlite, pumice, expanded clay, vermiculite dolomite etc. which on contrarily develops good mechanical and durable concrete. This paper direct to evaluate the researches to know durability aspects of light weight concrete using vermiculite as aggregate which possess the strength required.

II. LITERATURE REVIEW

A. M.V.S.S. Sastry, P.Ashveen Kumar, K.Jagannadha Rao (2018)

In this experimental investigation, the mechanical aspects of M20 grade concrete with varying percentages vermiculite at a extent of 0-100% with an addition of 20% as limited replacement with vermiculite to the absolute weight of fine aggregate(sand) along with mineral admixtures such as Ultra-fine Fly ash (UFA) and micro silica (SF) is reinstated with cement by disparate percentages i.e., from 5-15%, and Micro silica (SF) at 5%, 10% and 15% by gross weight of cement. The compressive strength no matter when is declining due to reinstatement of Exfoliated Vermiculite (EV), but a cost effective design was retrieved with 20% replacement to sand (fine aggregate).

B. M. Preethi, P. Ashveen Kumar, M.Hamraj(2021)

The present study focuses on the preparation of M30 grade concrete by replacing fine aggregate with 0%,5%,10%,15%,20%,25% of vermiculite and cement with 0% and 10% of constant silica fume to improve the performance of concrete. In the present study, an attempt is made to study the effect on acid exposure on strength and weight of concrete through experimentation. Concrete cubes of different mixes(12Nos) are casted and exposed to sulphuric acid of (pH=3). Cubes of size 100mm x 100mm x 100mm are cast with M30 grade of concrete, following which the cubes are immersed (cured) in water for 28 days. Next, the cubes are immersed in and sprayed with 4% concentrated Sulphuric acid for 7 days.

The cured cubes are then tested under compressive testing machine to determine their compressive strength Also, this project investigates the effects of FOSROC CONPLAST SP430, a water reducing super plasticizer on compressive strength and weight of concrete.

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C. M.Preethi, P. Ashveen Kumar, M.Hamraj(2021)

This paper aimed to compare the mechanical aspects of light weight concrete of M30 concrete with and without silica fume as replacement to cement by 10% along with sand as partial replacement of 0%, 5%, 10%,15%,20%and 25%variations of vermiculite.Specimens are tested for compressive strength using 10cm x 10cm x 10cm cubes for 7, 14 and 28 days flexural strength was determined by using 10cm x 10cm x 50cm prisms at 28 days and split tensile strength is determined using 15cm diameter and 30cm height cylinder specimens at 28 days The test show that it is possible to produce a natural light weight concrete with increase in mechanical properties using vermiculite and silica fume.

D. M.Preethi,P.Ashveen Kumar, M. Hamraj(2021)

The research study purpose is on the preparation of M30 grade concrete by partial replacement of fine aggregate with 0% to 25% of vermiculite with an increment of 5% and cement with 0% and 10% of constant silica fume to promote the achievements of concrete. In this experimental work an effort is made to know the effect of HCL acid exposure on strength and weight of concrete. Concrete cubes of different mix proportions are prepared and exposed to hydrochloric acid of (pH=5). Cubes of size 100mm x 100mm x 100mm are cast for M30 grade of concrete, following which the cubes are cured in water for 28 days. Next, the cubes are immersed with 4% concentrated Hydrochloric acid for 7 days in curing drum maintaining a pH of 5. The cured cubes are then tested for weight and to determine their compressive strength. Also, this project investigates the effects of FOSROC CONPLAST SP430, water reducing super plasticizer on compressive strength and weight of concrete.

III. RESULTS

The experimental setup is prepared to determine the mechanical properties of M30 grade concrete by partial replacement of fine aggregate with 0% to 25% of vermiculite with an increment of 5% and cement with GGBS and Dolomite. In this study two different concrete mixes are prepared M1 – M6 for replacement of cement with GGBS and M7 – M12 for replacement of cement with Dolomite.

