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Experimental Research of Brick Kiln Dust and Marble Powder when Substitute to Ordinary Portland cement

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***Abstract:** This Experimental research aims towards the sustainable waste management from Brick Kiln Dust (BKD) and Marble Powder (MP) in Cement Industry. Brick and Marble Industry brings a lot of dust and waste material which causes several environmental troubles. To enlarge the economic benefits and sustainable environment, this research proposes the substitution of BKD and MP with Ordinary Portland Cement mortars. Mortar is an extensively used construction material composed of cement, fine aggregate and water. In this experimental research the BKD and MP replaced with cement at proportions of 4%, 8%, 12%, 16%, 20%, 24% and 28% to enumerate the Comp. strength, Consistency and Setting time (Initial and Final). Experiments were performed for both BKD and MP, which showed optimum replacement of both pozzolans with cement and enumerates Comp. strength for respective mixes.*
***Keywords:** Waste Management, Brick Kiln Dust, Marble Powder, Cement, Comp. Strength and Consistency.*

I. INTRODUCTION

Mortar is like other construction materials contracts and expands due to several variables in temp. and environmental conditions (1). Cement and Mortar are second mostly used construction materials which basically utilize to resist strength and have main contribution in infrastructures like buildings, dams, roads etcetera. Composition of mortar consist water, cement and fine aggregate. BKD is a lavish material which produces as a waste in brick kilns and construction sites. MP is obtains from the metamorphic rock resulting from the transformation of pure lime stone. Many researchers utilizing varieties of materials as a substitute of cement to check the chemical and physical properties of mortar. The present era experiencing vast enlargement in cement mortar construction especially in enhancing infrastructures which leads to emission of CO_2 (Carbon-di-oxide) (2).

For enhancing the strength and durability of infrastructure utilization of Pozzolans like BKD and MP as a substitute of cement were used in this experimental research. According to ASTM-C125, Pozzolans have little or no cementitious value and in presence of water, a class of siliceous or alumino-siliceous material reacts with calcium hydroxide to form cementitious compounds.

This experimental research showed the Comp. strength, Setting time (Initial and Final) and Consistency of the cement mortar cubes which were made with mix proportion of 1:3 as a replacement of 4%, 8%, 12%, 16%, 20%, 24% and 28% of BKD and MP by the weight of cement. This study enumerates the comp. strength, consistency and setting time of all seven mixes and these assigned with these notifications BD4, BD8, BD12, BD16, BD20, BD24 and BD28 & MP4, M8, MP12, MP16, MP20, MP24 and MP28 for BKD and MP respectively.

II. OBJECTIVE AND SCOPE OF RESEARCH

The main objective of this experimental research is to enumerate the comparative relation of strength and durability, setting time and consistency of partially substituted cement mortar with BKD and MP.

III. LIERATURE REVIEW

1) *Himanshu Pratap Singh (3):* This research investigated that the Comp. Strength increased up to 20% replacement of BKD and this showed the optimum content for higher comp. strength.
2) *Dr. D. Jayganesh (1):* The study work carried out of this experimental investigation includes the comparative results of BKD and MP. The Bar charts showed that the replacement of BKD gave higher comp. strength than MP at same proportions.
3) *Ayaz Khan (2):* This research gave the optimum comp. strength up to 20% replacement of BKD with cement and then it decreases at further substitution. So, it concluded that BKD might be used as plasticizer because it decreases the water demand as increases the workability.

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IV. MATERIALS USED AND THEIR PROPERTIES

1) *Cement:* According to IS 8112-1989, the cement used was OPC (43 Grade) with the specific gravity of 3.10. OPC 43 Grade was used in the whole experimental investigation and some physical tests also carried out to obtain its properties as shown below

Table-1

SiO_2 %	19.50
Al_2O_3%	5.10
Fe_2O_3%	3.68
CaO%	62.10
SO_3%	2.68
K_2O%	0.91
LOI %	0.95



2) *Fine Aggregate (Sand):* Fine aggregate used in this experimental investigation was river sand having no impurities likes stones, shell & clay etcetera. The sand passed through 1.08mm sieve and it was tested as per Indian Standards IS 383-1970.

Table-2

Bulk density	1.6 gm/cc
Specific gravity	2.6
Fineness Modulus	2.66
Void Ratio	0.468
Sieved by	1.08mm



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3) *Water:* Water is a main constituent of mortar mix, as it works as a binder in cement mortar paste. Since it helps in the strength gain of the cement mortar so, the quantity and quality of water should be maintained and required as per Indian Standards norms.

