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A Comparative Study on Plastic Concrete and Partially Replaced Plastic Concrete using Plastic Aggregate with Conventional Concrete

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Abstract: Solid waste management is one of the major environmental concerns in our country now a day. The present study covers the use or recycled plastics as replacement of coarse aggregates in concrete. The main aim of the study is to investigate the change in mechanical properties of concrete with the addition of plastics in concrete. Along with the mechanical properties, thermal characteristics of the resultant concrete are also studied.
It is found that the use of plastic aggregates results in the formation of lightweight concrete. The compressive, as well as tensile strength of concrete reduces with the introduction of plastics. The most important change brought about by the use of plastics is that the thermal conductivity of concrete is reduced by using plastics in concrete. Therefore, it can be said that recycled plastics can be used for thermal insulation of buildings.
Keywords: Plastic aggregate, self compacting concrete, Compressive strength, Tensile Strength.

I. INTRODUCTION

The main source for recycled aggregates is construction and demolition waste. Most of the waste materials produced by demolishing structures are disposed by dumping them as landfill or for reclaiming land. But with the demand for land increasing day by day, the locations, capacity and width of the land that can receive waste materials are becoming limited. Added to it, the cost of transportation makes disposal a major problem. Hence, reuse of demolition waste appears to be an effective solution and the most appropriate and large-scale use would be to use it as aggregates to produce concrete for new construction. Recycled aggregate concrete utilizes demolition material from concrete and burnt clay brick masonry construction as aggregate.
It is necessary to work out a project proposal to carry out further studies on various aspects such as collection, processing and effective utilization of this waste material. To start with, such a study could be initiated with the following components:

A. Estimation of the types, quantity and useful components present in the waste plastic materials in the city and surrounding areas.
B. Methodology for collection and sorting out the useful components of the plastic waste.
C. Methodology for processing the plastic bags as required for use in the preparation of modified bitumen, including cleaning, shredding and further processing of the plastic waste materials
D. Carrying out further laboratory investigations, construction of some test tracks and field studies on the performance of concrete using the modified concrete.
E. Working out relative economics of using the modified concrete mixes in road construction works, considering the improved performance and increased service life of the pavement.

II. LITERATURE REVIEW

In this research work concerning to the various application and methods used for testing of the concrete made by recycled aggregate and recycled plastics aggregates are discussed. This chapter gives a comprehensive review of the work carried out by various researchers in the field of using recycled plastics in concrete as full or partial replacement of aggregates.
The most important property of concrete in fresh state is its workability. It is defined as the ease with which concrete can be mixed, transported, placed and finished easily without segregation. From many research papers we investigated the effect of ground plastic on the slump of concrete. The Concrete mixes with partial replacement of plastic aggregate up to 20% are proportioned to the fine aggregates is gives the best results. Hence we consider the Partial replacement of plastic aggregate upto 20% (Taken 5%, 10%, 15% % 20%) for different mix proportions. Details of mixture proportions are decided for further is based on the research papers listed in reference sections.

It is also observed that the change in water cement ration may also effect the strength and workability of concrete, hence different water cement ratios (0.40, 0.44, 0.48 & 0.52) are also taken in account in this research.

(Siddique, 2007). It was concluded that 19 mm fibrillated polypropylene fibers had no obvious effect on the compressive strength of concrete. However, 19 mm fibrillated polypropylene fibers enhanced the energy absorption and toughness characteristics of concrete under compression, as evidenced by increase in compressive toughness index of concrete with fiber addition.

III.EXPERIMENTAL PROGRAM

A. Basic Materials

1) *Cement:* 53 Grade Ultra Tech cement was used for casting cubes and cylinders for all concrete mixes. The cement was of uniform colour and before use the compressive strength and tensile strength of cement is determined and for w/c ratio consistency of cement is also determined by using vicat apparatus. The initial and final setting time, fines of cement also determined. All the details are show in table below:-

S.No.	Characteristics	Values obtained	Standard values
1.	Normal Consistency	33%	-
2.	Initial Setting time	48 min	Not be less than 30 minutes
3.	Final Setting time	240 min	Not be greater then 600 minutes
4.	Fineness	4.8 %	<10
5.	Specific gravity	3.09	-
Compressive strength:- Cement : Sand (1:3)			
1.	3 days	24.5 N/mm^2	27 N/mm^2
2.	7 days	35 N/mm^2	41 N/mm^2
3.	28 days	53.5 N/mm^2	53 N/mm^2

