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# Partial Replacement of Course and Fine Aggregate by Mossiac Tile Chips and Granite Powder

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***Abstract:*** ***Since last few years, construction industries has taken boom and due to this the concrete jungles had replaced the greeneries. This process continues due to increase in population also housing is the basic need of humans. But for these housing and other major constructions large amount of concrete is required and so as the requirement of coarse as well as fine aggregate arises. This leads to depletion of natural resources as quarrying sand and aggregates have adverse effect on environment. Also due to modernization people are using cladding material highly for lavish decoration of houses. Which includes excessive use of tiles, marbles and granites in new houses? Due to these reasons the reuse of constructional wastes like mosaic tiles, granite powder, marble chips came into the picture to reduce the solid waste and to reduce the scarcity of natural aggregates for making concrete. The tile waste which happens from the dismantling of structures as well as from the producing factories. Studies show that about 20-25% of tiles made in the tiles making industries are transforming into waste. This waste material must be recycled and used again to stop the depletion of natural aggregate and to reduce the construction wastes and to avoid polluting the environment. This article is about finding the optimum percentage of replacement of course as well as fine aggregate and to perform various tests regarding strength of concrete.***

***Keywords: Crushed mosaic tiles, Granite powder, workability, Compressive strength, Split Tensile strength.***

## I. INTRODUCTION

Due to the modern civilization, day by day, the solid waste is increasing from the demolitions of constructions. There is a huge usage of ceramic tiles in the present, constructions are going on and it is increasing in day by day construction field. Indian tiles production is 750 million ton per year in the ceramic industry, about 15%-20% waste material generated from the total production. This waste is not recycled in any form at present, as of their chemical as well as physical properties, the ceramic waste is durable, hard and highly resistant to biological, chemical and physical degradation forces so, it can be used as a replacement material to the basic natural aggregate to reuse them and to decrease the amount of the solid waste produced from dismantles of construction as well as manufacturing waste. Waste tiles and granite powder were collected from the local shops and manufacturing units.

Now a days innovations and development in construction field are increased so the use of both course and fine aggregates is also increased tremendously and at the same time, the production of solid wastes from the dismantling of the constructions is also very high. Also because of increase in lavish living, peoples are now a days moving towards elegant and furnish lifestyle In INDIA, the granite processing is one of the most flourishing industry. granite industries in India manufactures more than 3500 metric tons of granite powder per day. During the cutting process about 25% the original granite mass is lost in the form of dust. The advancement of concrete technology can reduce the use of innate resources and energy sources which in turn further lessen the burden of pollutants on the environment. The use of partial replacement of fine aggregate(sand) by granite powder, cut down some concrete production, thus brings down the requirement for land area for drawing resources and disposal of industrial waste too. Now a days, huge quantity of granite powder is coming out in natural stone processing plants having an adverse effect on the environment as well as humans Crushed waste ceramic tiles and Granite powder are used as a replacement to the coarse aggregates and fine aggregate. The ceramic waste crushed tiles were partially replaced in place of coarse aggregates by 10%, 20%, 30%, 40% and 50%. Granite powder was replaced in place of fine aggregate by 10% along with the ceramic coarse tile. M25 grade of concrete was designed and tested. The mix design for different types of mixes were prepared by replacing the coarse aggregates and fine aggregate at different percentages of crushed tiles and granite powder. Experimental investigations like workability, Compressive strength test, Split tensile strength test, Flexural strength test for different concrete mixes with different percentages of waste crushed and granite powder after 7, 14 and 28 days curing period has done. It has been observed that the workability increases with increase in the percentage of replacement of granite powder and crushed tiles increases. The strength of concrete also increases with the ceramic coarse tile aggregate up to 30% percentage.

## II. LITERATURE REVIEW

After the progress have been made in replacement of aggregate by different materials, analyst have achieved various accomplishment in a few phase still on urge to find out material to increase the strength of concrete by replacement.