Table 1: Basic proportions of materials for cement with GGBS replacement

Mix	Cement (kg)	GGBS (kg)	Fine Agg. (kg)	Vermi (kg)	Coarse Agg. (kg)	W/C	Water (litres)
M1	16.93	11.30	40.93	0.00	46.0	0.40	11.30
M2	16.93	11.30	38.89	2.04	46.0	0.40	11.30
M3	16.93	11.30	36.84	4.09	46.0	0.40	11.30
M4	16.93	11.30	34.79	6.14	46.0	0.40	11.30
M5	16.93	11.30	32.75	8.18	46.0	0.40	11.30
M6	16.93	11.30	30.70	10.23	46.0	0.40	11.30

Table 2: Basic proportions of materials for cement with Dolomite replacement

Mix	Cement (kg)	Dolomite (kg)	Fine Agg. (kg)	Vermi (kg)	Coarse Agg. (kg)	W/C	Water (litres)
M7	19.70	8.47	40.93	0	46.00	0.40	11.30
M8	19.70	8.47	38.89	2.04	46.00	0.40	11.30
M9	19.70	8.47	36.84	4.09	46.00	0.40	11.30
M10	19.70	8.47	34.79	6.14	46.00	0.40	11.30
M11	19.70	8.47	32.75	8.18	46.00	0.40	11.30
M12	19.70	8.47	30.70	10.23	46.00	0.40	11.30

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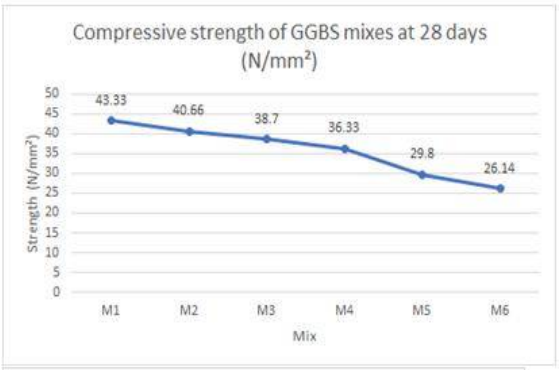
Table 3: Compressive Strength at 28 days (replacement of cement with GGBS)

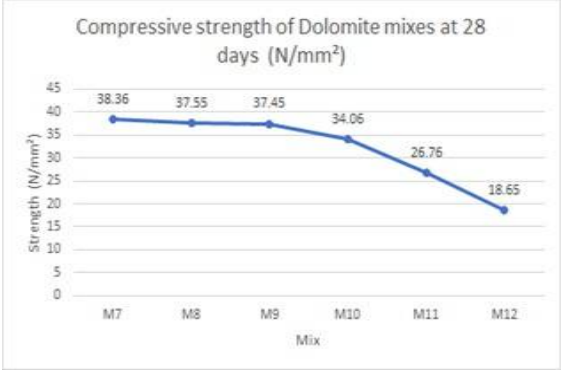
Mix	Weight (Kg)	Avg. Wt. (Kg)	Force (KN)	Area (mm^2)	Stress (N/mm^2)	Avg. Stress (N/mm^2)
M1	2.665	2.681	436	1000	43.60	43.33
	2.720		434	1000	43.40	
	2.660		430	1000	43.00	
M2	2.378	2.403	401	1000	40.10	40.66
	2.410		408	1000	40.80	
	2.423		411	1000	41.10	
M3	2.219	2.203	388	1000	38.80	38.70
	2.180		385	1000	38.50	
	2.211		388	1000	38.80	
M4	2.080	2.109	365	1000	36.50	36.33
	2.149		364	1000	36.40	
	2.100		361	1000	36.10	
M5	2.086	1.984	298	1000	29.80	29.80
	1.910		298	1000	29.80	
	1.957		298	1000	29.80	
M6	1.880	1.847	262	1000	26.20	26.14
	1.855		260	1000	26.00	
	1.808		262	1000	26.20	