2) *Coarse Aggregates:* The coarse aggregate used were a mixture of two locally available crushed stone of 20 mm and 10 mm size in 70:30 proportion. Coarse aggregate of maximum size 20mm and minimum 10 mm is used throughout the concrete. The specific gravity of coarse aggregate is 2.825.
3) *Fine Aggregates:* Fine aggregate which is used in this experimental study for concrete is taken from local river sand conforming to zone- II. The specific gravity of fine aggregates 2.68.
4) *Plastics Aggregates:* Recycled plastic was used to replace coarse aggregates for making concrete specimens. These aggregates were available in three different sizes (Bigger size plastic aggregate – PB, Medium sized plastics aggregates – PM & Smaller sized plastics aggregates - PS) as shown in Figure below:

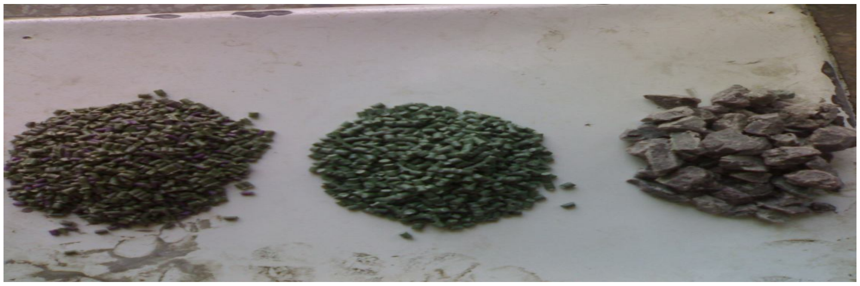

Figure.3.2. Three types of plastic aggregates (smaller, medium and coarser size)

Fineness Modulus of bigger sized plastic aggregate, Medium sized plastics aggregates & Smaller sized plastics aggregates is 7.59, 9.99 and 9.18 respectively. Specific gravity of the plastics aggregates =1.1

IV. METHODOLOGY

A. Mix Prapotioning

In this work the water cement ratio is ranges between 0.40 to 0.52 and the Partial Replacement of plastic aggregate per cube of various water cement ratios is done. The mix proportioning is listed in table below:

S. No.	% of Plastic Agg.	W/C Ratio
MR1	5	0.40
MR2	10	0.40
MR3	15	0.40
MR4	5	0.44
MR5	10	0.44
MR6	15	0.44
MR7	5	0.48
MR8	10	0.48
MR9	15	0.48
MR10	5	0.52
MR11	10	0.52
MR12	15	0.52

B. Moulds

To determine the compression strength of the self-compacting concrete, cubes of 150mm×150mm×150mm size were used. Cylindrical moulds are used to determine split tensile strength, having the dimension 150mm diameter and 300mm length. For flexural strength test, Prisms of 100mm×100mm×500mm size were used.

Figure: Casting of Concrete

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V. RESULTS

In this chapter, the experimental results are presented and discussed. The effects of various important parameters on the slump test, compressive strength, split tensile strength of control concrete, plastic concrete and partially replaced concrete are studied for percentage reduction of compressive and split tensile strength and there results are shown below. Tests were performed after 7 and 28 days of proper curing of concrete.

A. Compressive Strength

Table: Percentage reduction in 7 Days Compressive strength of Control concrete and Plastic concrete

W/C Ratio	7 Days Compressive strength (MPa)		Percentage reduction in Compressive strength (%)
	control concrete	plastic concrete	
0.40	25.84	8.55	66.91
0.44	25.16	7.51	70.15
0.48	23.10	6.84	70.39
0.52	18.21	6.60	63.76

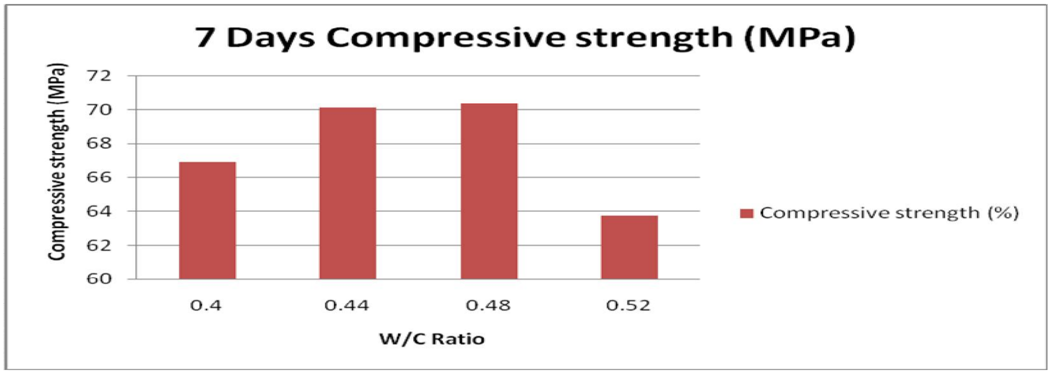

Table: Percentage reduction in 28 Days Compressive strength of Control concrete and Plastic concrete

