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Effect of Fly Ash and Sand Stone Slurry on Mechanical Properties of Concrete after Seven Days Curing

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***Abstract:** As we all know very well India is developing country and population of our country is also increasing very rapidly. In our country development is growing also in the field of construction of various infrastructures, building structure, roads, bridges, canals, dams etc. These activity activities increasing day by day to full fill the requirement of people of the country for their living and comfort. In past when our country was young we are not suffering from lake of natural resources of raw materials like cement, sand, aggregate. These three materials are the key element of any type of construction work. Now a day the natural resources going to deplete due to increasing the construction activity. Many researcher finding the alternate material of these three materials and they finding satisfactory result with other material so in my research I am also taken attempt on the alternate of cement and sand with Fly ash and sand stone slurry by replacement of amount of cement and sand with 5% to 25% FA and 10% to 50% SSS. Six mixes were prepared one is standard and other five is trial mixes. Three sample from each mix was prepared and tested after 7 days curing and to determine the mechanical properties of prepared mix we are conducted the compressive strength and flexural strength test.*
***Keywords:** Cement, Fly ash, Mechanical properties, sand, sand stone slurry.*

I. INTRODUCTION

Concrete is the most vital material used in construction. The main component of the concrete is cement, sand, aggregate. These material bind together by Portland cement in the presence of water through hydration reaction. As we all know present era is most developing era in which higher demand of concrete structure is required, due growing infrastructures today leads to rapidly depletion of natural resources of concrete components. To maintain the consumption of natural resources researcher are finding alternatives of these component.

The world is generating billions of tons of industrial waste per year. Studies show that a systematic consumption of recycled products can help solve the problem of waste disposal [1]. In this regard, the use of recycled fine and coarse aggregates in construction has grown interest among researchers and concrete industries. A review of existing literature on the subject reveals that numerous recent studies have aimed at improving the production of economical and environmentally-friendly concrete using various recycled fine and coarse aggregates such as aggregates derived from demolished structural units [2–5], crushed tile [6], ceramic waste [7, FRP scrap [8], and ground glass waste [9]. Most of these studies involved specific experiments to investigate the regular parameters of concrete, such as compressive strength, tensile strength, flexural strength, etc. These parameters are correlated with the properties of aggregate used in concrete. However, given the fact that recycled aggregates are obtained from different sources, they possess markedly different characteristics than natural aggregates. This includes differences in gradation, shape, texture, and specific gravity. Moreover, the containment of impurities due to the variation in sources is another major concern. These properties significantly influence the mechanical and durability characteristics of concrete, an effect which cannot be accurately predicted without testing [10–14]. Many researchers are currently conducting research on the partial or full replacement of natural aggregates with recycled aggregates. Studies have shown that recycled concrete strength properties strongly depend on the level of replacement. Ulloa et al. [15] showed the influence of recycled aggregate replacement ratio and effective water-binder ratio (w/c ratio) on the compressive strength of recycled concrete. Some researchers have restricted the level up to 30% replacement for maintenance of standard requirements for 5% absorption capacity of aggregates [14]. It was revealed by Etxeberria et al. [13] and Ulloa et al. [15] that concrete produced with 100% recycled coarse aggregate replacement significantly reduce the compressive strength and necessitates a large amount of cement in order to lower the water/cement ratio as well as to improve the compressive strength, a requirement which may compromise the economic viability of a project. Again, full replacement was also not suggested by Thomas et al. [16], Topcu and Canbaz [9], and Evangelista and de Brito [17] in their research studies. Studies on coarse aggregate replacement have been carried out by numerous researchers, whereas the subject of fine particle replacement has garnered only a few studies [8,17]. With some exceptions, both of these replacements show light variations in compressive strength with respect to conventional concrete. However, a large fluctuation in modulus of elasticity and tensile strength was observed due to the lack of compactness of recycled aggregate indicated by the big stiffness loss of concrete [17,18]. Another study has demonstrated the successful application of ceramic waste as a replacement of coarse aggregate due to its lower tensile to compressive strength ratio compared to conventional concrete [7]. To investigate the proper utilization of recycled material, durability of concrete is another vital criterion as the performance of concrete significantly depends on the durability properties. Topcu and Canbaz [6] showed that the application of crushed tile in concrete not only adversely affect its compressive strength, but also poses an adverse effect on abrasion and freeze-thaw durability. This issue has also arisen with the incorporation of coarse recycled concrete and ceramic aggregates, which results in a higher chloride intrusion than with conventional concrete [18]. Similar results have been found by Thomas et al. [16]. Again Evangelista and de Brito [17] have observed a linear increase in water absorption with increased replacement ratio due to the porosity of fine recycled aggregate. From the research of Huda [18] it was also observed that, durability properties of concrete with recycled aggregates can be further analysed by sulphate test. However, when the issue of durability can be neglected for some structures depending on the nature of the project, the partial replacement of natural aggregate with recycled aggregate may be viable. The present study addresses a gap in the literature in its investigation of the application of granulated steel as an alternative partial replacement of fine aggregates in concrete. A large number of steel rolling mills are currently running all over the world in order to serve the growing demand for reinforced steel. Granulated steels are the by-product left in the steel rolling mills after the production of reinforcing bars. An effective utilization of this recycled material can be beneficial for resource conservation as well as enhancement of properties of concrete. Though RGS has a resale value, but it is negligible compare to the NFA. Given the growing concern today about environmental issues and the need to mitigate carbon footprint, the use of RGS in concrete will have a positive environmental impact as it conserves natural resources and saves the environment from significant amount of carbon emissions associated with remoulding the RGS in a steel plant as an alternative use of the by-product. To date, no literature has been found that has studied the possible utilization of this unused industrial waste (i.e., granulated steel) in concrete mixtures. Hence, the use of RGS in concrete is a new avenue of research and has been found promising in this current study. First, a study is conducted to investigate the fresh and hardened properties of concrete that uses RGS. Further investigation targets a detailed micro-structural characterization and also examines durability in harsh environmental conditions. The outcome of this study will pave the way for effective utilization of this industrial waste for producing commercially viable structural concrete. This research will help develop new green building materials for sustainable construction. The current practice in the construction industry of Bangladesh is to achieve concrete compressive strength of 25 MPa in 28 days for structural applications. Keeping this in mind, this research aims to investigate the influence of RGS on the fresh, hardened, and durability properties of concrete, and compares these properties with those of control concrete specimens containing natural aggregates. Here RGS is proposed as a replacement to fine aggregate up to 60% by weight. The post-peak energy dissipation of different RGS concrete mixes is evaluated through flexural toughness factors. Finally, micro-structure of concrete specimens is investigated using scanning electron microscopy (SEM) images.

