iJRASET
International Journal For Research in Applied Science and Engineering Technology



INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 10 **Issue:** I **Month of publication:** January 2022

DOI: https://doi.org/10.22214/ijraset.2022.39981

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International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 10 Issue I Jan 2022- Available at www.ijraset.com

Experimental Study on Self-Healing Concrete Using GGBS and Metakaolin

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.Abstract: ***This project will study self-healing concrete using GGBS & Metakaolin. Concrete is delicate and hence it causes crack easily. To fix these cracks, it took maintenance which will be costly. To do away with this trouble self-healing technique is brought in the concrete. The Objective of the present investigation is to obtain the performance of the concrete and self-healing phenomena by using GGBS (Ground Granulated Blast Furnace), Superplasticizer, and Bacteria. The selection of the bacteria is according to their alkali environment. Different bacteria are used for the experiments by different researchers for their study.***

The result has been analyzed for studying the effect of a different parameter such as GGBS (0,10,15,20) percent of the weight of the cement. The purpose of the prevailing research isn't to reach at a particular strength or workability but develop to better insight into the repercussion of GGBS on different properties of concrete.

Keywords: Ground Granulated Blast Furnace, Super Plasticizer, Metakaolin, Compressive Strength, Bacteria.

I. INTRODUCTION

This is a new type of concrete. It mimics the automatic healing of body wounds by extracting a certain type of matter. Self-adhesive material is defined as self-adhesive material and in concrete is used to describe concrete that automatically repairs its cracks. Also known as automatic adjusting concrete. It is widely used in heavy construction because of its strength and durability. Many factors influence the strength and strength of concrete, one of the most important obstacles to the formation of cracks. Larger cracks can cause a fall in the concrete structure and have a negative impact on its strength. To reduce the risk of cracking, the structure had to be maintained, which could be expensive. In the process of reducing costs to increase the stability of the building use self-adhesive concrete**.**

II. OBJECTIVE

A. Develop high strength concrete and self-healing property with a characteristic compressive force of 40 MPa with different combinations of additional cementitious materials such as GGBS and Metakaolin.
B. Select a suitable admixture throughout the flow test.
C. To improve self-healing property in concrete.
D. To enhance the workability of the mixed concrete.

III. METHODOLOGY

A. Material Used

1) Cement: The cement used was a Ordinary Portland cement grade 43 (manufacturer name: Ultratech) compliant with IS: 8112 - 1989. Table 1 provides the test results for the basic concrete structures.

Table 1 Fundamental Properties of Cement

Properties	Cement
Specific gravity	3.12
Type of Cement	OPC
Grade of Cement	43
Initial Setting Time	230 minutes
Final Setting Time	550 minutes

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2) *Fine Aggregate:* Sand deposited in the bank of river was utilized in the project as fine aggregate. The size of sand particle is below 4.75mm conforming to zone II. The aggregate was tested as per IS 2386. Table 2 provides the test result for the fundamental properties of sand.

Table 2 fundamental properties of sand

Properties	Fine aggregate
Specific Gravity	2.60
Water Absorption	1.0

3) *Coarse Aggregate:* Rough aggregate size below 20mm in line with zone II. The aggregate has been tested according to IS 2386. The aggregate used is of good quality and has an angular shape; which provides a good bonding bond. Table 3 shows the basic features of a coarse bond

Table 3 fundamental properties of coarse aggregate

Properties	Coarse aggregate
Specific Gravity	2.95
Water Absorption	0.5

4) *Ground Granulated Blast Furnace:* GGBS is obtained from a steel plant. It is the by-product of iron & steel. the basic features of GGBS mentioned in Table 4

Table 4 fundamental properties of GGBS

Properties	GGBS
Specific gravity	2.88
Water absorption	0.14%
Material retained on 45 u Sieve (%by mass)	Nil

5) *Super Plasticizer:* It is mainly used for high strength concrete (M_{20} toM_{50}). In this project we use PC-300 superplasticizer is used (Asian paints). The specification is listed in below Table 5.

Table 5 Specification of Super Plasticizer

Name	Maximo plats PC 300
Color	Orange yellow
Specific gravity	1.13
PH	6 - 6.5

6) *Water:* Potable water was used in current of ingredients are discussed IS: 456 was used.

B. Mix design of M40 grade concrete

The mixed design method was kept as simple as possible with a water cement ratio of 0.36 and cement was replaced by GGBS @ 0%, 10%, and 15% replaced by cement weight.