G.sai chand, P.ravi kumar (2017)[1]: For tile waste based concrete, coarse aggregates were replaced by 20mm down size, tile wastes by 10%, 20%, 30%, 40% and 50%. Crushed tile powder is also used as partially replace fine aggregate by 10%.The maximum compressive strength of concrete is obtained at a replacement of 30%. A reduction of 10-15% of strength is observed compared to conventional concrete at 50% of tile aggregate replacement. The workability of tile waste concrete is in the range of medium.

Batriti Monhun R. Marwein (2016)[2] : Batriti had replaced the coarse aggregate by waste tiles at 0%, 15%, 20%, 25% and 30%. M20 grade concrete is adopted.This paper suggests that the replacement of waste tile aggregate should be in the range of 5-30% and also it is suitable to ordinary mixes like M10,M15 etc.

Topçu and m. Canbaz (2010)[3]. The use of tile waste has a beneficial effect on environment and in the cost aspects too. This study shows that adding tile waste in place of aggregate can reduce the self weight of the concrete utpo 4%. This papers suggested that more than 50% replacement had bad effect on both the compressive and split tensile strength of concrete. But this paper studied maximum replacements of tile waste which can be further divided into smaller percentages and can be utilized in concrete with desirable properties.

Julia Garcia-González, Desire Rodríguez-Robles, Andrés Juan-Valdés, Julia Ma Morán-del Pozo and M. Ignacio Guerra-Romero et al(2014)[4] : The study concentrates on the ceramic waste from industries in Spain. The concrete design is done as per the Spanish concrete code and the recycled ceramic aggregates met all the technical requirements imposed by current Spanish legislation. The ceramic aggregates are replaced up to 100% replacement of coarse aggregate. Flexural strength test for different concrete mixes decreases. The concrete was shows the property similar to normal stones.

Md Daniyal and Shakeel Ahmad et al(2015)[5] : A large quantity of ceramic materials goes into wastage during processing, transporting and fixing due to its brittle nature. They replaced the coarse aggregate by waste tiles at 0%, 15%, 20%, 25% and 30%. M20 grade concrete is adopted The study states that the use of ceramic tile aggregate in concrete enhances its properties and it has been observed an increase in both compression and flexural strength.

## III. METHODOLOGY

### A. *Materials And Properties*

1) *Cement:* A cement is a binder, a substance used in construction that sets and hardens and can bind other materials together. The Portland cement is commonly being used since decades. There are many varieties of Portland cement available in the market. While the most commonly used cement in constructions is ordinary Portland cement. In this research OPC of 53 Grade of brand name Ultra Tech Company, available in the local market was used.

2) *Fine Aggregates:* River sand locally available in the market was used in the investigation. The sand was tested as per IS: 2386-1963.The sand was surface dried before use.

| S.No | Description Test | Result |
|---|---|---|
| 1 | Sand zone | Zone- III |
| 2 | Specific gravity | 2.59 |
| 3 | Free Moisture | 1% |

Table 1: Properties of Fine Aggregate

3) *Coarse Aggregates:* Crushed aggregates below 20mm size produced from local crushing plants were used. The aggregate exclusively passing through 20mm sieve size and retained on 10mm sieve is selected. The aggregates were tested as per IS: 2386-1963. The particular specific gravity and water absorption of the mixture are given in table.

| S.No | Description | Test Results |
|---|---|---|
| 1 | Nominal size used | 20mm down |
| 2 | Specific gravity | 2.9 |
| 3 | Water absorption | 0.15% |
| 4 | Sieve analysis | 20mm |

Table 2: Properties of Coarse Aggregate

4) *Water:* Water plays a very important role in gaining the strength of concrete. For complete hydration it requires about 3/10th of its weight of water. If water content exceeds permissible limits it may cause bleeding. If less water is used, the required workability is not achieved. Potable water fit for drinking is required to be used in the concrete and it should have pH value ranges between 6 to 9. Normal drinking water is used for batching

5) *Mosaic Tile Aggregate:* Broken tiles were collected from the solid waste of ceramic manufacturing unit and from demolished building. The waste tiles were crushed into small pieces by manually and by using crusher. The required size of crushed tile aggregate was separated to use them as partial replacement to the natural coarse aggregate.

