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Experimental Study on the Partial Replacement of the Cement with Waste Marble Dust and Fine Aggregate with CRT Waste

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Abstract: ***The attention of the world towards sustainable development is one of the major concerns from the past few years. This act of using huge volume of natural aggregates in construction industry leads to the shortage of natural aggregate in construction process. The latest trend in construction industry is to use alternate materials which can be best substitute of natural aggregates so that there is no compromise in terms of strength and durability considerations of structure. Reusing waste materials as an alternative to natural aggregates can help in reducing environmental problems, pollution, waste disposal and global warming. From the last few years, it has been found that the waste generated from demolition of construction site and old structures is increasing at more rapidly. Thus, reusing and recycling these wastes may reduce the usage of natural aggregates and thus contribute in reducing environmental hazards. In the present experimental work, the natural fine aggregates are partially replaced by crushed CRT Glass aggregates with replacement ratio of 0%, 5%, 10%, 15% and 20% and cement is partially replaced by marble dust with replacement ratio of 0%, 5%, 10%, 15% and 20%. Five different mixes of were prepared and based on the results. In this experiment, five different mixes of combined Marble Dust and crushed CRT aggregates were used in the present study. The different mixes are studied for mechanical and durability properties of M-35 concrete. The results have demonstrated that the concrete mixes with 5% CRT aggregates and 10% marble dust replacement gives compressive strength and split tensile strength slightly more than the normal design mix.***

Keywords: **Marble Dust, Crushed CRT Aggregate, Compressive strength, Split tensile test, Flexure strength.**

I. INTRODUCTION

Concrete is the most widely used construction material, and huge amounts of natural resources are required to manufacture it and as we know the present world no construction activity can be imagined without concrete. About 70–80% volume of the structural concrete is occupied by the aggregates, in which coarse aggregate (CA) contributes 40–50% and fine aggregate contributes 25–30%. Conventionally, naturally available materials like crushed rocks and river sand are used as coarse and fine aggregate respectively. Nowadays scarcity of resources is a major problem resulted by the excessive depletion of natural aggregates. Over the last few years, Cathode-Ray Tube (CRT) technology has been lagging behind due to the continuous replacement of new technologies, namely the LED Display Panel and the Liquid Crystal Displays (LCD) which is causing an increase in the number of discarded CRTs around the world the number of discarded CRT's that need to be disposed every year. By the year 2050, the amount of discarded CRT might be six times higher than the current amount. The disposal of waste materials from the marble industry, consisting of sludge that is composed of powder mixed with water, is one of the current worldwide environmental problems. We can aid to this problem by reusing and recycling the waste products, reducing the use of natural materials and using environmentally friendly materials. Minimizing the waste can be achieved by using waste products as aggregates and other materials in construction practices. In the present study a part of cement is replaced by marble dust and natural fine aggregates with heavy crushed CRT Tube aggregates. It will help in studying the change in behaviour in mechanical properties of concrete. The study presents an opportunity for the utilization of waste marble dust and CRT Tubes and provides a correlation between compressive strength and the various durability parameters. All the durability characteristics were found to be within the limits prescribed by the codes for normal concrete. The concrete with marble dust and CRT was seen to have the best resistance against abrasion and good workability.

In India, tones of marble dust and Waste CRT Tubes are generated per year and disposal of it to the environment is one of the major challenges as it leads to environmental pollution. Disposal of waste reduces landfill space and harms the environment and humans.

Utilizing both waste materials in concrete is an efficient alternate to solve this environmental problem and saving our natural resources. R Reusing these materials in construction and other industrial sectors is one such possible alternative for saving natural resources and protecting environments from various pollutants.

II. MATERIALS

A. OPC 43 Grade Cement

Cement is a fine, grey powder. It is a fine powder produced by grinding Portland cement clinker (more than 90%), a limited amount of calcium sulphate (which controls the set time) and up to 5% minor constituent it is mixed with water and materials such as coarse aggregates and fine aggregates to make concrete. The cement contains two basic ingredients namely argillaceous and calcareous. The ordinary Portland cement (OPC) is the most important type of cement. The OPC is classified into three grades, namely 33 grade, 43 grade and 53 grade depending upon the compressive strength of cement of 28 days. Portland cement concrete is foremost among the construction materials used in civil engineering projects around the world. The reasons for its often use are varied, but among the more important are the economic and widespread availability of its constituents, its versatility and adaptability, as evidenced by the many types of construction in which it is used, and the minimal maintenance requirements during service. In this experiment, we have used OPC 43 grade cement.

