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Study on Partial Replacement of Coarse Aggregate with Steel Slag

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Abstract: This paper investigates the partial replacement of the coarse material and improves the mechanical properties of concrete. Stainless steel is currently one of the fastest growing sectors in the manufacturing industry due to the increasing use of these metal products in the construction and industrial industries, and considering the highly priced balance between steel and there are basic problems. Flux is used to cover welding joints and to protect the welding performance from air pollution, and is converted into a waste slag. This metal slag is used to investigate the impact of new and durable concrete structures where the coarse natural coating is replaced by indirect slag steel. , Sorptivity test it exhibits a dense microstructure and improves durability.

Keywords: Green concrete, Compressive strength, Tensile strength, Flexural strength, Durability, Sorptivity.

I. INTRODUCTION

Slag is a product produced during the production of pig iron and iron. It is produced by the action of various variables within the ganggue material within the iron ore during the process of making pig iron in an explosive furnace and the production of metal in the smelter store. Basically, slag contains calcium, magnesium, manganese and aluminum silicates in various compounds. The slag cooling process is primarily responsible for producing the different types of slags required for different end use users. Although, the chemical composition of slag may remain unchanged, the body structures vary greatly with the changing process of cooling.

The blast furnace (BF) is charged with stainless steel, fluxing agents (usually limestone and dolomite) and coke as fuel and a reducing agent in metal production.

Iron ore is a mixture of iron oxides, silica, and alumina. From this and additional flow agents, alkaline earth carbonates, molten slag, and iron are formed. The oxygen in the pre-heated air blown into the furnace combines with the coke carbon to produce the required heat and carbon monoxide. At the same time, iron is reduced to iron, especially for carbon dioxide. Oxides of calcium and magnesium combine with silica and alumina to form slag. The reaction of carbon monoxide and iron oxide produces carbon dioxide (CO2) and iron ore. Fluxing agents break down into calcium and magnesium oxides and carbon dioxide. Oxides of calcium and magnesium combine with silica and alumina to form slag.

Depending on the cooling method, three types of BF slag are produced: air cooled, expanded, and mixed. Allowing melted slag to cool slightly in the air in an open hole produces cool slag in the air. Air-cooled blast furnace slag is defined in ASTM standard C-125 (American Society for Testing and Materials, 1999) as "material caused by the solidification of molten furnace slag under atmospheric conditions. " Solid slag has a vesicular structure with closed pores. The coarse structure of the vesicular coating gives it more space than smooth proportions of equal volume and provides excellent bond with Portland cement, as well as high stability of bitumen compounds. The expanded slag is made by cooling. rapid control of dissolved slag in water or water with a mixture of steam and compressed air, steam and other gases improve the porosity and vesicular nature of the slag, resulting in a lightweight coating suitable for use in concrete. they have high pressure to produce granulated slag.

Extinguishing prevents the shining of minerals that form the formation of slag, thereby resulting in granular, glass aggregate. This slag is crushed, ground, and tested for various processes, especially in the production of cement, due to its pozzolanic properties (hydraulic cementations). Slags are also a composite product of metal processing processes.

Metallurgy requires the removal of excess silicon by forming minerals and carbon by oxidation in pig or crude metal. Stainless steel is a strong metal that almost resembles stainless steel. It contains valuable amounts of free steel, which gives it its high density and durability, making it particularly suitable as a road construction kit. The slag is transported to the processing industry, where it undergoes grinding, milling and testing operations to meet various application requirements. Processed slag is sent to its buyer for immediate use or, at season, stored.

Different types of slags find different uses in the industry. BF slag cooled in the air is crushed, filtered and used mainly as road metal and foundations, asphalt paving, rail ballast, dumping ground and concrete mixing. Extended or foam slag binds well to cement and is used mainly as a aggregate of lightweight concrete. However, it is not produced by domestic steel plants. Granulated BF slag is used as a pozzolanic material to produce portland slag cement. It is also used to prepare the soil.

BF slag is used to make mineral wool for separation purposes. Iron Slag has found use as a preventive remedy for garbage dumps where heavy metals often penetrate the surrounding area. The metal Slag forces heavy metals to stop the solution in flowing water due to its high oxygen oxide content. Iron slag has been used successfully to treat the release of acidic water from discarded mines. Slags are useful in the production of clinkers and such use can reduce the fuel consumption of the cement base and emissions of carbon dioxide per ton of cement. Granulated slag found in various metal plants is dried in a slag dryer. The clinker is ground into a ball Mill with 40-50% dry slag and 6% gypsum. The result of the product is Portland slag cement. Portland blast furnace slag Cement contains up to 60% ground slag from metal production processes. The slag cement has a low hydration temperature, a low alkali reaction, high resistance to chloride and sulphate and can replace the use of 43 and 53 marks of standard Portland cement. In other consumer sectors such as road construction, ground filling and ballasting, cooled slag is mechanically crushed or hammered into small pieces and delivered to various consumers for final use.