II. EXPERIMENTAL PROGRAM

A. Materials

The details of materials used in preparation of concrete specimen are as following.

1) *Cement:* In this research, ordinary Portland cement (OPC) 43 grade used as the binding material following the specification IS: 8112: 2013 [20]. The cement used is fresh and lumps free and its fineness of more than225 m^2/kg after 90 micron sieving. OPC is generally available in local market and OPC is widely used in general construction work. The chemical composition of OPC is shown in Table. 1.
2) *Fly Ash:* In this research, Fly Ash (FA) used with OPC replacement 5%-25% range respectively. FA collected from precipitators of Kota thermal power plant which fall in class F FA category. The chemical composition of FA shown in Table. 1.
3) *Sand Stone Slurry:* Sand stone slurry (SSS) is a product which residue after cutting of sand stone (SS) in a industry, this is waste in nature presently used to dumped in empty land. SSS available at the cutting plant of sand stone nearby Kota. The chemical composition of SS is shown in Table. 1.
4) *Natural Coarse Aggregate:* Crushed stone aggregate with a maximum size of 20mm and minimum size of 4.75mm are used in this research. According to Indian Standers: 383-1970, [22] specific gravity, fineness modules, water absorption are 2.66, 6.83, .56%. Fig.1 represents the gradation curve of coarse aggregate.
5) *Natural fine Aggregate:* Locally available well graded natural river fine aggregate (FA) of maximum grain size 4.75mm is used. According to IS: 2386 (Part I) [23] test method specific gravity, bulk density, fineness modulus, is 2.567, 1.48g/cc, 2.465. Fig. 2 represents the gradation curve of natural river fine aggregate.