B. Aggregate

Generally, aggregates occupy 70% to 80% of the volume of concrete and have an important influence on its properties. They are granular materials, derived for the most part from natural rock (crushed stone, or natural gravels) and sands. In addition to their use as economical filler, aggregates generally provide concrete with better dimensional stability and wear resistance. In order to obtain a good concrete quality, aggregates should be hard and strong, free of undesirable impurities, and chemically stable.

1) *Coarse Aggregate:* Materials which are large to be retained on 4.75 mm IS sieve and contain only that much of fine material as is permitted by the specifications are termed as coarse aggregates. The graded coarse aggregate is described by its nominal size i.e., 40 mm, 20 mm, 16 mm and 10 mm. Since the aggregates are formed due to natural disintegration of rocks or by the artificial crushing of rocks or gravel, they derive many of their properties from the parent rocks. These properties are chemical and mineral composition, specific gravity, hardness, strength pore structure and colour.
2) *Fine Aggregate:* It is aggregate most of which passes through a 4.75 mm IS sieve. Sand is generally considered to have a lower size limit of about 0.075mm. Depending upon the particle size distribution IS: 383-1970 has divided the fine aggregate into four grading zones. The grading zones become finer from grading zone I to grading zone IV

C. Marble Dust

The waste produced from marble industry is in viscous form and generally named as marble sludge. As the sludge of the marble is in wet form, it is dried properly so that it can be used properly as a replacement of cement. The marble powder was sieved through IS-90 micron sieve before mixing in concrete.

D. Crushed CRT aggregate

CRT glass fine aggregate were used in the preparation of cement mortar. The CRT glass is purchased and crushed to produce fine aggregates the aggregates produced were then sieved through 4.75 and 0.075mm sieve to get desired size. The maximum size of fine CRT aggregates used was 2.5 mm. CRT glass was crushed by hammer and sieved from 4.75mm sieve.

E. Water

Fresh and clean tap water is used for casting the specimen in the present study. The water is relatively free from organic matter, silt, oil, sugar, chloride and acidic material as per Indian standard.

III. METHODOLOGY

A. Concrete Mix Design

M-35 grade of Concrete will be used for this study. The present investigation includes design of concrete mix for medium strength concrete. The guidelines given in various codes like SP: 23-1982, IS: 10262-1982 and IS: 456-2000 have been adopted for mix design of concrete. Proportions of the different material as per design mix are:

Table 1: Normal Design mix of Concrete

Water	Cement	Fine Aggregate	Coarse Aggregate
191.59 litres	478.95 kg	522.05 kg	1064.35 kg
0.41	1	1.09	2.22

B. Mixing Proportions

Table 2: Mixing Proportion Designated with CRT and Marble Dust alone

Mix	Reference mix K0	D1	D2	D3	D4	C1	C2	C3	C4
Marble Dust %	0	5	10	15	20	--	--	--	--
Crushed CRT Aggregates%	0	--	--	--	--	5	10	15	20

Table 3: Mix Designation and Mix Proportions of M-35 Grade Concrete

Mix Designation	W/C ratio	Cement Content	F.A (kg)	C.A(kg)	Marble Dust (kg)	CRT Aggregates
K0	0.40	478.95	522.06	1054.07	--	--
D1	0.40	455.00	522.06	1054.07	23.95	--
D2	0.40	431.06	522.06	1054.07	47.90	--
D3	0.40	407.11	522.06	1054.07	71.84	--
D4	0.40	383.16	522.06	1054.07	95.79	--
C1	0.40	478.95	495.96	1054.07	--	26.10
C2	0.40	478.95	469.85	1054.07	--	52.21
C3	0.40	478.95	443.75	1054.07	--	78.31
C4	0.40	478.95	417.65	1054.07	--	104.41

IV. RESULT AND DISCUSSIONS

A. Combined Mix of Marble Dust & CRT Aggregates Based on Individual Tests

Based on Optimum values obtained from above test results two values of Marble Dust10% and 20%, and two optimum values of Crushed CRT Fine Aggregates 5% and 20% were selected and four different combinations were made as shown in table below:

Table 4 : Combined Mix of Marble Dust & CRT Aggregates

Mix Designation	W/C ratio	Cement Content	F.A (kg)	C.A(kg)	Marble Dust (kg)	CRT Aggregates
K0	0.40	478.95	522.06	1054.07	--	--
D2, C1	0.40	431.06	495.96	1054.07	47.9	26.10
D2, C4	0.40	431.06	417.65	1054.07	47.9	104.41
D4, C1	0.40	383.17	495.96	1054.07	95.79	26.10
D4, C4	0.40	383.17	417.65	1054.07	95.79	104.41

B. Slump Test

Minimum Water Absorption Value was obtained with 10% mix with Marble Dust and 20% CRT Aggregates.

