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To Study the Mechanical and Durability Properties of Recycled Aggregate and Marble Dust Concrete

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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 may be due to use of natural resources in bulk quantity in construction sector or any other industrial sector. 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 aggregates are replaced by recycled aggregates with replacement ratio of 0%,25%,50% and 100% and cement is replaced by marble dust with replacement ratio of 0%,5% and 10%. Twelve different mixes are used in the present study with varying replacement percentage of recycled aggregates and marble dust. The different mixes are studied for mechanical and durability properties of M30 concrete. Concrete mixes with 25% recycled aggregates and 10% marble dust replacement gives compressive strength and split tensile strength almost equals to normal mix. In terms of durability, the abrasion resistance test is performed on different concrete mixes. Results shows that depth of wear increases with increasing percentage of recycled aggregates and decreases with increasing percentage of marble dust. Concrete mix with 25% recycled aggregates and 10%of marble dust has comparable results in terms of abrasion resistance test to the normal concrete.

Keywords: Recycled Aggregates, Marble Dust, Compressive Strength, Split Tensile Strength, Abrasion resistance etc.

I. INTRODUCTION

Concrete is one of the most widely used construction material in the world. It has been found that after water only this material is extensively used on earth. Basically concrete is the mixture of four major ingredients i.e cement, fine aggregates, coarse aggregates and water. It is similar to artificial stone which is composed of above ingredients. With the passage of time, concrete has found its application in almost every aspect in construction like buildings, ports, dams, retaining walls, roads, railways, skyscrapers, airports and many more. Concrete plays a vital role in the development of economy of any country due to its utilization in huge volumes. Its production consumes almost 20 billions tons of raw materials. The research group of Fredonia stated that the global consumption of aggregates in construction practices may exceed 26 billions tons by 2012. It has been estimated that the pace by which urbanization is increasing, the demand of aggregates would be two times more in the next two to three decades. India is in one of the top ten leading countries that uses its natural resources.

The industrial sector of concrete uses the large amount of natural resources that causes threat to environment, consumes a large amount of energy and contributes to economic losses exploits 50% raw materials , consumes 40% of total energy and generates 50% of total waste. So this is one of the major challenges for environmental scientists to minimize those factors that pose obstruction in sustainable development. As aggregates are one of the most important ingredients in concrete and due to rapidly increasing demand of infrastructure in both the developed and developing countries, the demand of aggregates is becoming extensively high. This leads to the destruction of natural environment and construction of artificial environment in the society. The protection of environment is one of the major challenges in today's world. We can aid to this problem by reusing and recycling the waste products, reducing the use of natural materials and using environmental friendly materials. In order to have sustainable development one must focus on these environmental problems. Demolition of construction waste can be achieved by using recycled aggregates and other waste materials in construction practices. This will not only demolish waste but also preserve our natural resources. This will help in increasing its life span and thus reducing dumping of waste, space for landfill disposal and extracting natural resources. The present

paper focuses on studying the properties concrete and its usage by producing concrete using waste materials such as recycled concrete aggregates as a replacement of natural aggregates and marble dust as replacement of cement.