W/C Ratio	28 Days Compressive strength (MPa)		Percentage reduction in Compressive strength (%)
	control concrete	plastic concrete	
0.40	39.67	13.09	67.00
0.44	38.47	11.39	70.39
0.48	35.37	10.65	69.89
0.52	27.67	10.21	63.10

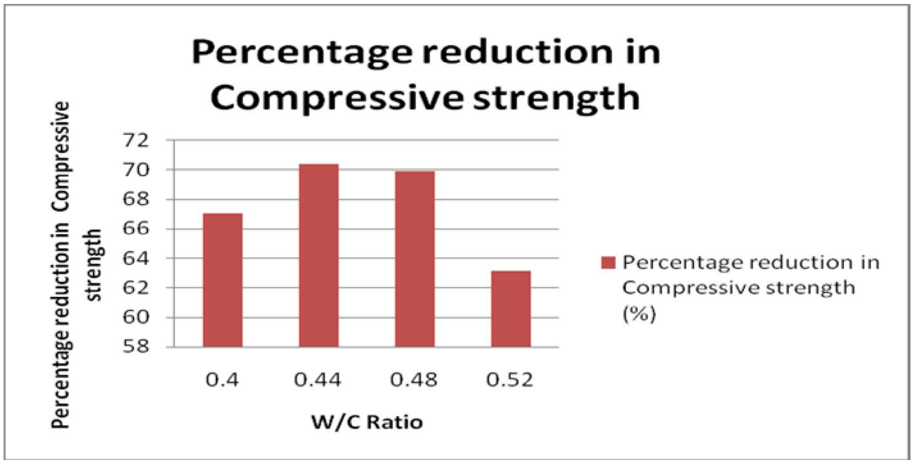

Table: Percentage reduction in 7 Days Compressive strength of Control concrete and partially Replaced Plastic aggregate concrete

S. No.	% Replacement of plastic Agg.	W/C Ratio	7 Days Compressive strength (MPa)		Percentage reduction in Compressive strength (%)
			control concrete	Partially Replaced	
MR1	5	0.40	25.84	21.65	16.23
MR2	10	0.40	25.84	20.99	18.78
MR3	15	0.40	25.84	17.77	31.22
MR4	5	0.44	25.16	20.66	17.88
MR5	10	0.44	25.16	20.53	18.39
MR6	15	0.44	25.16	18.19	27.72
MR7	5	0.48	23.1	21.74	5.87
MR8	10	0.48	23.1	18.62	19.38
MR9	15	0.48	23.1	16.15	30.08
MR10	5	0.52	18.21	15.53	14.74
MR11	10	0.52	18.21	14.94	17.98
MR12	15	0.52	18.21	11.82	35.11

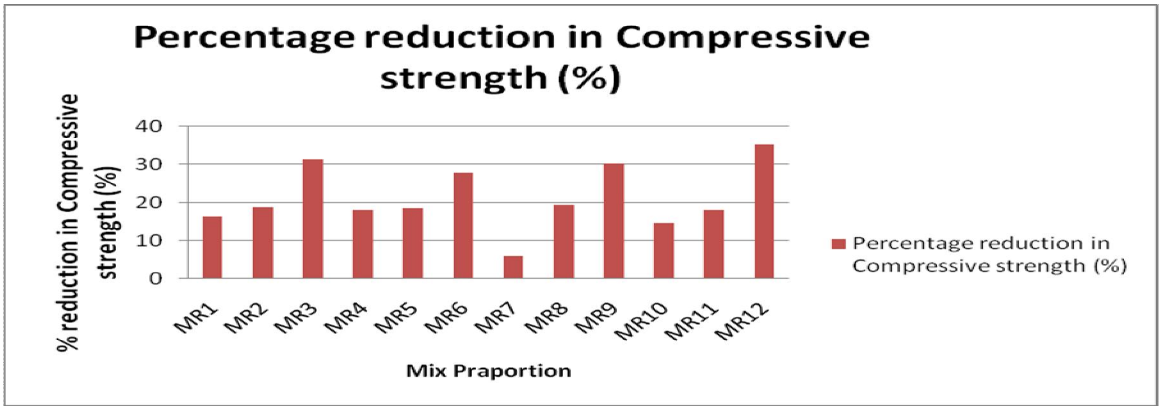

Table: Percentage reduction in 28 Days Compressive strength of Control concrete and partially Replaced Plastic aggregate concrete