II. Literature Review

Harsh Gupta et al (2017) The purpose of this study was to study the effect of steel slag such as changing the positive part by 0%, 10%, 20%, 30%, and 40% testing the concrete level of M25 & M30 after 7, 14, 28 and Days 50 water treatments. A rough amount of 20mm is selected and trained with a 10mm filter, a good amount of more than 4.75mm with a filter and stored in a filter of 600 microns used, compressive strength test, solid separation test, flexible test, steel slag was tested. The result shows that the maximum energy exchange rate combined is a slag metal for 7, 14, 28 days and 50 days for water healing.

Comparison of compression strength, flexibility and strength to separate ordinary concrete and concrete with Slag Steel as part replacement Results show that normal concrete strength is slightly lower than steel replaced Slag.

An increase in depressive strength is approximately 31.47% in 7 days treatment 20% in 14 days cures 18% 28 days and 40% slight decrease in 4.2% noted in 7 days and 3.4 days % 28 days of treatment compared to 30%.

Increased M 30 concrete pressure increase of approximately 24.9% 7 days of healing 17.5% 14 days of healing and 15.5% 28 days of healing while 40% slight decrease of 3.6% noted 7 days and 2.5%. 28 days of treatment compared to 30%. The strength of the separated slag increases by increasing the percentage of iron slag to 30% by weight of fine aggregate. Increased tensile strength was approximately 16.7% in 28 days healing M25 concrete range and increased by 15.6% in 28 days of M2 treatment. 30th level concrete. Flexural strength increases within the percentage of iron slag up to 30% by weight of fine aggregate. Increased flexibility strength test approximately 36.7% with 28 days healing M 25 grade concrete and 24.7% 28 days treatment M M concrete floor.

Liwu mo et al (2017) in their studies entitled Accelerated carbonation and the use of steel slag concrete as binding materials and aggregates. Experimental study, 60% of slag metal powders containing high free CaO content, 20% Portland cement up to 20% active magnesia and lime mixed to fix binding compounds. Binding mixtures were then used to cast concrete, when up to 100% of the natural composite material (limestone and river sand) was replaced with steel slag aggregates. Concrete was exposed to carbonation healing with a concentration of 99.9% CO2 and a pressure of 0.10 MPa at different times (1d, 3d, and 14d). Carbonation front, carbonate products, compressive strength, microstructure, and strength of concrete volume were investigated. The effects of CO2 treatment on carbonation depth, compressive strength, and volume stability of steel slag concrete as binding materials and aggregates were investigated.

Based on phenolphthalein index testing, with 0.1 MPa CO2 treatment, concrete specimens are almost carbonated within 3d, indicating that it is effective in accelerating concrete carbonation by compressed CO2. Under normal wet curing, the compressive strength of the concrete was mixed with binding mixtures consisting of 60% slag powders, up to 20% lime and magnesia, and only 20% of Portland cement was very low, 7.9 -10.7 MPa to -7. d and 9.4-11.5 MPa for 28 d. However, they increase significantly during subsequent CO2 treatment. The compressive strength of concrete under CO2 curing to 14 d is increased by a coating of 4.3-5.3 compared to that of cement moisture treated at 28 d. This is related to the strength of concrete caused by the formation of carbonate products. Under humid treatment, the replacement of natural aggregates (limestone and river sand) with steel slag has had minimal impact on the compression strength of the concrete. CO2 treatment in steel slag concrete improved its volume strength. On the other hand, carbonation directly reduced the periclase and free-CaO content in concrete. The results show that the compressive strength of steel slag concrete after CO2 treatment has increased significantly.

Ramesh et al. (2017) in this investigation entitled use of furnace slag (FS) and welding slag (WS) as a replacement of fine aggregates in concrete. The aim of this study is to examine the behavior of the WSA in HPC. For mixtures containing WS, the 7 d compressive strength of concrete cubes increased from 10 to 15% and 28 d compressive strength increased from 5 to 15%. It was concluded that 5% of WS and 10% FS replacement with fine aggregates is effective for practical purpose. On the basis of the above literature, weld slag was potentially used in the manufacture of bricks and as a replacement of fine aggregate in concrete.Six mixture proportions were made. Control mixture (CM) without weld slag was prepared and for other five mixtures, weld slag was replaced to fine aggregates at 10, 20, 30, 40 and 50%, respectively. To recognize the mixtures, each mixture was titled as CM, WSA 10, WSA 20, WSA 30, WSA 40 and WSA 50. WSA 20 denotes that the HPC mixture made with 20% WSA replacing the fine aggregate.

Ismail et al (2015) in this experiment entitled Reuse of waste iron as a partial replacement of sand in concrete the test of these waste –iron concrete mixes revealed that this method performed efficiently to improve the properties of the waste iron concrete mix. In this paper waste iron were partially replaced sand at 10%, 15% and 20% in total 1730 kg concrete mixtures. This test performed to evaluate waste iron concrete quality slump.