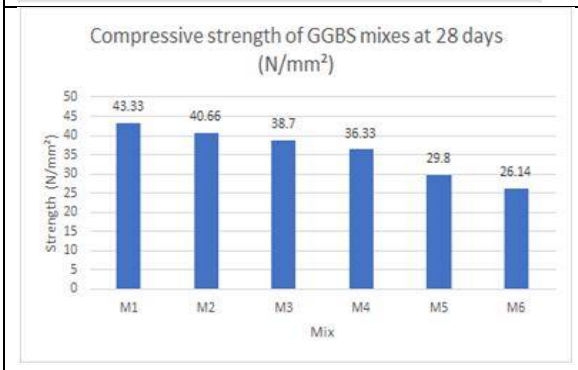
Table 4: Compressive Strength at 28 days (replacement of cement with Dolomite)

M7	2.562	2.532	384	1000	38.40	38.36
	2.496		384	1000	38.40	
	2.540		383	1000	38.30	
M8	2.480	2.441	376	1000	37.60	37.55
	2.420		375	1000	37.50	
	2.423		375.50	1000	37.55	
M9	2.346	2.300	375	1000	37.50	37.45
	2.265		374	1000	37.40	
	2.290		374.50	1000	37.45	
M10	2.196	2.091	341	1000	34.10	34.06
	2.060		341	1000	34.10	
	2.017		340	1000	34.00	
M11	1.987	1.962	268	1000	26.80	26.76
	1.960		268	1000	26.80	
	1.940		267	1000	26.70	
M12	1.863	1.843	187	1000	18.70	18.65
	1.857		186	1000	18.60	
	1.810		186.50	1000	18.65	

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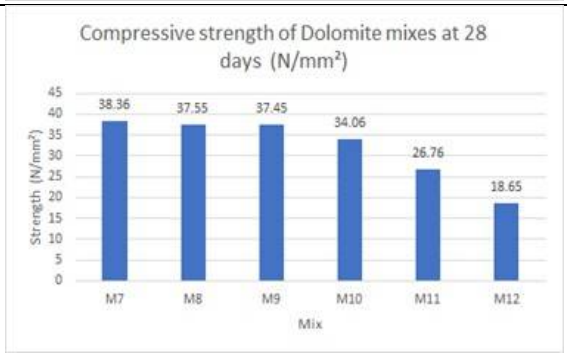


Fig 1: graphical representation of 28 days compressive strength of concrete using GGBS as replacement to cement.

Fig 2: graphical representation of 28 days compressive strength of concrete using Dolomite as replacement to cement.

Table 5: Split Tensile Strength for 28 days (with GGBS replacement)

Mix	Weight (Kg)	Force (KN)	Split Tensile Strength (STS) (N/mm^2)	Avg. Split Tensile Strength (N/mm^2)
M1	12.732	296.80	4.19	4.11
	12.763	295.00	4.17	
	12.745	282.60	3.99	
M2	12.220	245.00	3.46	3.57
	12.210	258.50	3.65	
	12.268	255.20	3.61	
M3	11.683	215.00	3.04	2.97
	11.676	209.50	2.96	
	11.640	205.50	2.90	
M4	10.653	156.00	2.21	2.08
	10.662	137.50	1.94	
	10.612	149.50	2.11	
M5	10.352	88.70	1.25	1.16
	10.376	80.50	1.13	
	10.327	78.90	1.11	
M6	9.650	58.50	0.83	0.79
	9.626	56.40	0.80	
	9.631	53.10	0.75	

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Table 6: Split Tensile Strength for 28 days (with Dolomite replacement)

M7	12.675	268.50	3.79	3.75
	12.730	262.00	3.70	
	12.695	266.50	3.77	
M8	12.240	247.40	3.50	3.48
	12.265	245.60	3.47	
	12.195	246.00	3.48	
M9	11.656	204.90	2.89	2.92
	11.475	208.00	2.94	
	11.490	207.50	2.93	
M10	11.035	176.70	2.50	2.51
	11.005	177.80	2.51	
	11.066	179.00	2.53	
M11	10.540	124.50	1.76	1.75
	10.596	126.00	1.78	
	10.565	122.50	1.73	
M12	9.280	97.50	1.38	1.34
	9.260	92.00	1.30	
	9.265	96.50	1.36	