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B. Mix Proportion And Curing

Six different batches of m20 grade concrete for this research work was prepared in which one is standard concrete and other five with 5%, 10%, 15%, 20%, 25% FA and 10%, 20%, 30%, 40%, 50% SSS partially replaced with OPC and natural river fine aggregate. Each batch 6 specimen was prepared, 6 for cube of size $15cm^3$, 6 specimens for cylinder having dimension 15 cm diameter and 30 cm height, 6 specimens for beam of size 500cm x 10cm x 10cm. W/c ratio increasing as we are increasing the fa and SSS. After casting the specimen, they are demoulded with in 24hrs to maintain the curing period of 7 days.

C. Test Setup

The compressive strength of concrete specimen is measured after 7 days' water curing according to is: 516-1959 [24]. A compressive strength machine calibrated according to is code used for compressive strength test of concrete cubes specimens. The split tensile strength of cylindrical specimen is measured after 7 days' water curing according to is: 5816-1999 [25]. The flexural strength of concrete beam specimen is calculated after 7 days of water curing. The flexural strength of beam specimen is measured by flexural testing machine as shown in Fig.3. Fig. 6 show the prepared specimen and curing of specimen

Table. 1 Chemical composition of Cement, Fly ash, Sand stone.

COMPOSITION	PORTLAND CEMENT%	FLY ASH%	SAND STONE %
SiO2	21.82	53.39	93-94
Al2O3	6.49	16.07	1.4-1.5
Fe2O3	1.93	13.05	1.5-1.6
CaO	60.74	6.33	0.8-0.9
MgO	1.08	5.48	0.2-0.25
SO3	2.62	1.06	--
Na2O	0.14	1.59	1.0-1.2
Free Cao	0.84	0.11	--

Fig.1 Natural Coarse Aggrgate

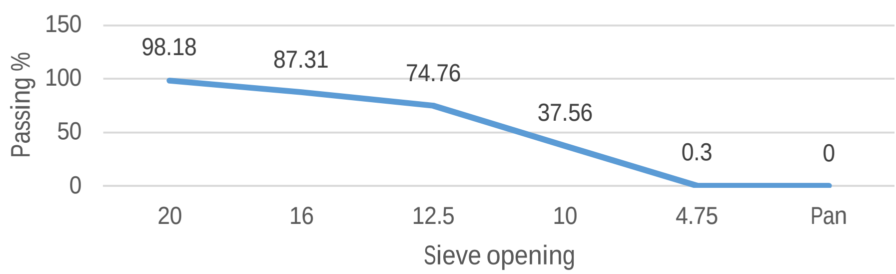

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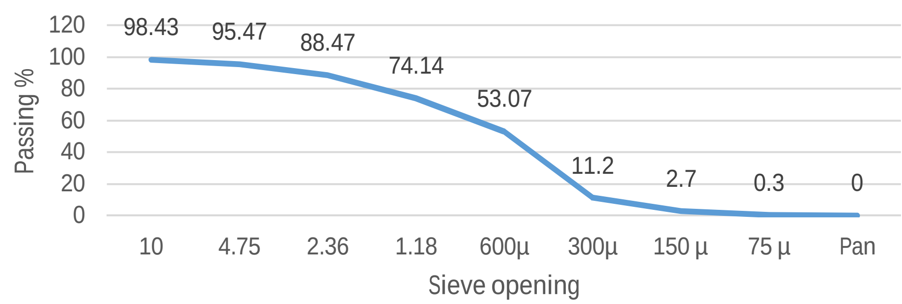
Fig. 2 Natural Fine Aggregte



III. EXPERIMENTAL RESULTS AND

A. Discussion

1) *Fresh Concrete Properties:* The slump value is measured for all six different prepared concrete batches. It shows as we increasing the percentage of fly ash and sandstone slurry we required more water to make concrete consistency same for all mixture. The values of different concrete batches are shown below in Table- 2

Table: 2 Slump value of freshly mixed concrete

Properties	Conventional	5% 10%	10% 20%	15% 30%	20% 40%	25% 50%
		FA SSS	FA SSS	FA SSS	FA SSS	FA SSS
Slump Value (mm)	47	47	48	46	44	42
w/c ratio %	.4	.5	.55	.6	.7	.7