Figure 1: Waste tiles aggregate

The tile waste which is lesser than 4.75mm size was neglected. The crushed tile aggregate passing through 16mm sieve and retained on 12.5mm sieve are used. Crushed tiles were partially replaced in place of coarse aggregate by the percentages of 10%, 20% and 30%, 40% and 50% individually and along with replacement of fine aggregate with granite powder also

| S.No | Description | Test Results |
|---|---|---|
| 1 | Specific gravity of crushed tiles | 2.6 |
| 2 | Water absorption of crushed tiles | 0.19% |

Table 3: Properties of mosaic tile chips

6) *Granite Powder:* Since granite powder is obtained from crushing of granite rocks, the chemical and mineral composition of granite is similar to that in cement and natural aggregates. It is chosen to test the behaviour of concrete along with the ceramic tile waste

| Sr.No | Description | Test Results |
|---|---|---|
| 1 | Specific gravity of granite powder | 2.4 |
| 2 | Water absorption of granite powder | 0.10% |

Table 4: Properties of Granite Powder

From Industry granite powder will be collect; 4.75 mm passed materials was separated to use it as a partial replacement to the fine aggregate. Granite powder was partially replaced in place of fine aggregate by the percentages of 10% along with replacement of coarse aggregate with crushed tiles also.

*B. Methodology*

The methodology of research includes the collection of required materials from the various sources and determining the properties of all the materials gathered. Designing the concrete mix proportions for all types of replacements and Preparation of the concrete mix, Moulding and curing. The testing of concrete includes Slump cone test, compaction factor test for determining workability of concrete in fresh state and compressive strength, split tensile test and flexural test for determining the strength of concrete in hardened state. Total 13 types of mixes are prepared along with conventional mixes. The coarse aggregates are replaced by 10%, 20%, 30%, 40% and 50% of crushed tiles and the fine aggregate is replaced by 10% of both crushed tile powder and granite powder individually but along with the coarse aggregate. The details of mix designations are as follows:

| S.no | Mix | Cem % | CA (%) | | FA (%) | |
|---|---|---|---|---|---|---|
| | | | NCA | Tiles | Sand | GP |
| 1 | M0 | 100 | 100 | 0 | 100 | 0 |
| 2 | M1 | 100 | 90 | 10 | 100 | 0 |
| 3 | M2 | 100 | 80 | 20 | 100 | 0 |
| 4 | M3 | 100 | 70 | 30 | 100 | 0 |
| 5 | M4 | 100 | 60 | 40 | 100 | 0 |
| 6 | M5 | 100 | 50 | 50 | 100 | 0 |
| 7 | M6 | 100 | 90 | 10 | 90 | 10 |
| 8 | M7 | 100 | 80 | 20 | 90 | 10 |
| 9 | M8 | 100 | 70 | 30 | 90 | 10 |
| 10 | M9 | 100 | 60 | 40 | 90 | 10 |

Table 5: Details of aggregate replacement

*Mix Design For M25 Grade Concrete:*

C : FA : CA : WATER
384 : 646.4 : 1271.30 : 187.5
1 : 1.68 : 3.31 : 0.50

## IV. TEST RESULTS

### A. *Workabilty*

1) *Slump Cone Test:* The pattern of workability obtained is True Slump. Workability Results obtained from slump cone test for various grades of concrete are shown in following

| S.No | Mix | % (CCA+GP ) | Workability (mm) |
|---|---|---|---|
| 1 | M0 | 0+0 | 69 |
| 2 | M1 | 10+0 | 72 |
| 3 | M2 | 20+0 | 74 |
| 4 | M3 | 30+0 | 77 |
| 5 | M4 | 40+0 | 81 |
| 6 | M5 | 50+0 | 83 |
| 7 | M6 | 10+10 | 76 |
| 8 | M7 | 20+10 | 82 |
| 9 | M8 | 30+10 | 94 |
| 10 | M9 | 40+10 | 92 |