1) Material Stipulations for Proportioning

a)	Grade	-	M40
b)	Type of cement	-	OPC 43
c)	Maximum Nominal Size Aggregate	-	20 mm
d)	Exposure Condition	-	Moderate
	Chemical Admixture	-	Superplasticizer (PC 300)
e)	Cementitious Material	-	GGBS
f)	Workability	-	125mm (Slump)

2) Data For Materials

a)	Cement Used	-	OPC 43
b)	Specific Gravity of Cement	-	3.12
c)	Specific Gravity of		
	1. Coarse Aggregate	-	2.95
	2. Fine Aggregate	-	2.60
	3. Superplasticizer	-	1.13
	4. GGBS	-	2.8
d)	Water Absorption Of		
	1. Coarse Aggregate	-	0.5%
	2. Fine Aggregate	-	1.0%

- *Target Strength for Mix Proportioning*

$F_{mc} = f_{ck} + 1.65\sigma$

$F_{mc} = 40 + 1.65 \times 5 = 48.25$ MPa (N/mm^2)

- *Entrapped Air Content*

For 20mm nominal maximum size of aggregate approximate air content is 1%. (Table 3 Clause 5.2, IS 10262-2019)

- *Selection Of Water Cement Ratio*

The target strength of 48.25 N/mm^2 of free water cement ratio is 0.36 for OPC 43 grade curve.

- *Selection Of Water Content*

From Table 4, Water content = 186 (for 50mm slump) for 20mm aggregate,
Estimated water content for 125 mm slump
= 186 + 9/100 x 186
= 202.74 kg
Mainly based on experimental information, a 20% reduction in water content is considered while the use of superplasticizer at a cost of 1% per cement weight.
= 202.74 x 80/100
=162.192 kg

- *Calculation Of Cement Content*

Water cement ratio = 0.36
Cement content = 162/0.36
= 450 kg/m^3
Cementitious Material Content
= 450 x 1.10
= 495 kg/m^3
Water Content = 162kg/m^3
So, Water Cementious Ratio
= 162/495
= 0.33

3) Proportion Of Trial Mix

Cement = 445.5 (kg/m^3)
Water = 147 kg
Fine aggregate = 600 (kg/m^3)
Coarse aggregate = 1300 (kg/m^3)
Water cement ratio = 0.33

4) Ratio Obtained

Cement: Sand: Aggregate = 1: 1.34: 2.91

Table 7 Proportion of GGBS and Super Plasticizer

Sample	GGBS %	Super plasticizer %
S1	5	1.2
S2	10	1
S3	15	0.8

Table 8 Test Required

S. No.	Test for material	Test for concrete
1	Sieve analysis	Slump cone test
2	Specific gravity	Compressive strength test
3	Water absorption	-

IV. RESULT AND DISCUSSION

A. *Slump Cone Test*

It is the workability test, that ease with which we can work with concrete and the following test result obtained in table 9.