4) *Brick Kiln Dust (BKD):* BKD stands for Brick-Kiln Dust. BKD is the third enlarged industry where clay bricks were baked using coal and the dust powder of the brick used as the replacement of cement in the cement industry. To accomplish the requirement of clay bricks the development of brick kiln increases as per the growth of the population. Brick kiln dust is the waste obtains from the burning of clay bricks in the form of brick kilns. In this investigation, BKD used by passed through the 90micron sieved and retained at 45micron.

Table-3

SiO_2 %	67.43
Al_2O_3%	1.99
Fe_2O_3%	7.99
CaO%	2.12
SO_3%	-
Na_2O%	0.08
K_2O%	-
Total Na Eq. alk. %	-
LOI %	1.10
Blaine Fineness m^2/kg	-
Relative density	2.50



5) *Marble Powder (MP):* In the Marble industry huge amount of waste is produces in powder form. MP is one of the wastes in marble industry. MP is formed during the process of cutting, dressing and polishing. MP used in this experimental research was sieved by 300mm sieve and the properties of MP can enhance or diminish the comp. strength of mortar as per substitution.

Table-4

SiO_2 %	26.43
Al_2O_3%	2.78
Fe_2O_3%	9.40
CaO%	42.45
SO_3%	-
Na_2O%	-
Fe_2O_3%	0.603
Specific gravity	2.68
LOI %	3.35
Blaine Fineness m^2/kg	1500
Relative density	2.55

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V. METHODOLOGY AND RESULTS

1) *Comp. Strength:* The Comp. strength of all seven mixes was determined by the CTM (Compression Testing Machine) in N/mm^2 or MPa. The comp. strength of mortar cubes was enumerated at 3, 7, 28 and 56 days of curing period. The durability and strength of the mortar varies with the substitution proportions and it may enhance or diminish the comp. strength of the mortar cubes. Some images shown below of mortar cubes after Comp. strength test at CTM.

Fig-A



Fig-B



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2) Now the Table-5 shows the comp. strength of the BKD with all the seven proportion mixes and Graph-1 give elevation between the mortar mixes for higher increment.

3) Table-6 shows the comp. strength of the MP with all proportions of mortar mixes and graph-2 shows the comparison of the strength in elevation.

Table-5

Sr. No.	% of BKD	Comp. Strength, N/mm^2			
		3days	7days	28days	56days
BD4	4%	13.44	13.97	16.85	19.92
BD8	8%	13.04	13.70	17.20	23.50
BD12	12%	13.83	13.36	17.75	24.00
BD16	16%	14.30	13.23	18.44	25.50
BD20	20%	10.96	13.04	15.10	20.97
BD24	24%	10.55	11.20	14.44	19.19
BD28	28%	10.10	10.50	13.85	16.50