Table 6: Test results from slump cone test for workability in mm

2) *Compressive Strength:* A total of 126 cubes of size 150 x 150 x 150 mm were cast for 7 days, 14 days and 28 days testing. For each grade of concrete 42 cubes are tested, 14 each for 7, 14 and 28 days and the results are tabulated below:

| S.No | Mix | Aggregate Replacements % (CCA+GP) | Compressive strength of M25 grade in N/mm$^2$ | | |
|---|---|---|---|---|---|
| | | | 7 days | 14 day | 28 days |
| 1 | M0 | 0+0 | 16.46 | 24.13 | 29.20 |
| 2 | M1 | 10+0 | 19.27 | 23.11 | 29.55 |
| 3 | M2 | 20+0 | 21.02 | 26.24 | 31.60 |
| 4 | M3 | 30+0 | 20.90 | 28.02 | 32.51 |
| 5 | M4 | 40+0 | 19.17 | 25.42 | 29.73 |
| 6 | M5 | 50+0 | 17.78 | 23.10 | 27.34 |
| 7 | M6 | 10+10 | 16.84 | 22.91 | 29.68 |
| 8 | M7 | 20+10 | 19.68 | 25.86 | 31.90 |
| 9 | M8 | 30+10 | 20.12 | 27.72 | 32.91 |
| 10 | M9 | 40+10 | 17.06 | 22.47 | 29.07 |

Table 7: Test results from compressive strength

3) *Split Tensile Strength:* The split tensile strength obtained by testing the cylindrical specimen for M15, M20 and M25 grades of concrete to all the mixes designed for various replacements are given in graphical representation as follows:

| S.No | Mix | % (CCA +GP ) | Split Tensile Strength M25 in N/mm$^2$ |
|---|---|---|---|
| | | | 28 days |
| 1 | M0 | 0+0 | 2.53 |
| 2 | M1 | 10+0 | 2.58 |
| 3 | M2 | 20+0 | 2.59 |
| 4 | M3 | 30+0 | 2.62 |
| 5 | M4 | 40+0 | 2.56 |
| 6 | M5 | 50+0 | 2.49 |
| 7 | M6 | 10+10 | 2.55 |
| 8 | M7 | 20+10 | 2.62 |
| 9 | M8 | 30+10 | 2.63 |
| 10 | M9 | 40+10 | 2.59 |

Table 8: Test results from tensile strength

## V. DISCUSSION

1) *Workabilty:* From the results it is observed that the workability is increased by an amount of 4.3%, 7.24%, 11.59%, 17.39%, 20.28%, 10.14%, 18.8%, 36.23%, 49.2% for M1, M2, M3, M4, M5,M6,M7,M8,M9 mixes respectively over conventional M25 concrete grade(M0).

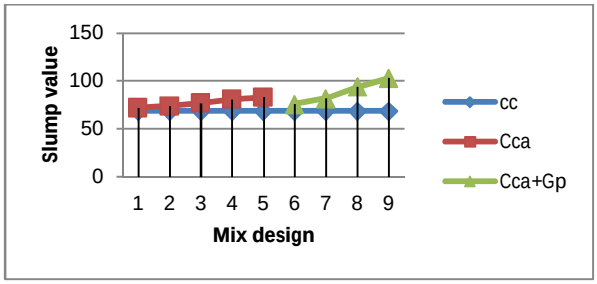


Figure 2: Comparison of workability for different mixes

2) *Compressive Strength:* The Compressive strength of concrete varies as 17.14%, 27.74%, 36.39%, 16.5%, 8.04%, 2.36%, 19.62%, 36.64% and 3.64% for M1, M2, M3, M4, M5, M6, M7, M8, M9 compared with the conventional concrete after 7days of curing.While Compressive strength of concrete varies as 9.99%, 14.92%, 31.49%, 11.31%, 1.19%,0.3%, 17.65%, 34.54% and -1.57% for M1, M2, M3, M4, M5, M6, M7, M8, M9, compared with the conventional concrete after 14 days of curing. The Compressive strength of concrete varies as 10%, 19.04%, 30%, 11.99%,3.01%, 19.04%, 27% and 1.98% for M1, M2,M3, M4, M5, M6, M7, M8, M9 compared with the conventional concrete after 28days of curing.On comparing the strengths of all mixes, M3, M8 has the highest i.e., 30% replacement of coarse aggregate. The addition of granite powder has positive effect on strength while improving the workability also.