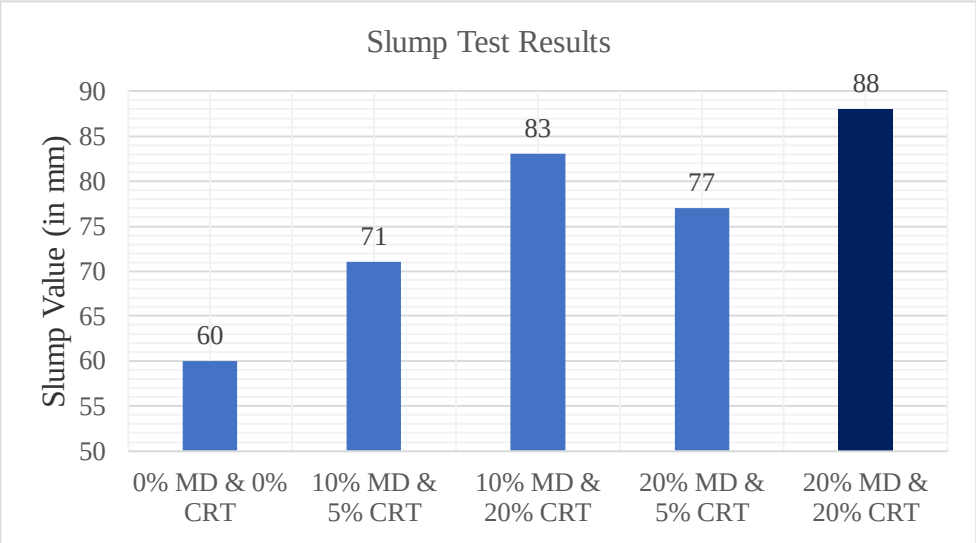

Fig. 1 Slump Test Result of Combined Mix

C. Water Absorption Test

Minimum Water Absorption Values were obtained with 10% mix with Marble Dust and 20% CRT Aggregates.