Graph-1

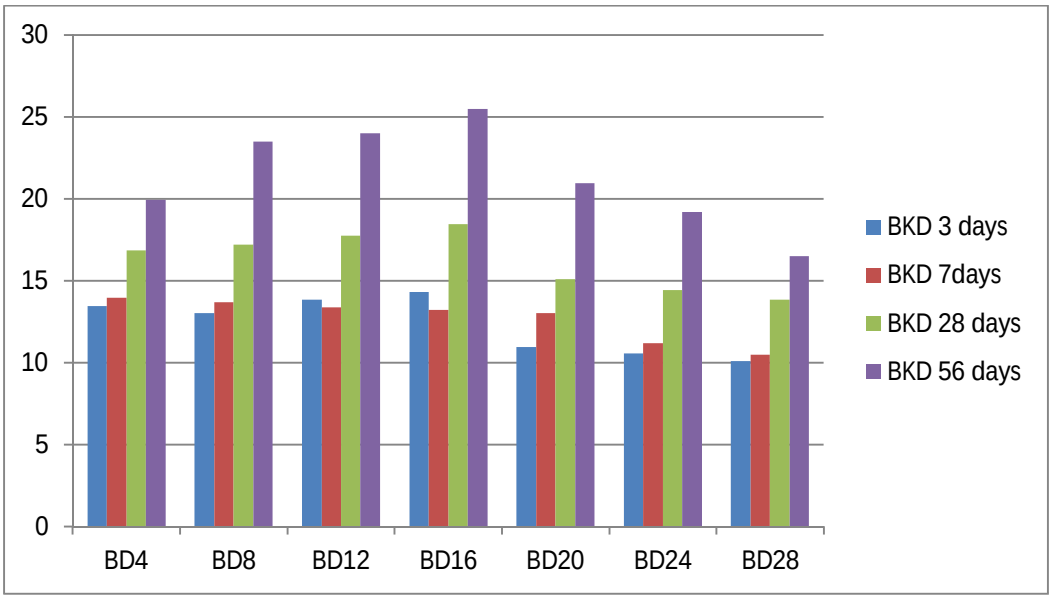
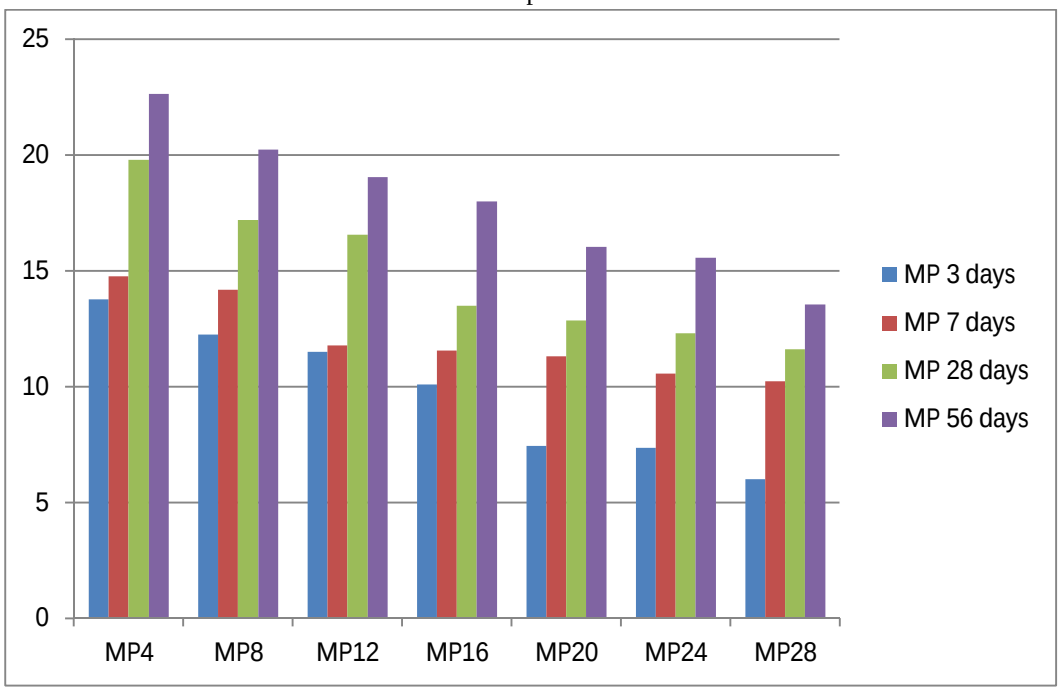


Table-6

Sr. No.	% of MP	Comp. Strength, N/mm^2			
		3days	7days	28days	56days
MP4	4%	13.77	14.77	19.80	22.62
MP8	8%	12.25	14.17	17.20	20.22
MP12	12%	11.50	11.77	16.55	19.04
MP16	16%	10.10	11.56	13.50	18.00
MP20	20%	7.44	11.32	12.86	16.04
MP24	24%	7.35	10.56	12.30	15.56
MP28	28%	6.01	10.22	11.60	13.55

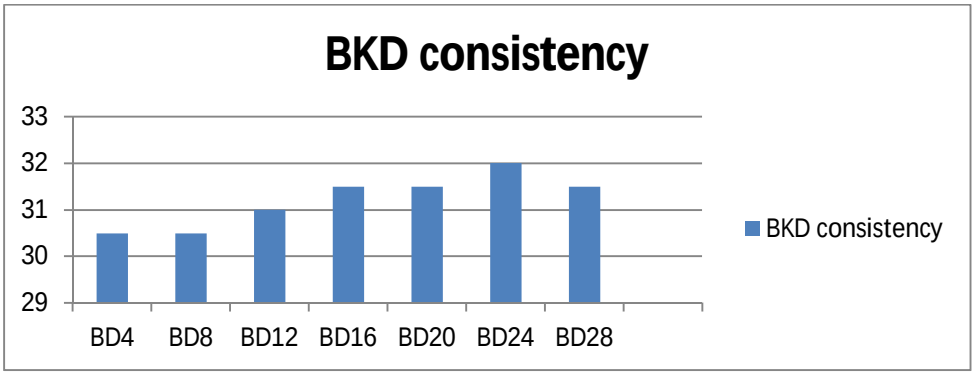
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Graph-2