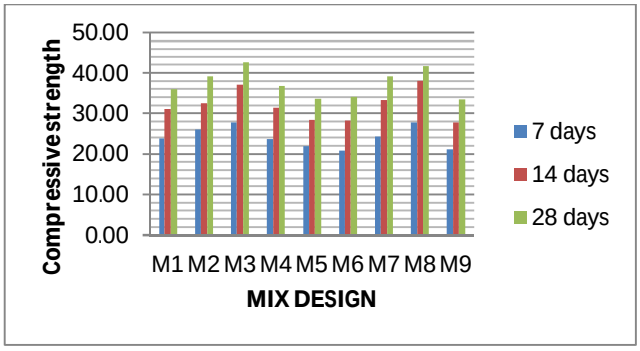


Figure 3: Strength comparison at 7, 14 and 28 days for M25 concrete

3) *Split Tensile Strength:* The split tensile strength of concrete varies as 1.95%, 5%, 7%, 1.18%, -1.6%,0.78%, 3.5%, 3.9% and 2.3% for M1, M2, M3, M4,M5,M6,M7,M8,M9 compared with the conventional concrete after 28days of curing.

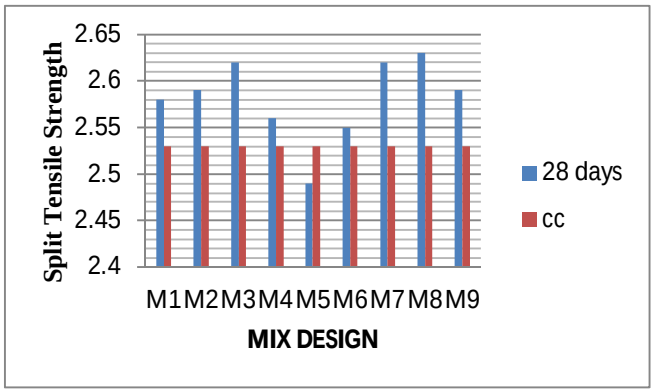


Figure 4: Strength comparison at 7, 14 and 28 days for M25 concrete

## VI. CONCLUSION

The following conclusions are made based on the experimental investigations on compressive strength, split tensile strength and flexural strength considering the—environmental aspects also:

*A.* The workability of concrete increases with the increase in tile aggregate replacement. The workability is further increased with the addition of granite powder which acts as admixture due to its chemical properties.
*B.* The properties of concrete increased linearly with the increase in ceramic aggregate up to 30% replacement later it is decreased linearly.
*C.* Mix of concrete produced a better concrete in terms of compressive strength, split tensile strength and flexural strength than the other mixes. But the mixes up to 50% of ceramic coarse aggregate can be used.

## VII. COST ANALYSIS

Conventional Concrete

| Ingredients | Quantity (kg) | Rate (kg) | Cost (Rs) |
|---|---|---|---|
| Cement | 384 | 6.2 | 2380.8 |
| Sand | 646.4 | 3 | 1939.2 |
| Coarse agg | 1271.3 | 2.2 | 2796.86 |
| Water | 187.5 | 2 | 375 |
| Total | | | 7491.86 |

Table 9: Conventional Concrete rate analysis

Newly Proposed Concrete

| Ingredients | Quantity (kg) | Rate (kg) | Cost (Rs) |
|---|---|---|---|
| Cement | 384 | 6.2 | 2380.8 |
| Sand | 581.4 | 3 | 1744.2 |
| Granite powder | 64.6 | 0.5 | 32.3 |
| Coarse agg | 889.9 | 2.2 | 1957.78 |
| Tile chips | 381.39 | 0.5 | 190.69 |
| Water | 186 | 2 | 372 |
| Total | | | 6709.77 |