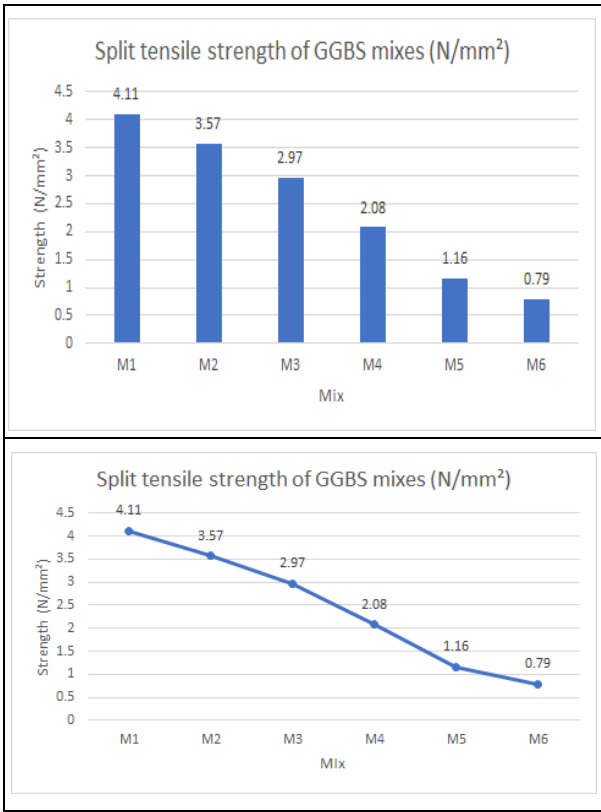


Fig 3: Split Tensile Strength at 28 days
(with GGBS as replacement to cement)

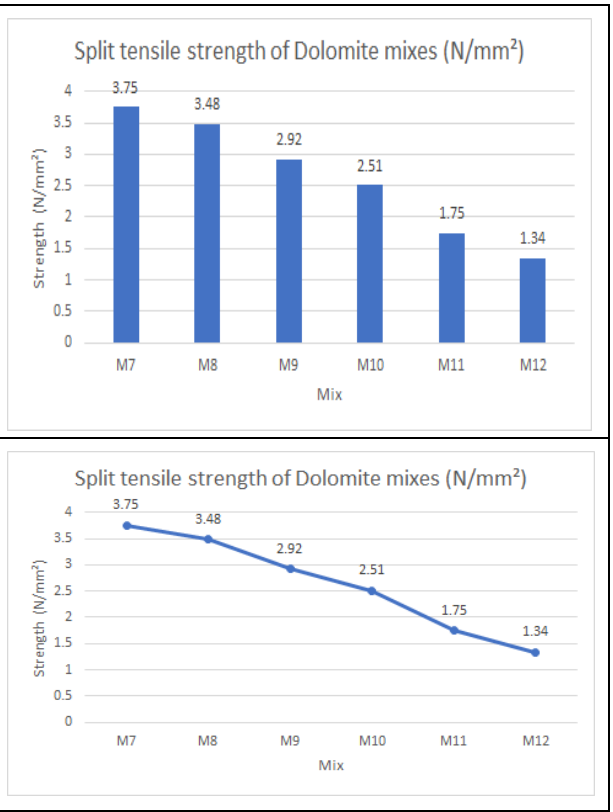


Fig 4: Split Tensile Strength at 28 days
(with Dolomite as replacement to cement)

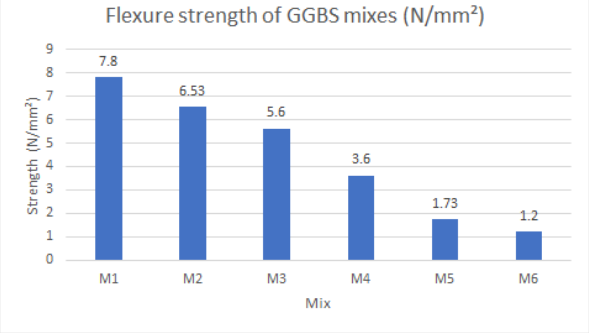
Table 7: Flexural Strength for 28 days (replacement of cement with GGBS)