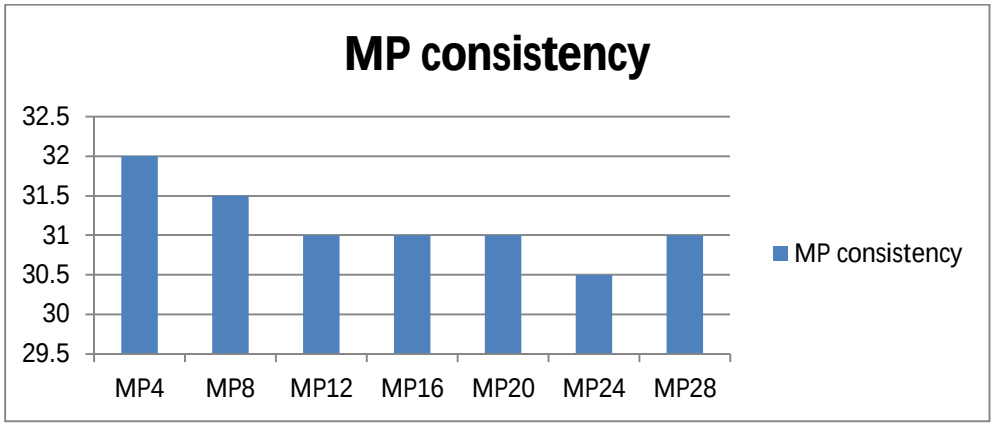


4) Consistency: Consistency of every mix was calculated by performing test before every mix proportion. The consistency of the mixes shows the amount of water required for the substituted pozzolana-cement proportion and it may be varies because of unskilled labor or work experience.

Graph-3



Graph-4



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5) *Setting Time:* The initial and final setting time of the mix proportion of substituted pozzolana shows the effective relation between the chemical and physical properties of BKD and MP. Graphs and tables shown below.

Table-7

	IS min (BKD)	FS min (BKD)
BD4	45	630
BD8	50	580
BD12	48	570
BD16	55	620
BD20	59	610
BD24	62	650
BD28	67	660

Graph-5

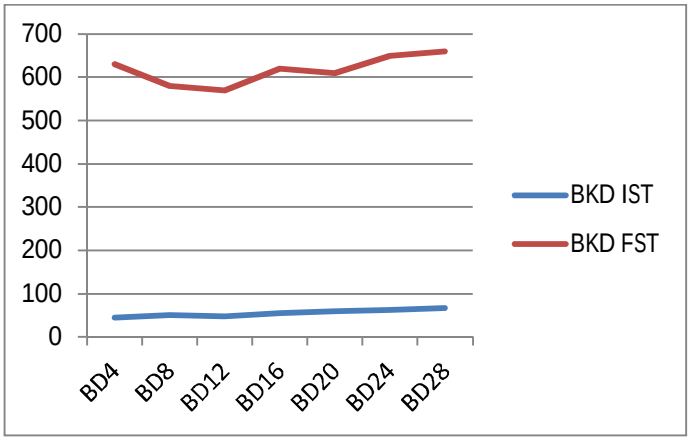
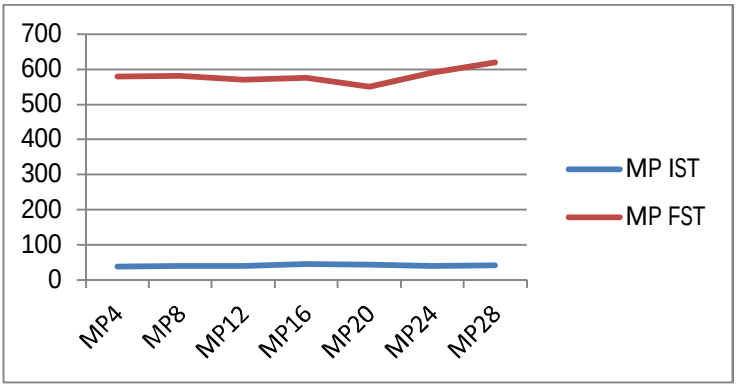


Table-8

	IS min (MP)	FS min (MP)
MP4	38	580
MP8	40	582
MP12	41	570
MP16	45	575
MP20	44	550
MP24	40	590
MP28	42	620

Graph-6



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VI. CONCLUSION

6) As shown in Table-5 and Graph-1 Comp. strength of the BKD increases up to 15% replacement of cement and then it decreases. So up to 15% replacement of BKD shown the maximum Comp. strength in mortar cubes for 3, 7, 28 and 56 days.