2) *Compressive Strength:* The compressive strength test is performed after 7 days on six different batches as specified in Table.3. Three specimen form each batch are tested at 7 days curing with the compressive testing machine and the data is mention below in Table. 3. The compressive strength of prepared mix with 5% FA and 10% SSS to 15% FA to 30% SSS increasing after that strength is decreasing as shown in Fig.3. Fig.4 shows the testing of cube specimen.
3) *Splitting Tensile Strength:* The splitting tensile strength test is performed after 7 days curing of 15cm diameter and 30 cm height specimen size on six different prepared concrete mix as specified in Table. 4. Three specimen from each mix is prepared and tested, splitting tensile strength test results of the cylindrical specimen shown in Table: 4.4. From the Table: 4.4 it is observing that the incremental replacement of FA and SSS decreases the split tensile strength after 7 days curing by replacement of 15% FA and 30% SSS to 25%FA, 50% SSS by 3.58%, 18.18%, 7.12% respectively as compared to conventional concrete mix. Before that the split tensile strength of the concrete compared to the conventional concrete specimen beyond 5% FA, 10% SSS to 10% FA to 20% SSS replacement, the increment shown by FA and SSS in split tensile strength of concrete by 10%, 28% increased respectively. This test outcome thus leads to the conclusion that only up to 10% FA and 20% SSS will produce satisfactory results by achieving proper bonding with other components of the concrete. Fig. 4 shows the increment and decrement in splitting tensile strength.
4) *Flexural Strength:* The Flexural strength test is performed after 7 days curing of 50cm x 10cm x 10cm specimen size on six different prepared concrete mix as specified in Table.5 three specimens from each mix is prepared and tested, Flexural strength test results of the beam specimen shown in Table.5. From the Table.5 it is observing that the incremental replacement of FA and SSS decreases the flexural strength after 7 days curing by replacement of 5% FA and 10% SSS to 25%FA, 50% SSS by 11.11%, 16.66%, 27.77%, 38.88%, 61.11% respectively as compared to conventional concrete mix and the Fig. 5 shows that. This test outcome thus leads to the conclusion that no any increment shown after mixing FA and SSS in concrete.

Fig.3 Flexural Strength Testing of Beam Specimen

Fig.4 Compressive Strength Testing of Cube specimen

Table: 3 Compressive strength test after 7 days curing in N/MM^2

Properties	Conventional	5% 10%	10% 20%	15% 30%	20% 40%	25% 50%
		FA SSS	FA SSS	FA SSS	FA SSS	FA SSS
Compressive Strength	14.073	25.77	19.33	17.11	14	13.7