II. LITERATURE REVIEW

Hyungu Jeong (2011). This paper studies the properties of recycled aggragte concrete(RAC) that relates its use in construction. It was observed with using 74% initial moisture states of RAC, the compressive strength was similar to that of normal concrete and shrinkage was less. S.A Abukersh (2011). This paper deals with the change in properties of recycled aggregates concrete when part of cement is replaced by red granite dust with upto 30% by mass of cement content. Test trails showed that introducing red granite dust is suitable in terms of workability, stiffness and strength as compared to normal aggregate and Portland cement concrete. Red granite dust addition beyond 30% cause a strength decrease, mechanical properties remains acceptable upto 50% of red granite dust for cement replacement. M. Shahul Hameed, (2012). This paper used marble sludge powder (MSP) and crushed rock dust (CRD) which were discarded in in the near by land is used as a filler in concrete. Addition of these waste materials helped in reducing total void contents and hnce improves strength of concrete. The experimental result shows that compressive strength increases with increase in percentage replacement of MSP upto 15% of CRD in place of fine aggregates. Split tensile strength is directly proportional to compressive strength. Ankit Nilesh Chandra (2013). This research works on developing ecofriendly concrete from stone waste. In this study PPC cement was replaced by stone waste in the range of 0%,10%,30%,40%,and 50% by weight of cement. M25 concrete grade was used for the present work. The various concrete admixtures were produced, tesed and compared in terms of workability and strength properties to the conventional concrete. It was observed that compressive strength increased up to 20% replacing of stone waste. M.Surya, et.al(2013). This paper reports the result of a laboratory based experimental study focused at characterizing the properties of recycled aggragates concrete in order to verify their utilization in civil infrastructure. Recycled aggragates used in the study were obtained by crushing concrete cube tested in laboratory. Five different concrete mixes were produced with 0%,50%, 75%, and 100% recycled aggregates with fly ash and two natural aggregates concrete with and without flyash. It was observed that there is no significant variation in compressive strength, flexural strength, and split tensile strength of concrete. But the modulus of elasticity and resistivity decreases and water absorption increases. Noha M. Soliman (2013). This research aims to study the affect of using marble powder as partially replacement of cement on the properties of concrete and influence of marble powder on RC slab is also investigated. The experimental results showed that up to certain amount of marble powder increases the workability, compressive strength, tensile strength. Compressive strength increases by about 25% and 8% for marble powder replacement ratios 5% and 7.5% and same results shows with split tensile strength. It was found that using 5% marble powder decreases the deflection and increases the stiffness of slab. A.V Alves et.al (2014). This paper aims to evaluate the effect of addition of recycled ceramic fine aggregates obtained from crushed bricks and crushed sanitary wares on the mechanical properties of concrete. Seven different concrete mixes were casted with replacement ratios 20%, 50% and 100% of natural fine aggregates with fine recycled brick aggregates or sanitary waste aggregates. Result shows that concrete with fine brick aggregates can exhibit adequate quality as structural concrete unlike concrete with fine sanitary ware aggregates. Compressive and split tensile strength doesn't significantly affected by fine brick aggregates but decreases with the addition of fine sanitary aggregates.

Antonious KAnellopoul et.al (2014). This paper aims at evaluation and effective use of recycled lime powder (RLP) and recycled concrete aggregates(RCA). The results of this paper shows that both RLP and RCA have the potential to produce good quality concrete mixes both in terms of mechanical and durability performance. C. Dhanlaxmi, et.al. (2015). In this study marble powder is used as mineral addition for mortars and concrete in presence of super plasticizing admixture. This paper studies the properties of concrete in which cement is replaced by certain percentages. Limestone powder and marble powder was used as compensating materials with different ratio of cement include 0%,10%,15%,20%,25% and 30%. The result showed increase in compressive strength made with 15% limestone powder. The slump of concrete relatively increases with high values of percentage of compensating of cement with limestone powder. Aditya Rana et.al (2015). This study examines the feasibility of using marble slurry in concrete production as partial replacement of cement. Six concrete mixes were prepared in whch up to 25% of marble slurry was used. The various tests are evaluated such as strength, permeability, porosity, resistance to chloride. It was observed that optimal replacement level of cement by marble slurry was 10%. Gulden Cagin Ulubeyli et.al (2015). This paper works on studying the usage of marble powder in different areas of concrete were studied. In this paper compressive strength, split tensile strength, flexural strength, modulus of elasticity, porosity of concrete were examined. It was concluded that waste marble powder in concrete shows a filler effect up to 5%-10% and using waste marble powder also reduces porosity. Using waste marble powder upto 10 % showed positive effects on properties of concrete. Iveta Novakova et.al (2016). This paper studies the use of recycled concrete aggregates as a replacement of natural aggregates for a concrete production. In this research work precast waste elements were recycled into

recycled concrete aggregates with beneficial properties. It was proved that replacement of raw aggregates by Recycled concrete Aggregates up to 20% has no negative influence on physic mechanical properties.

III. PROPERTIES OF MATERIALS

A. Cement

Ordinary Portland cement (OPC) of grade 43 of brand Ultra Tech was used for all concrete mixes. The cement was fresh and without any lumps. The tests conducted on cement with their respective results are specific gravity= 3.10, consistency= 32%, initial setting time= 80minutes, final setting time =210 minutes and compressive strength at 28 days=43.3Mpa. The various tests for determining the physical properties of cement were done as per Indian Standard Specifications (IS: 8112-1989).