7) In Table-6 and Graph-2, the optimum comp. strength shown at the 4% replacement of the MP and this shows that the MP give higher comp. strength at less replacement with cement for 3, 7, 28 and 56 days.

8) Consistency of the BKD and MP shown in Graph-3 and Graph-4 respectively for all proportion and it varies due to the work experience of an individual.

9) In Table-7 or Graph-5 and Table-8 or Graph-6, the setting time of BKD and MP shown respectively. The initial setting time of BKD is higher than MP at all proportion approximately due to this the Long term strength in BKD is much higher than MP.

10) Graph shows the comparative behavior of Pozzolans BKD and MP for replacement with cement.

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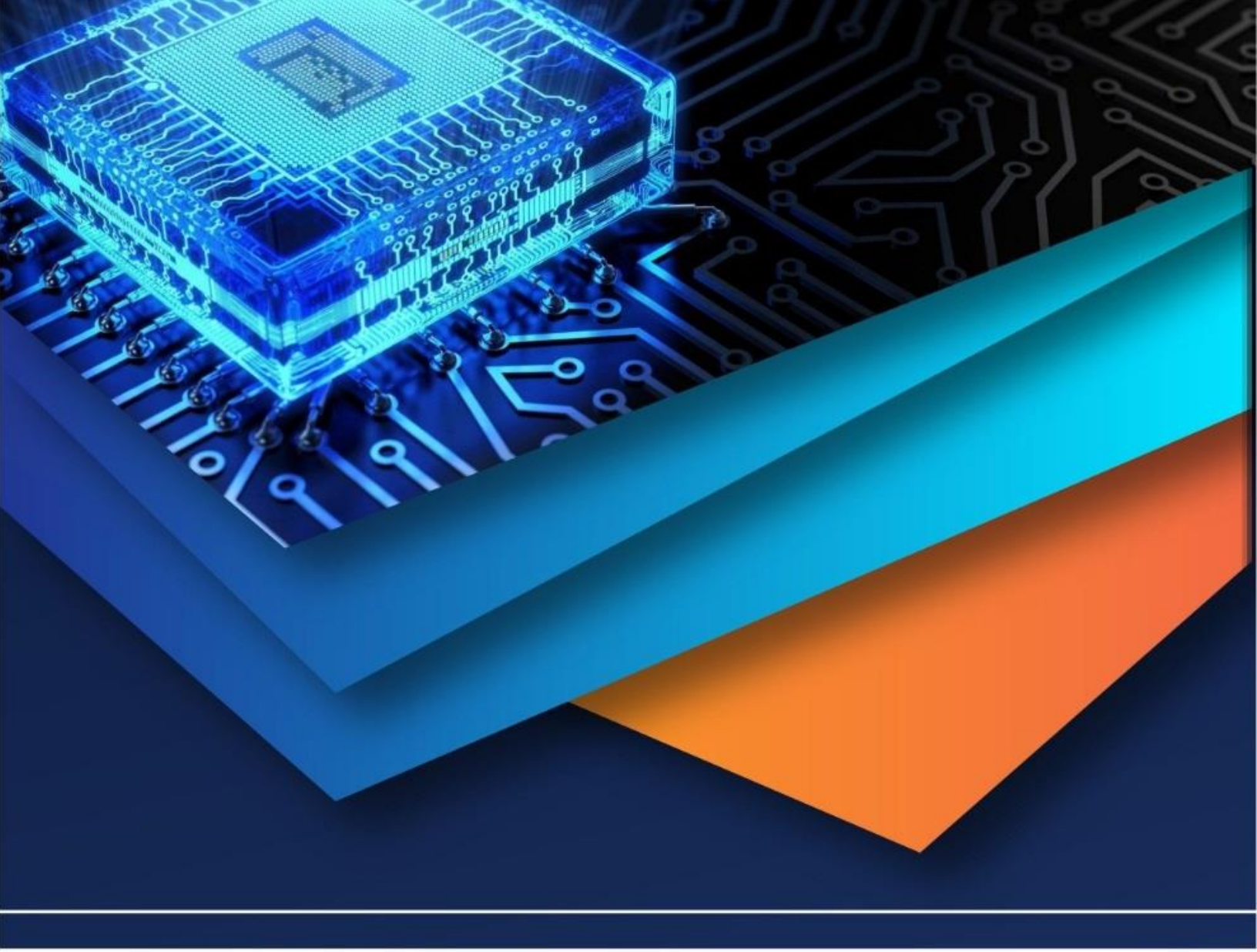
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