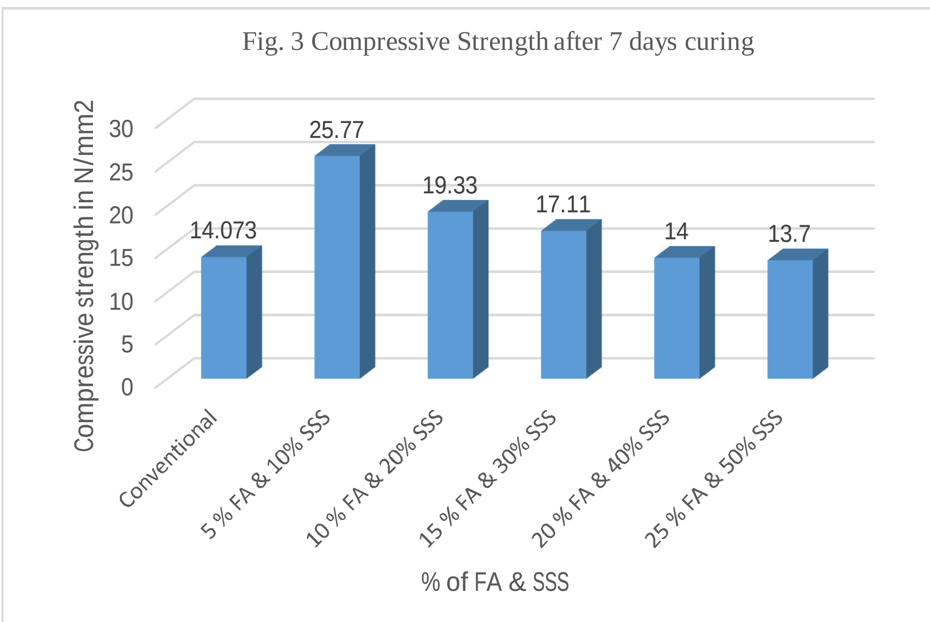


Table: 4 Splitting Tensile strength test after 7 days curing N/MM^2

Properties	Conventional	5% 10%	10% 20%	15% 30%	20% 40%	25% 50%
		FA SSS	FA SSS	FA SSS	FA SSS	FA SSS
Splitting Tensile Strength	1.98	2.178	2.546	1.909	1.62	1.839

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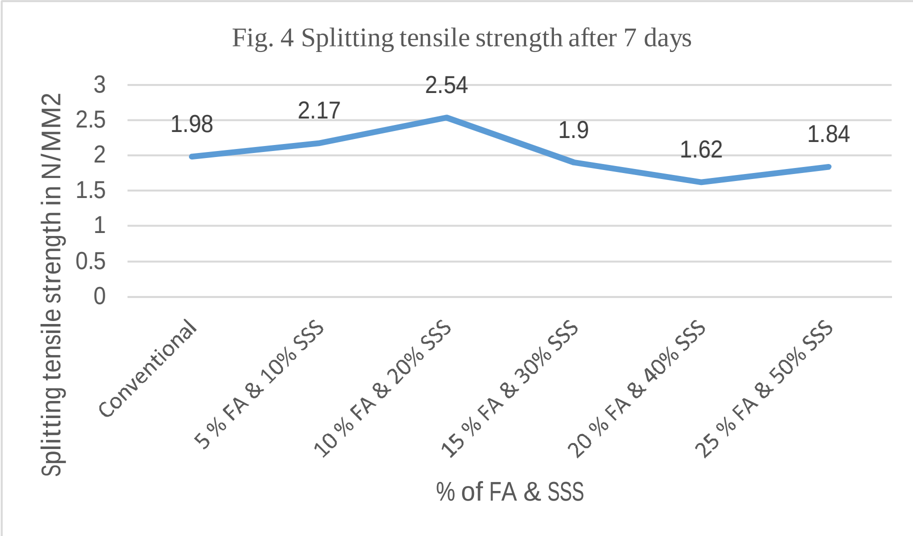
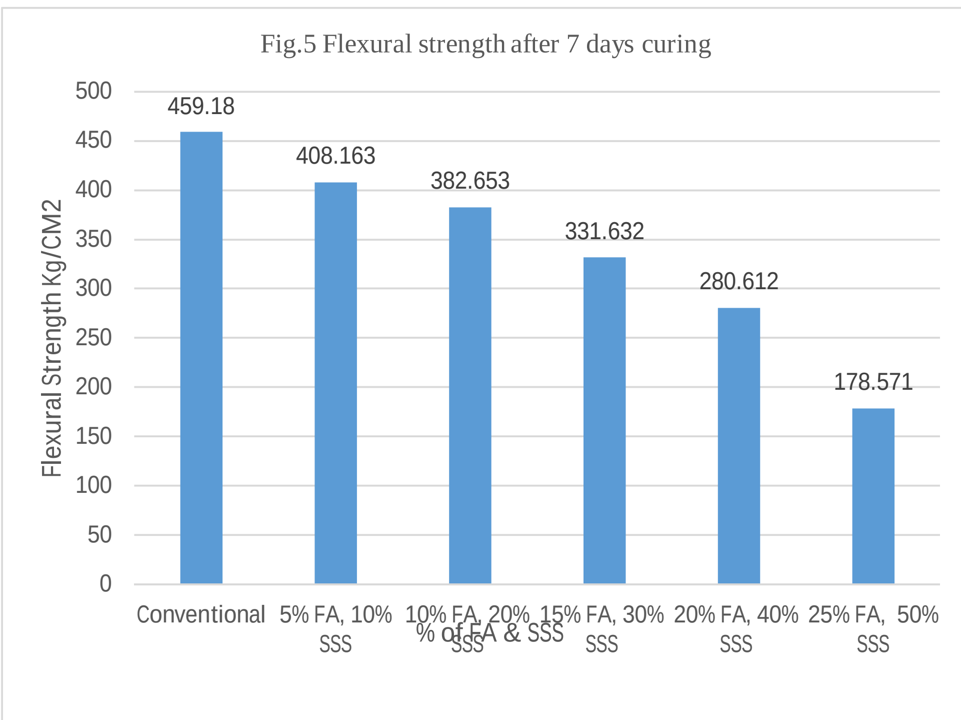