S. No.	% Replacement of plastic Agg.	W/C Ratio	28 Days Compressive strength (MPa)		Percentage reduction in Compressive strength (%)
			control concrete	Partially Replaced	
MR1	5	0.40	39.67	33.08	16.61
MR2	10	0.40	39.67	32.08	19.13
MR3	15	0.40	39.67	27.76	30.03
MR4	5	0.44	38.47	32.80	14.75
MR5	10	0.44	38.47	31.53	18.04
MR6	15	0.44	38.47	27.45	28.64
MR7	5	0.48	35.37	33.12	6.37
MR8	10	0.48	35.37	28.17	20.37
MR9	15	0.48	35.37	25.01	29.28
MR10	5	0.52	27.67	23.47	15.17
MR11	10	0.52	27.67	22.51	18.65
MR12	15	0.52	27.67	18.05	34.78

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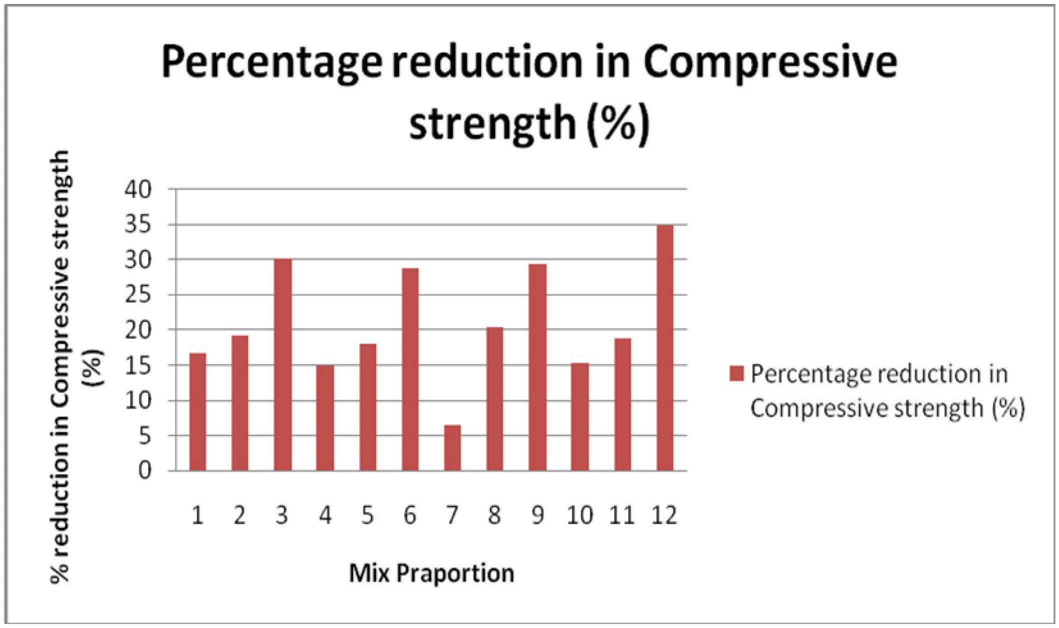


B. Split Tensile Strength

Table: Percentage reduction in 28 Days Split tensile strength of Control concrete and Plastic concrete

W/C Ratio	28 Days Split tensile strength (MPa)		Percentage reduction in Split Tensile strength (%)
	control concrete	plastic concrete	
0.40	3.98	1.13	71.6
0.44	3.92	0.8	79.6
0.48	3.67	0.76	79.3
0.52	3.04	0.74	75.7