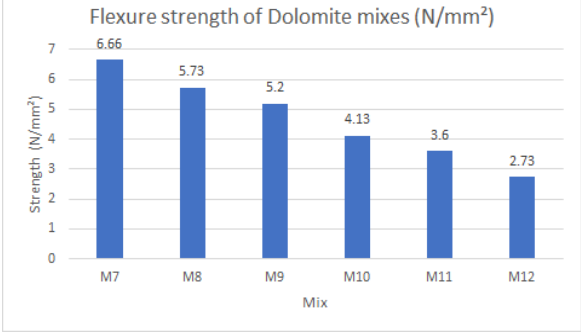
Mix	Weight (Kg)	Force (KN)	Flexural Strength (STS) (N/mm^2)	Avg. Flexural Strength (N/mm^2)
M1	11.970	20	8	7.80
	12.124	19	7.6	
	12.025	20	8	
M2	11.860	17	6.8	6.53
	12.005	16	6.4	
	11.986	16	6.4	
M3	11.545	14	5.6	5.60
	11.336	13	5.2	
	11.380	15	6	
M4	11.056	9	3.6	3.60
	10.762	8	3.2	
	10.553	10	4	
M5	10.050	4	1.6	1.73
	9.973	4	1.6	
	9.895	5	2	
M6	9.562	2	0.8	1.20
	11.970	3	1.2	
	12.124	4	1.6	

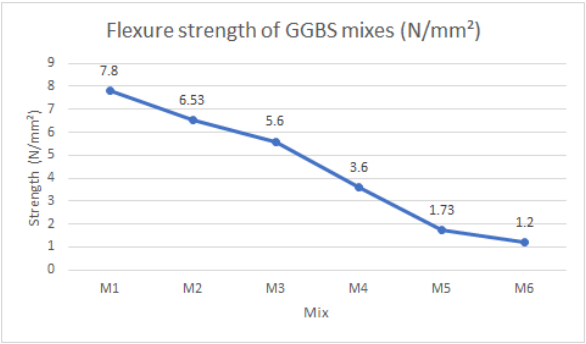
Table 8: Flexural Strength for 28 days (replacement of cement with Dolomite)

M7	11.653	16	6.4	6.66
	11.645	17	6.8	
	11.820	17	6.8	
M8	11.580	14	5.6	5.73
	11.482	14	5.6	
	11.530	15	6	
M9	11.019	13	5.2	5.20
	11.117	14	5.6	
	11.056	12	4.8	
M10	10.594	10	4	4.13
	10.349	10	4	
	10.340	11	4.4	
M11	9.819	9	3.9	3.6
	9.930	10	4	
	10.005	8	3.2	
M12	8.927	7	2.8	2.73
	9.050	8	3.2	
	8.950	6	2.4	

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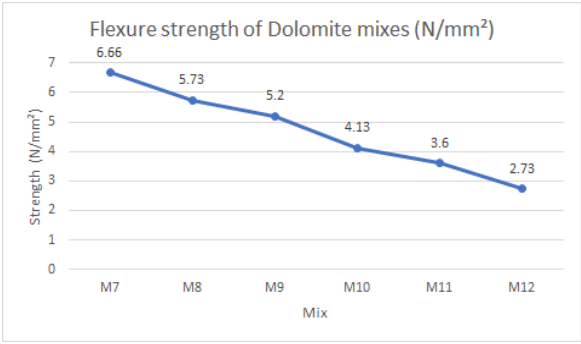


Fig 5: Flexural Strength at 28 days (with GGBS as replacement to cement)

Fig 6: Flexural Strength (with dolomite as replacement to cement)

IV. CONCLUSIONS

A. Strength with 5 and10% replacement of fine aggregate with vermiculite and 40% replacement of cement with GGBS and 30% replacement of cement with dolomite had given good strength.

B. On comparison of GGBS and dolomite it was found that maximum strength is obtained using GGBS

C. Compressive strength was found to be increased compared to conventional concrete.

D. Mechanical aspects decreased with increase of percentage of vermiculite beyond 10% when used as replacement to fine aggregate.

E. On comparison it was found with increase of vermiculite as replacement fine aggregate reduced the weight of concrete mixes making concrete Light weight concrete s.