Table: 5 Flexural strength test after 7 days curing

Properties	Conventional	5% 10% FA SSS	10% 20% FA SSS	15% 30% FA SSS	20% 40% FA SSS	25% 50% FA SSS
Flexural Strength (Kg/CM^2)	459.18	408.163	382.653	331.632	280.612	178.571



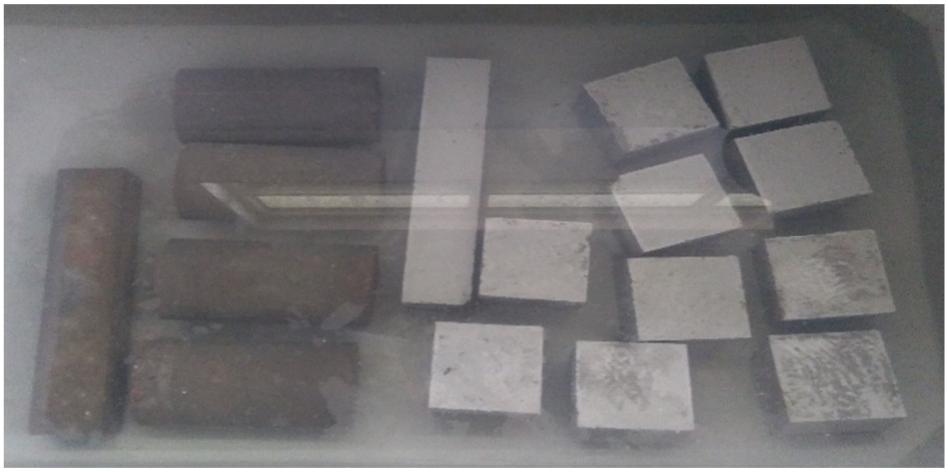


Fig. 6 Shows the prepared specimen and curing

IV. CONCLUSION

This research represents the mechanical properties of six different prepared concrete batches one is conventional other five with fly ash and sand stone slurry incremental replacement with cement and sand in range of 5% FA to 25% FA and 10% SSS to 50% SSS. All the procedure and test performed according to Indian Standard. The compressive strength, Splitting tensile strength, Flexural strength test results if different concrete batches. Based on the test result it can be concluded that use of FA and SSS with replacement of cement and sand in concrete will not only conserve the natural resources of sand as well cement, but it will also enhance the properties of concrete.

On the basis of experiment following conclusion can be made:

A. The compressive strength of prepared mixes after 7 days curing were maximum increased up to 83.11% with 5% FA and 10% SSS as compared with conventional concrete other four mixes shows 37.35% increment with 10% FA and 20% SSS, 21.66% increment with 15% FA and 30% SSS after that strength decrease by .52% with 20% FA and 40% SSS, 2.65% with 25% FA and 50% SSS as compared with conventional concrete. As per standard all five mixes achieve the limit of 65% gain of strength after 7 days curing

B. The Splitting tensile strength of prepared mixes after 7 days curing were maximum increased up to 28 % with 10% FA and 20% SSS as compared to conventional concrete mix, other four mixes shows 10% increment with 5 % FA and 10% SSS after that split tensile strength decreases by 3.58% with 15% FA and 30% SSS, 18.18% with 20% FA and 40% SSS, 7.12% with 25% FA and 50% SSS as compared to conventional concrete mix.