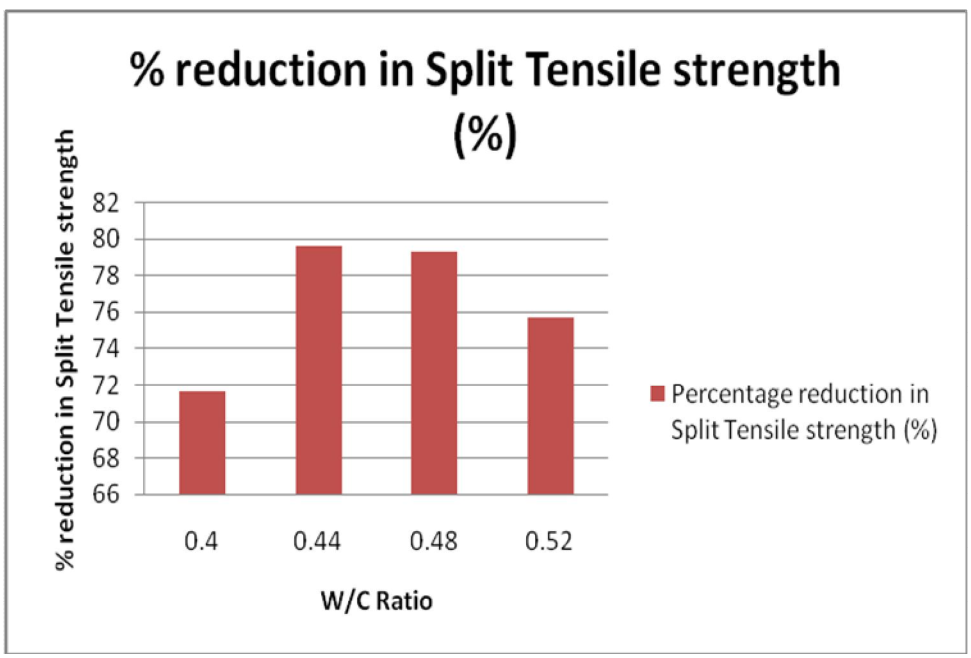
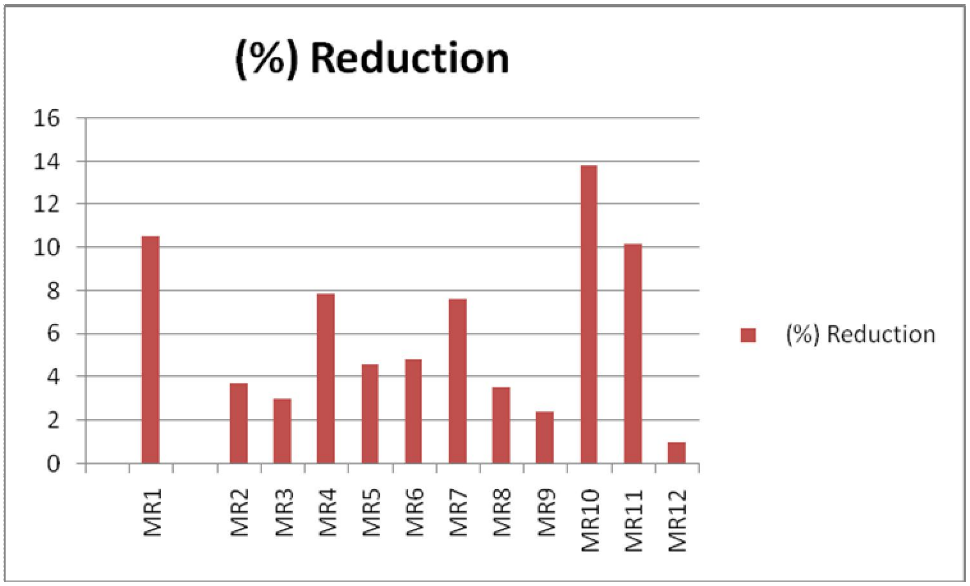


Table: Percentage reduction in 28 Days Split tensile strength of Control concrete and partially Replaced Plastic aggregate concrete

S. No.	W/C Ratio	28 Days Split tensile strength (MPa)		(%) Reduction on split tensile strength
		control concrete	Partially Replaced	
MR1	0.40	3.98	4.4	- 10.55
MR2	0.40	3.98	4.13	-3.76
MR3	0.40	3.98	3.86	3.01
MR4	0.44	3.92	4.23	-7.9
MR5	0.44	3.92	4.1	-4.6
MR6	0.44	3.92	3.73	4.85
MR7	0.48	3.67	3.95	-7.63
MR8	0.48	3.67	3.8	3.54
MR9	0.48	3.67	3.58	2.45
MR10	0.52	3.04	3.46	-13.82
MR11	0.52	3.04	3.35	-10.2
MR12	0.52	3.04	3.01	0.98



VI. CONCLUSIONS

A. The Plastics can be used to replace some of the aggregates in a concrete mixture. This contributes to reducing the unit weight of the concrete. This is useful in applications requiring non bearing lightweight concrete, such as concrete panels used in facades.