S. No.	GGBS (%)	Super plasticizer (%)	Slump value (mm)
1.	0%	0%	118
2.	5%	1.2%	123
3.	10%	1%	124
4.	15%	0.8%	123

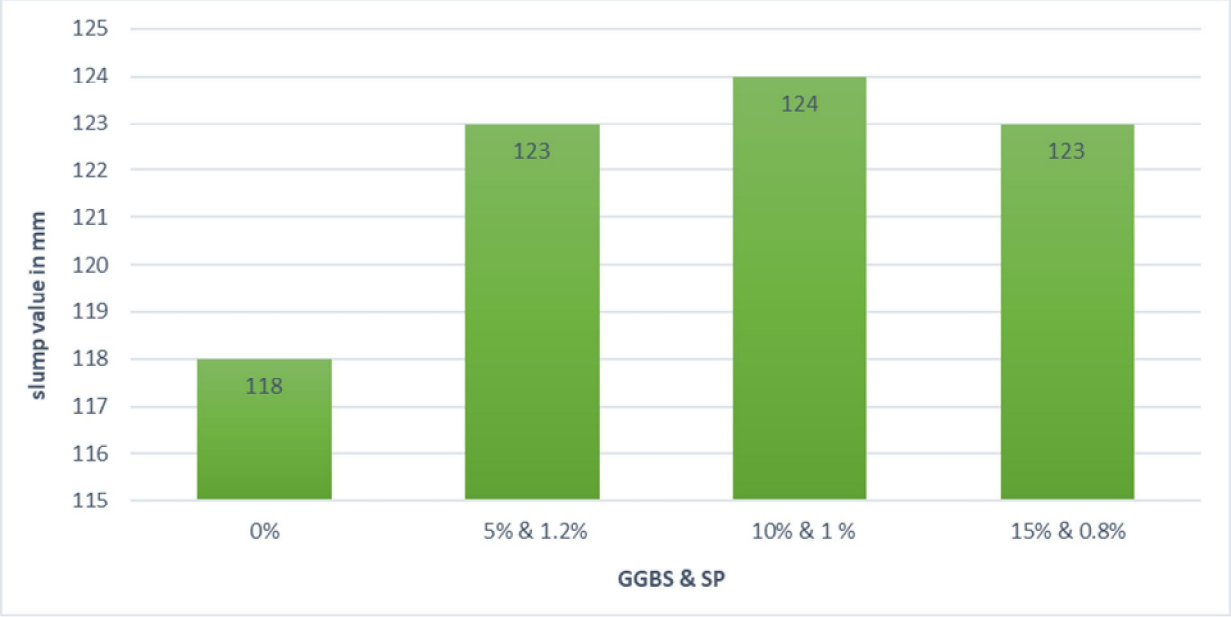


Figure 1: Slump Cone Test

B. Compressive Strength Test

Mechanical test which measures the maximum amount of load in which specimen fail are shown in the table below value in (N/mm^2)

Number Of Cube Sample	GGBS (%)	Super Plasticizer (%)	Average Ultimate Compressive Strength Test (N/mm^2)		
			3 Days	7 Days	28 Days
S1	0%	0%	20.82	31.03	40.70
S2	5%	1.2%	26.51	39.44	51.51
S3	10%	1%	27.63	40.39	51.98
S4	15%	0.8%	26.65	41.43	51.74