B. Fine Aggregates

Local available sand is used in this study. The various Physical properties and sieve analysis of fine aggregates are performed as per IS:383-1970. Before performing the tests, the sand was passed through 4.75mm sieve in order to remove any particles greater than 4.75mm and then washed properly to remove the dust. The tests performed on soil are specific gravity, water absorption, fineness modulus. The soil used above belongs to Zone III having fineness modulus =2.61. the specific gravity of soil found to be 2.62 and water absorption of 0.25%.

C. Coarse Aggregates

The local available coarse aggregates are used in the present work. The aggregates selected should be clean and free from dust. The maximum size of 10mm and 20mm was used in the present study. The aggregates are tested as per IS 383-1970. The fineness modulus of coarse aggregates is 7.06 and the specific gravity of proportioned aggregates is 2.72.

D. Recycled Aggregates

Recycled aggregates were used to replace coarse aggregates in the present work. These were procured from the concrete specimens such as concrete cubes, beams etc that were tested in the laboratory. Recycled aggregates were used to replace coarse aggregates in the present work. These were procured from the concrete specimens such as concrete cubes, beams etc that were tested in the laboratory. The specific gravity, water absorption and fineness modulus is 2.74, 3.52% and 7.66 respectively.

E. 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. In the present work marble dust was collected from Anand's marble house Jammu. The marble powder was sieved through IS-90micron sieve before mixing in concrete.

Table1: Physical properties of Marble Powder

Sr. No.	**Properties**	**Observations**
1.	Color	White
2.	Form	Powder
3.	Specific Gravity	2.66
4.	Blaine Fineness	1500 m^2/kg

Table2: chemical Composition of marble powder

S.NO.	MATREIAL	MARBLE POWDER (%)
1	LOI	40.63
2	SiO2	4.99
3	Al2O3	1.09
4	Fe2 O3	1.04
5	CaO	32.23
6	MgO	18.94
7	SO3	0.01
8	K2O	0.9
9	Na2O3	0.12

F. Water

The portable water is generally used for making concrete and curing concrete. In the present work tap water was used.

G. Admixture

Admixtures are the one of the ingredients of concrete which is added in concrete during mixing to alter the properties of concrete. Glenium sky was used as admixture in this study. The various admixture properties provided by the manufacturer are mentioned in table below:

Table 3: Physical Properties of Admixture

Form	Liquid
Color	Brown
Specific Gravity	1.06
pH value	7.01
Dosage	0.5 % to 2.0 by weight of cement

IV. RESULTS AND DISCUSSIONS

A. Compressive Strength

Compressive strength is one of the most important mechanical properties of concrete. This test was conducted according to IS 516-1956. The cubes of standard dimension 0f 150X150X150mm were placed in curing tanks were taken out after completion of 28 days. The concrete is basically designed for compression as it is strong in compression and weak in tension. In the present experimental work, compressive strength of concrete is calculated for different percentage of recycled aggregates(0%,25%,50%,and 100%) and marble dust (0%,5% and10%) after 28 days curing is mentioned in table below

Table 4 : Compressive Strength at 28 days for Different Concrete Mixes

S.No	Concrete Designation	28 Days Compressive Strength (Mpa)
1	R_0M_0	39.42
2	R_0M_5	41.21
3	R_0M_{10}	42.61
4	$R_{25}M_0$	37.01
5	R_{25} M_5	38.63
6	$R_{25}M_{10}$	39.44
7	$R_{50}M_0$	33.12
8	$R_{50}M_5$	34.20
9	$R_{50}M_{10}$	34.98
10	$R_{100}M_0$	27.13
11	$R_{100}M_5$	27.82
12	$R_{100}M_{10}$	27.95

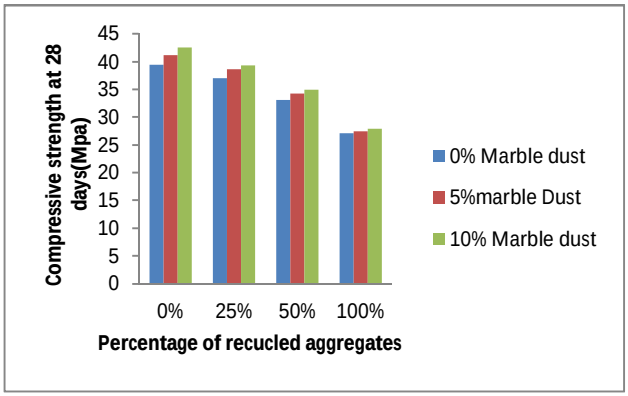

Figure 1: compressive strength at 28 days with varying Percentage of Recycled aggregates and Marble dust