C. The Flexural strength of the Concrete beam sample after 7 days curing, prepared with 5%, 10%, 15%, 20%, 25% FA and 10%, 20%, 30%, 40%, 50% SSS shows the continuous decrement by 11.11%, 16.66%, 27.77%, 38.88%, 61.11% in flexural strength of concrete. All five different concrete sample prepared for flexural strength falls below the conventional concrete sample.

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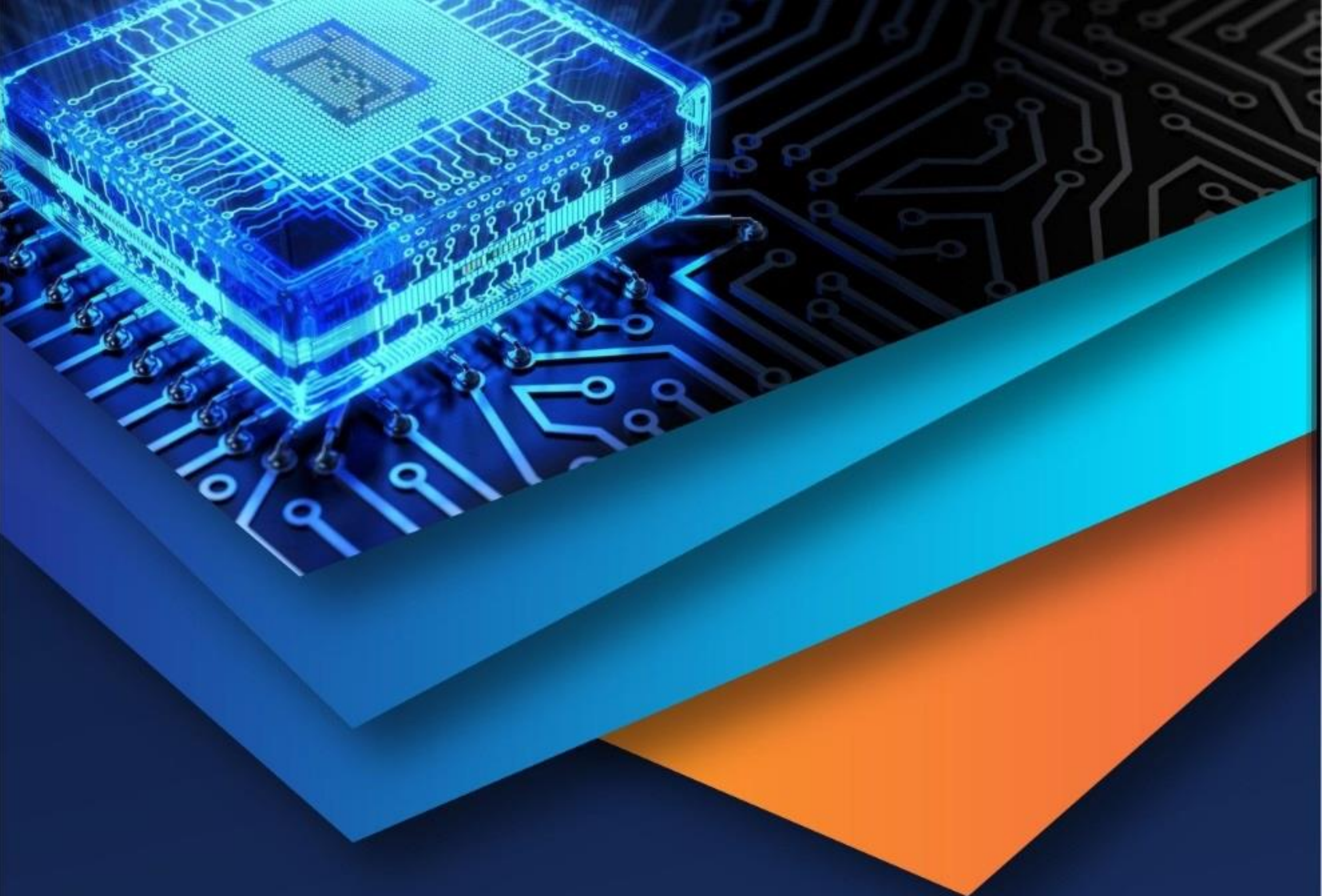

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