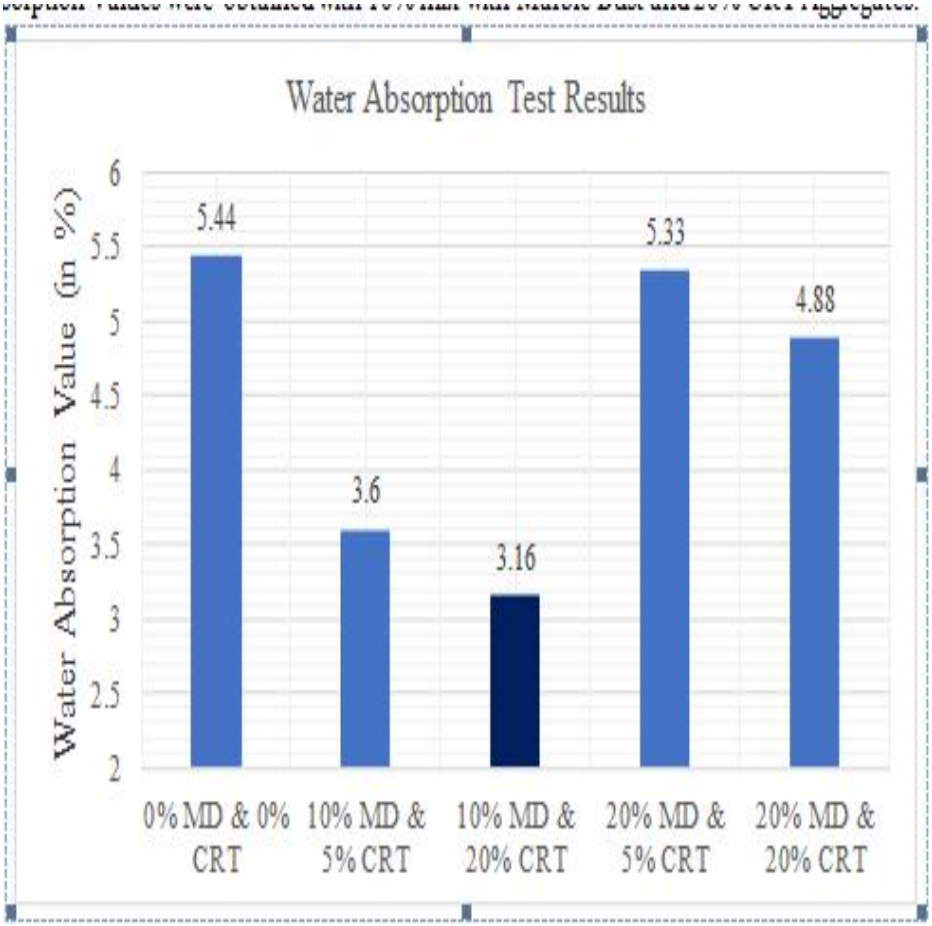

Fig. 2 Water Absorption test for combined mix

D. Compressive Strength

Maximum Compressive Strength value for 28 days was obtained with 10% mix with Marble Dust and 5% CRT Aggregates.

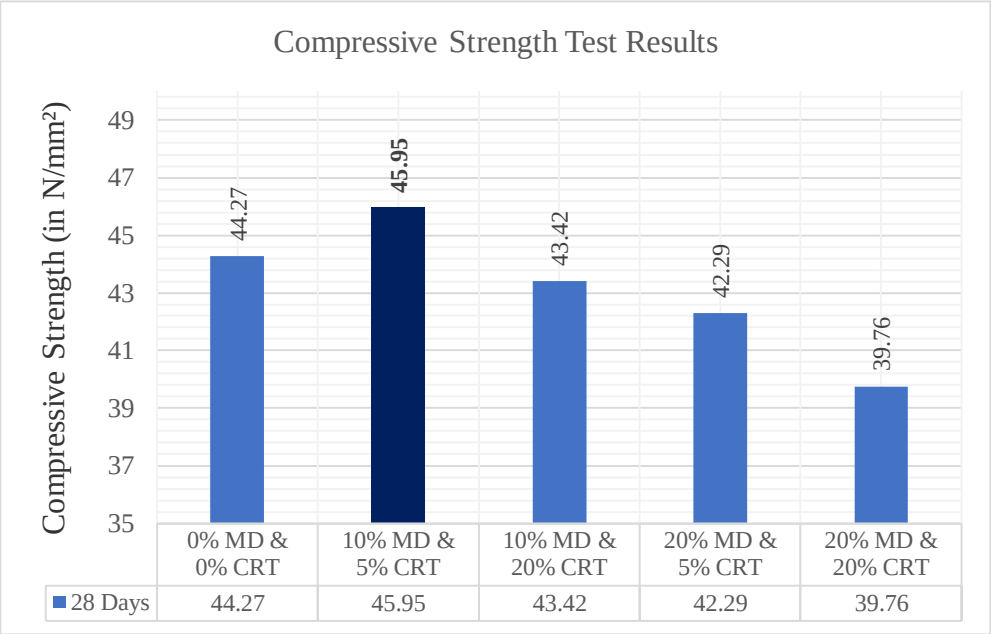

Fig. 3 Compressive strength test for combined mix

E. Split Tensile Strength Test

Maximum Split tensile Strength value for 28 days was obtained with 10% mix with Marble Dust and 5% CRT Aggregates.