B. Split Tensile Strength

The split tensile strength was conducted on cylinders of standard size 300mm*150mm according to IS code 5816-1970. The cylindrical specimen was placed on CTM at right angle to that of casting position. The load was gradually increased at constant rate of 2.4N/mm^2/minute till the failure of specimen took place and thus the split tensile strength of the specimen can be computed. The split tensile strength is calculated by using formulae given below:Tsp = (2P/ (dL))

Where, P= maximum load in N,

L = Length of specimen in mm

D = diameter of width of specimen in mm

Table 5: Split Tensile Strength of the M30 Concrete at 28 Days

S.No	Mix Designation	28 Days Split Tensile Strength (Mpa)
1	R0M0	2.94
2	R0M5	3.03
3	R0M10	3.18
4	R25M0	2.83
5	R25M5	2.87
6	R25M10	2.95
7	R50M0	2.61
8	R50M5	2.64
9	R50M10	2.70
10	R100M0	2.10
11	R100M5	2.11
12	R100M10	2.13

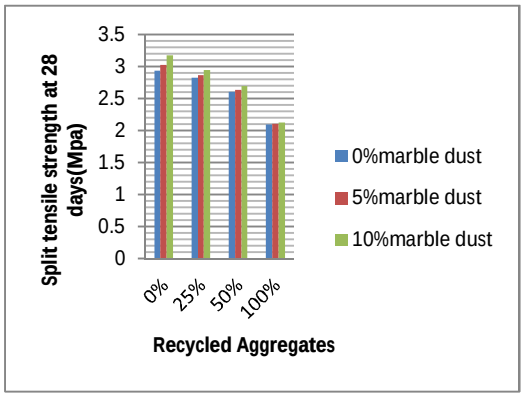

Figure 2: comparison of split tensile strength at 28 days of Normal mix Vs other mixes

C. Abrasion Resistance Test

As discussed earlier abrasion resistance is expressed as depth of wear. If depth of wear decreases it indicates abrasion resistance increases and vice versa. The depth of wear of concrete mixes is tabulated below:

Table 6: Abrasion Resistance of Various Concrete Mixes

S.No	Mix Designation	Depth of Wear (mm)
1	R0M0	1.31
2	R0M5	1.22
3	R0M10	1.10
4	R25M0	1.43
5	R25M5	1.37
6	R25M10	1.30
7	R50M0	1.57
8	R50M5	1.54
9	R50M10	1.51
10	R100M0	1.69
11	R100M5	1.68
12	R100M10	1.67

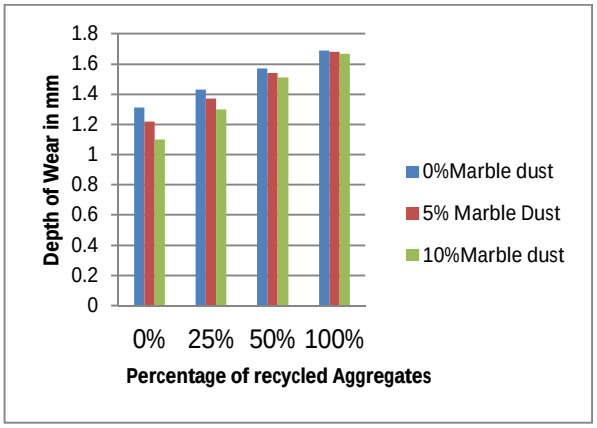

Figure 3: comparison of depth of wear for different concrete Mixes

V. CONCLUSIONS

The following conclusions can be drawn from this study

A. The Compressive strength of the Concrete decreases by the recycled aggregates. At 100 % replacement the Compressive Strength decreases by 31.1% due to the weak adhered mortar. Compressive Strength of the Concrete increases with the marble dust by 8% due to the increased porosity due to marble dust.

B. Split Tensile Strength of the Concrete also decreases by 27.55 % as compared to normal concrete on Replacement with the Recycled aggregates .Replacement with the marble Dust increases the Split Tensile Strength of the Concrete.

C. Concrete Mix having 25 % Recycled Aggregates and 10% marble dust will give the Compressive Strength equivalent to the Normal Mix, hence this can be considered as the optimum mix in terms of the Strength.