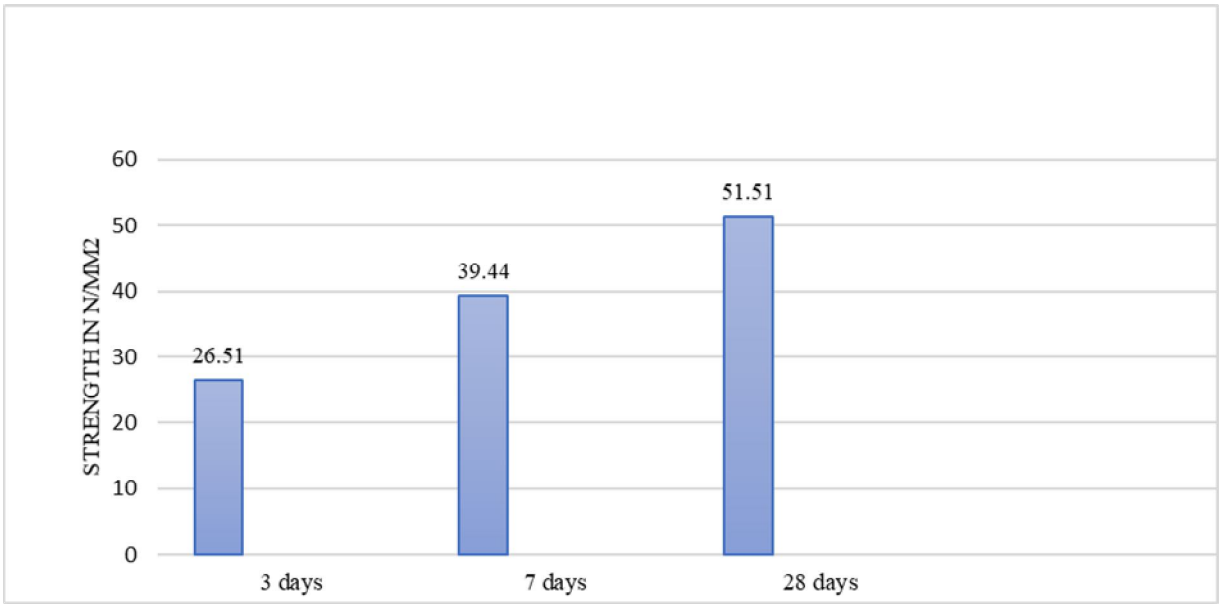


Figure 3: 5% of GGBS containing

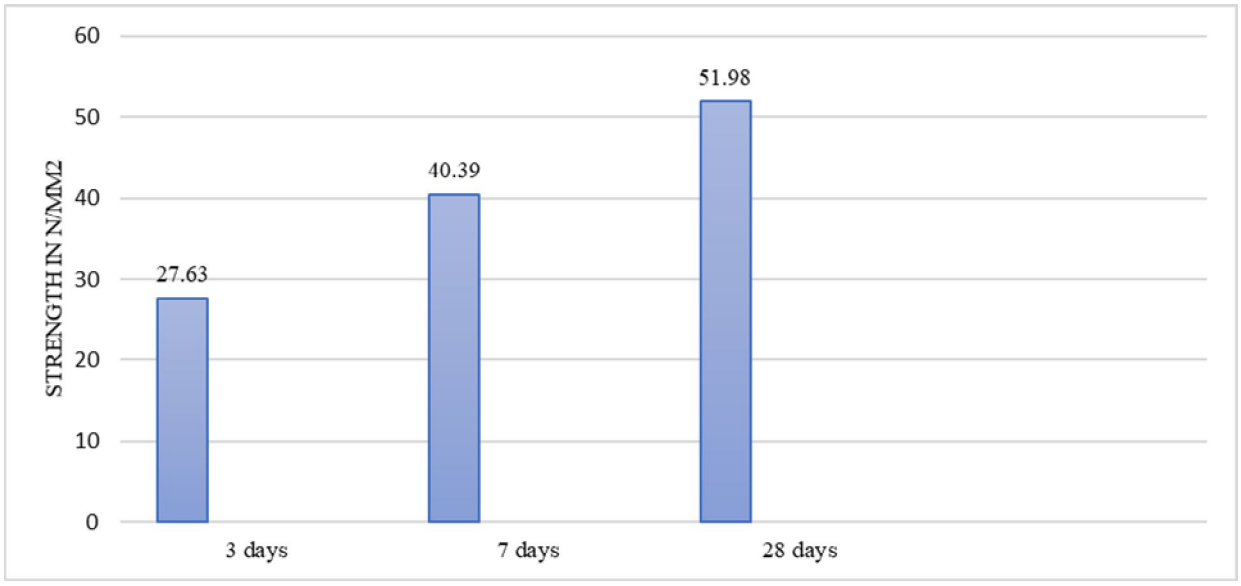


Figure 4: 10% of GGBS containing

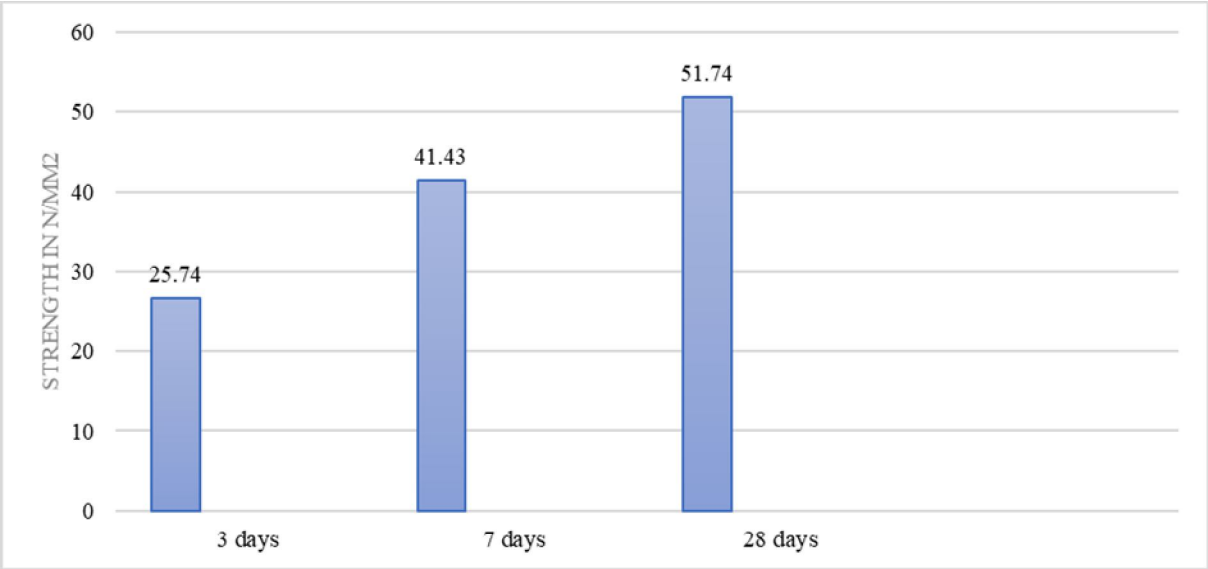


Figure 5: 15% of GGBS containing

V. DISCUSSION

The effects of GGBS compressive strength and super plasticizer concrete (cubes) where M40 grade concrete with 5%, 10%, and 20% instead of cement weight were tested for 3 days, 7 days , and within 28 days the result was presented. The models were made solid (built) with common materials of the same grade using Ordinary Portland Cement (OPC 43).