Table 10: Newly Proposed Concrete rate analysis

Note: The rates of tiles chips and granite powder are only of transportation
Cost analysis of new mix design:-
Saving for 1m3 concrete with 30% CCA & 10% GP replacement
=7491.86 - 6709.77
=782.09 Rs
Percentage decrease = 10.43%

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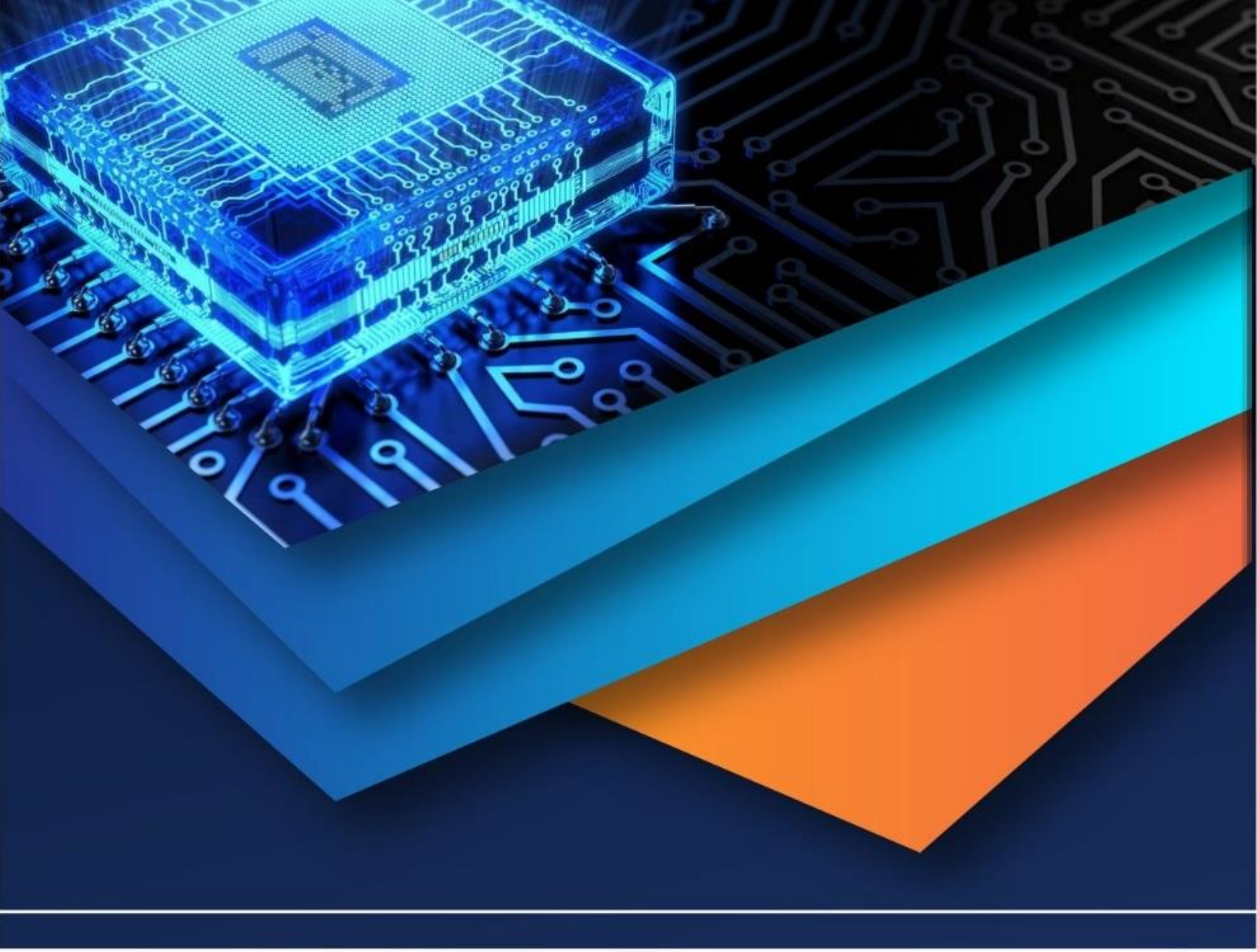

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