B. Partial replacement of plastic aggregate shows less reduction in compressive strength as compared to complete replacement.

C. The split tensile strength of partially replaced plastic aggregate is more for less water cement ratio, so it can be used where split tensile strength are required and compressive strength may sacrificed.

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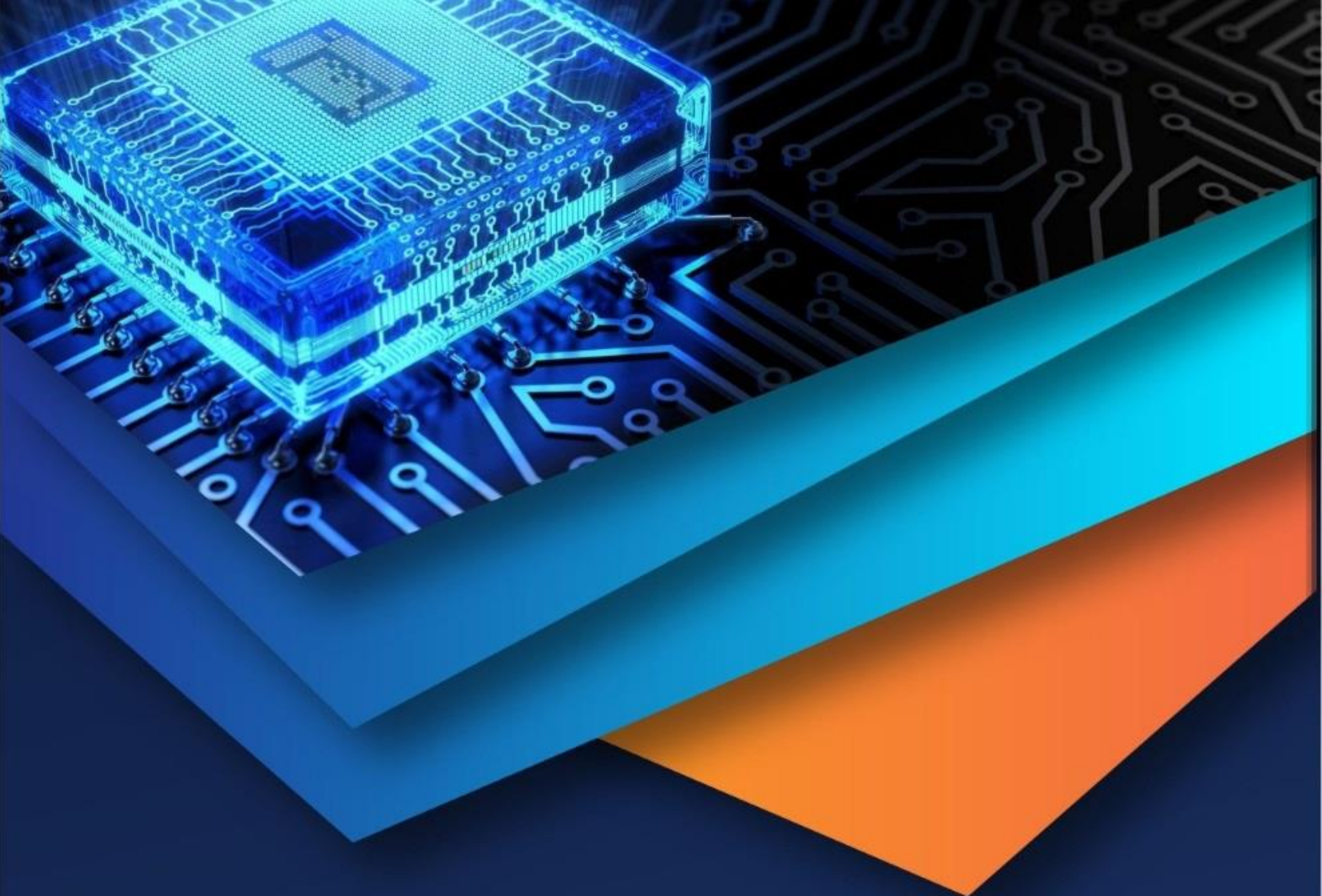

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