With the growth of concrete years, the compressive strength increased by up to 15% instead of GGBS and superplasticizer as cement.. The GGBS partial replacement and superplasticizer provided a 28-day high pressure compression rate at a 20% conversion rate.

VI. CONCLUSION

In the present study, an attempt was made to study the effect of partial cement replacement with GGBS and superplasticizer .M40 was selected as a high-performance compound based on compression strength. Several tests are performed such as GGBS filter analysis, GGBS specific gravity forces, performance tests, compressive strengths tested in all specimen. The obtained result was compared with the M40 control combination.

Based on a limited experimental survey the following conclusions were made: -

1) Concrete performance increased with an increase in GGBS content as increasing GGBS content reduced the percentage of superplasticizer.

2) Pressing power increased by up to 20% switch with GGBS and superplasticizer.

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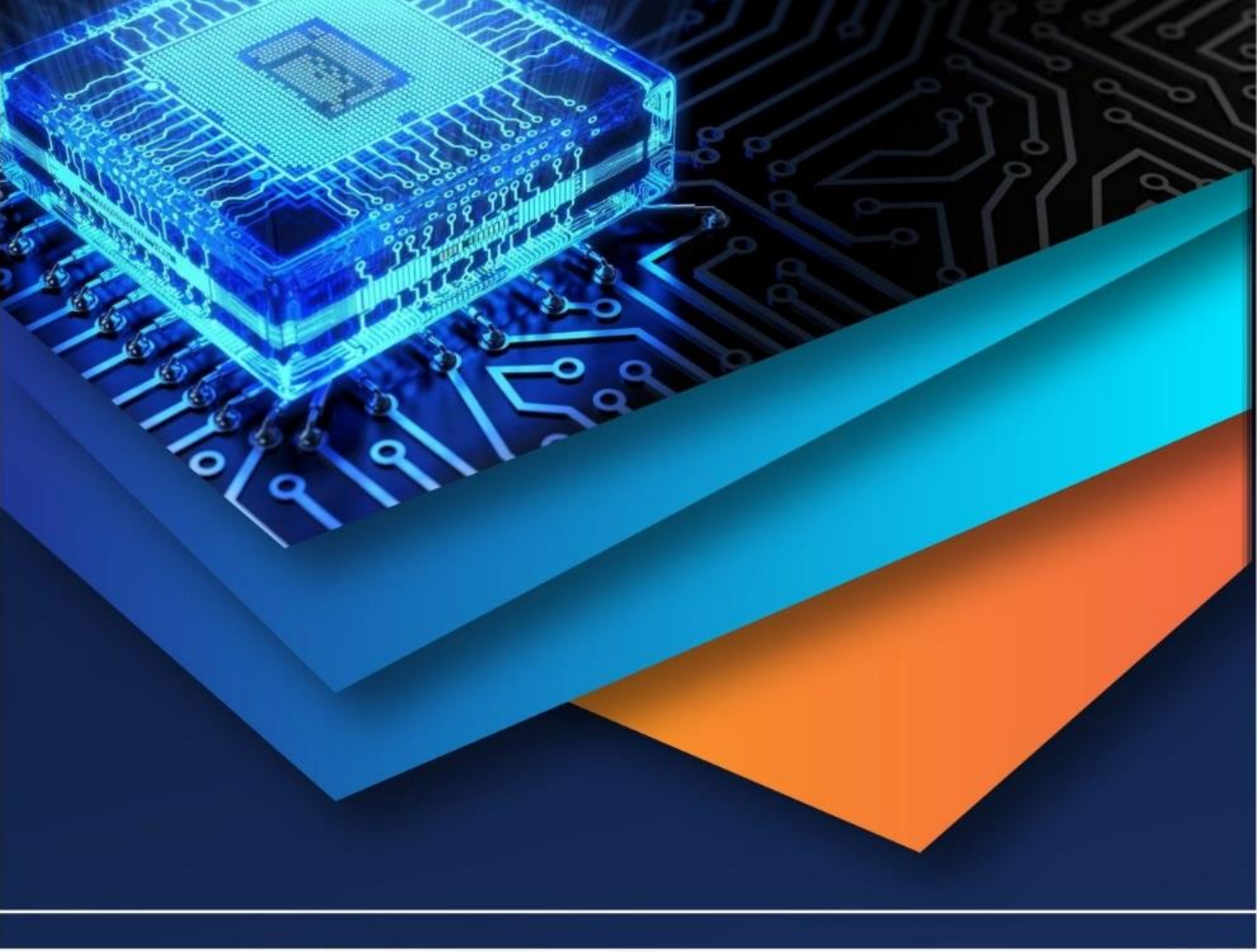
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