D. The abrasion resistance of the concrete decreases with the increase in the Recycled aggregate content or In simple words the Depth of wear increases with the recycled aggregate content. The depth of Wear increases by 9.16%, 19.84% and 29% at 25%, 50% and 100% Replacement by the recycled aggregates as compared to Normal Concrete due to weaker attached matrix of the Recycled Aggregates.

E. Replacement of the Cement with 10% Marble Dust decreases the Depth of Wear by 16.03% Compared to Normal Concrete. At a Particular Replacement percentage of Marble Dust, the effectiveness of marble dust in improving the depth of wear decreases with increasing recycled aggregate content due to the increase in the Porosity by the Recycled Aggregates.

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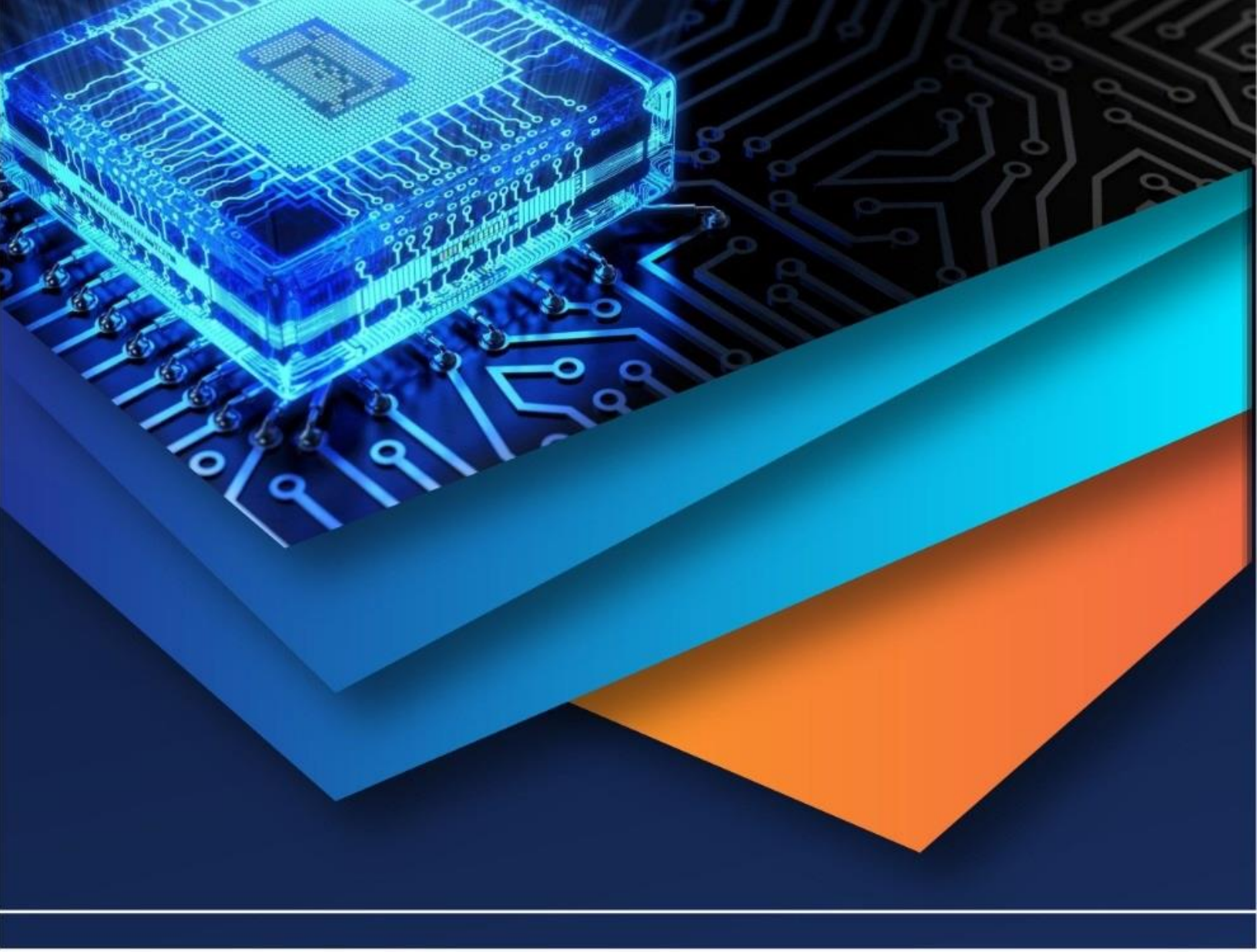

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