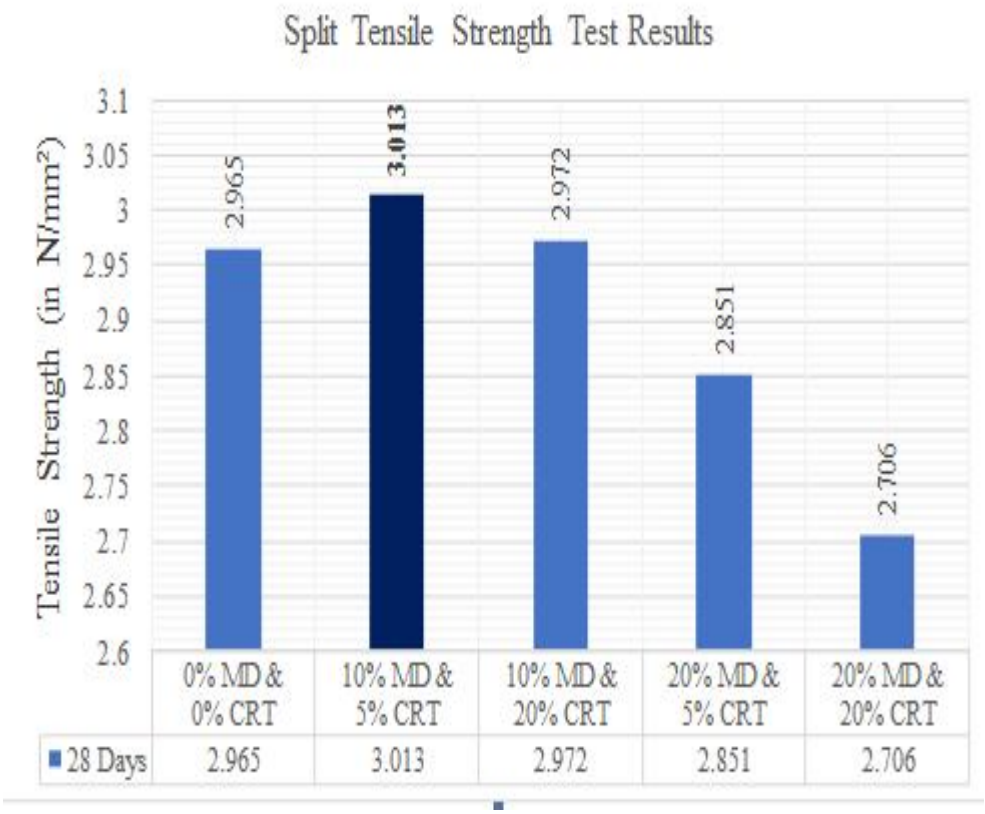

Fig. 4 Split Tensile strength test for combined mix

F. Flexure Strength Test

Maximum Flexure Strength value for 28 days was obtained with 0% mix with Marble Dust and CRT Aggregates.

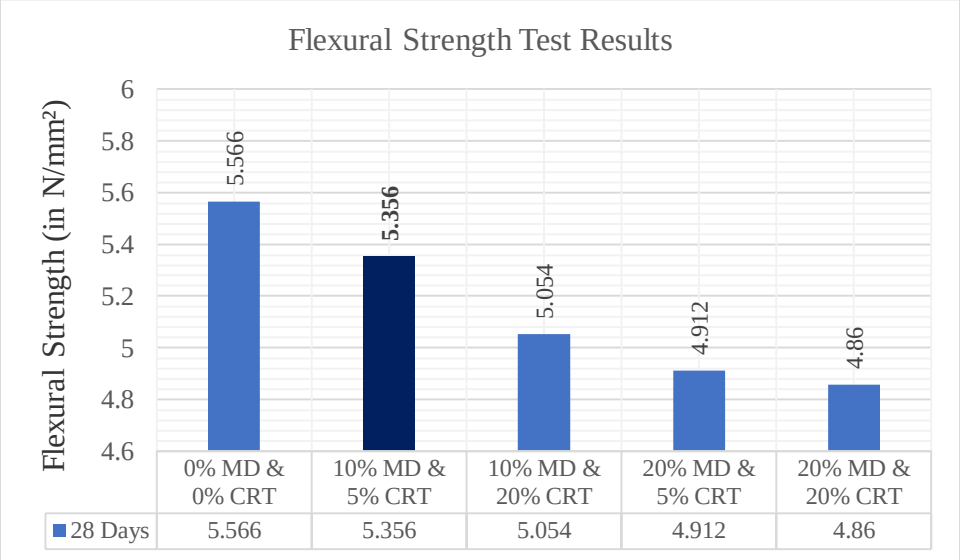

Fig. 5 Flexure strength test for combined mix

V. CONCLUSION AND FUTURE SCOPE

A. Conclusion

1) The maximum value of compressive strength was attained when there was 10% replacement of Cement with Marble Dust and 5% Replacement of Fine aggregates was done with crushed CRT Aggregates it was about 27.73 N/mm² after 7 Days and 45.95 N/mm² after 28 days.

2) The maximum value of Split Tensile strength was attained when there was 10% replacement of Cement with Marble Dust and 5% Replacement of Fine aggregates was done with crushed CRT Aggregates it was about 1.870 N/mm² after 7 Days and 3.013 N/mm² after 28 days.

3) The Minimum value of Water Absorption was attained when there was 10% replacement of Cement with Marble Dust and 20% Replacement of Fine aggregates was done with crushed CRT Aggregates it was about 3.16% which was 58% less than normal M35 Mix.