F. It was found that usage of Dolomite as replacement to cement gives although gave less compressive strength but gave considerable increase in flexural and split tensile strength when compared with replacement of GGBS.

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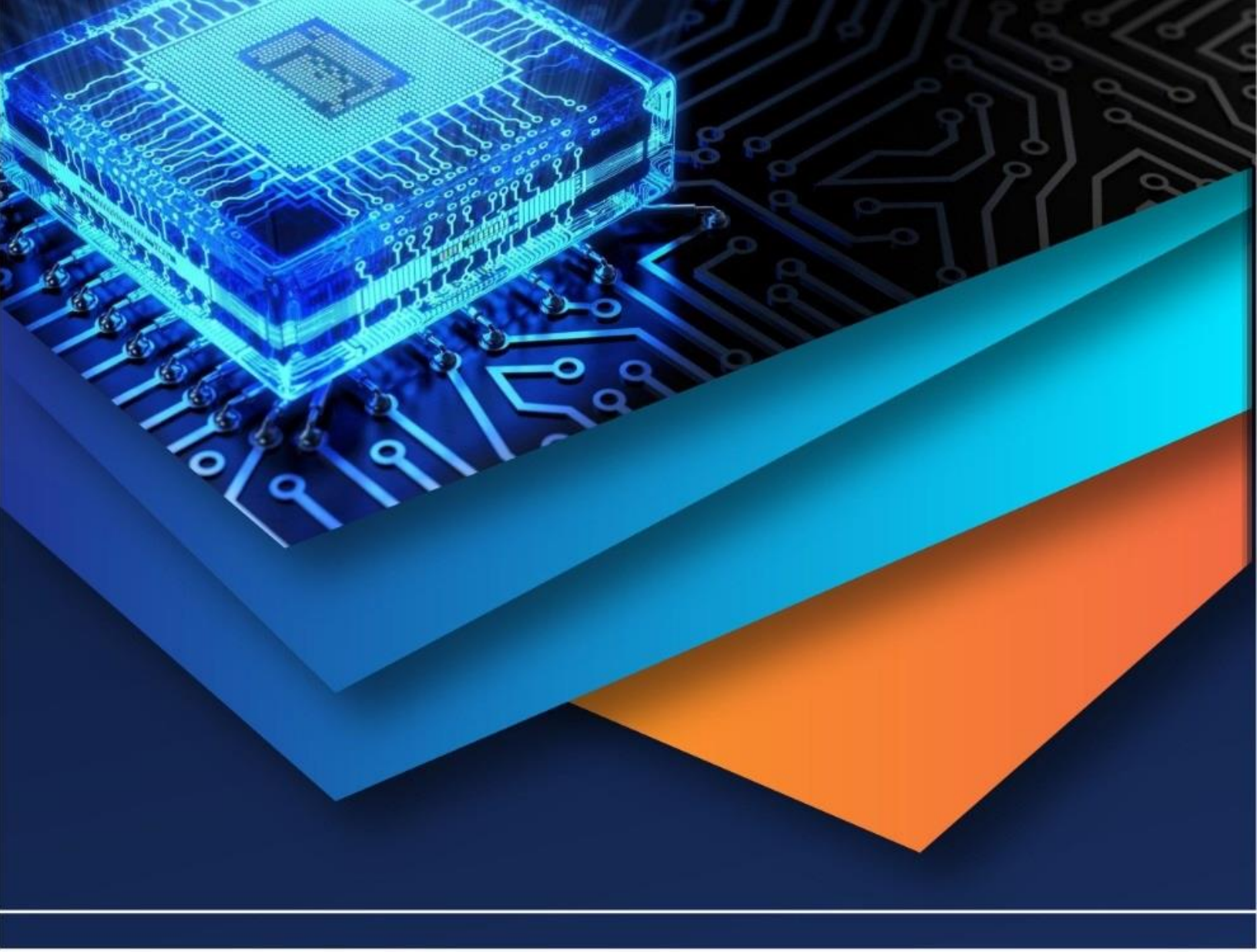
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