4) The Maximum value of Water Absorption was attained when there was 20% replacement of Cement with Marble Dust and 20% Replacement of Fine aggregates was done with crushed CRT Aggregates it was about 88mm which was 46% more than normal M35 Mix.

B. Future Scope

Based on the present trend of using different materials in concrete, the possibility of research in the following areas can be explored.

1) Other Different types of waste materials like, Broken and crushed LED panels, Circuit Boards, other waste electronic components recycled waste glass; tile aggregates, marble waste etc. can be used.

2) Other Different form of waste dust powders such as Stone Dust, Brick Dust, etc. can be used.

3) Other Different fibers such as steel fibers, polypropylene fibers, rubber fibers, plastic fibers, etc. can be used for further studies.

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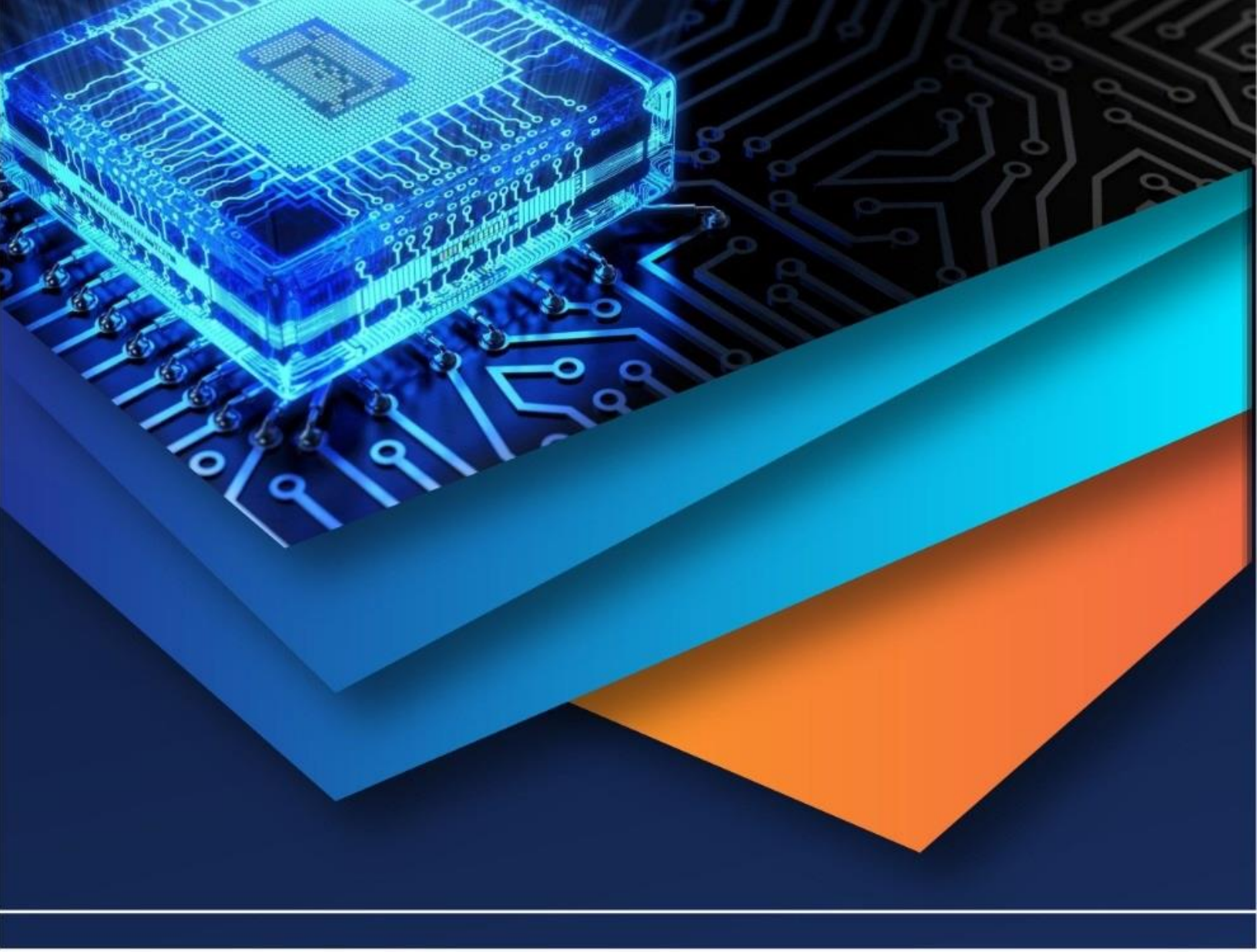

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