The flexural strength of waste iron concrete mixtures at all curing periods tends to increase above the reference concrete mixes with an increasing ratio of waste–iron aggregate. The highest flexural strength was that of the concrete specimens containing 20% waste –iron aggregate at 28 days of curing, which is 27.86%higher than the reference mix at the same curing period.

The compressive strength of the concrete mixes made of 20%waste-iron aggregate increase above the reference concrete mix by 22.60%, 15.90%, and 17.40% for 3,7 and 28 days curing periods. Both the fresh and dry density values of waste– iron concrete mixes at each age tend to increase above their reference values.

Rosales.j et al (2017) in this document entitled effect of stainless steel slag waste as a replacement for cement in mortars. In this studies replacing cement by stainless steel slag waste and improving the mechanical properties of the slag waste by using different types of treatment. The cement was replaced with different substitution percentage of untreated stainless steel slag and waste slag that was proceed to the crushing, burning, and both treatment to determine the optimum replacement ratio according to the mechanical properties. In this case based on multivariate factor analysis wasdeveloped to compare these proceed waste according to their mechanical behavior. A mortar sample with a mix proportion of 0.5:1:3(water; cement; sand) was designed as the control mix. To compare SW with cement made using common addition, three sets of cement with FA were manufactured with different substitution percentages (10%,20%,and 30%). samples with different substitution percentages for the manufacture of cement mortar were created to analyze the cement capacity of the stainless steel slag waste. The hardened mortar was characterized according to the six properties: bulk density, porosity, water absorption, compressive and flexural strength and dimensional instability. he shrinkage age was similar to or lowers than that of control OPC cement in mixes with a minimum substitution percentage in the manufactured of cement and concrete with steel slag. In cement mortar made with 20% and 30% SW, the shrinkage age value increased. Multivariate analyses were applied on compressive strength, flexural strength and shrinkage because they are main parameters to evaluate the possibility of using new cement. In this analysis were performed on the result of parameters used at 28 days of FS and CS and at 90 days for SH from cement mortar. The porosity of the material was observed using SEM analysis at 28 days. It indicates the high –resolution images of the fractured surfaces of different samples. The cement mortar with the addition of SW did not present large pores. The cursed and burned slag had lower values of loss relative to the control. Replacing cement with stainless steel slag waste for the manufacture of mortar improves the mechanical properties up to a certain degree of substitution. In these studies showed that replacing up to 20% of cement with crusted SW recommended.

III. OBJECTIVE OF THE STUDY

The present investigation has been done based on the following objectives.

1) The target for the present work is to design a concrete mix which would reduce the cost of construction and cost of ingredients of concrete.
2) To study the feasibility of attaining the strength with Ordinary Portland cement and induction furnace slag.

IV. METHODOLOGY

A. Mix Design

M25 grade of concrete mix design was carried out as per IS: 10262-2009. Induction furnace slag did complete replacement of fine aggregates and coarse aggregate were replaced in the 5%, 10%, 15% and 20%.

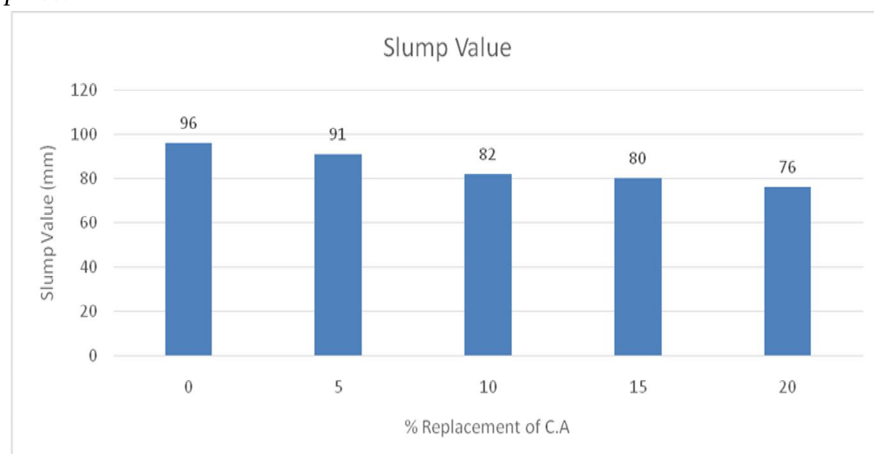
Table: Concrete Mix Proportions

S.No	Material	M25 Grade concrete per m^3
1	Cement	380 Kg
2	Fine aggregate	0 Kg
3	Induction furnace as a Fine aggregate	699 Kg
4	Coarse aggregate	929.50 Kg
5	Induction furnace slag as a Coarse aggregate	90 Kg
6	Water	235.6lt
7	Proportion	1 : 1.84 : 2.44
8	W/C ratio	0.62

The Workability, Compressive strength, Split tensile strength and flexural strength is tested after 7days and 28 days curing with standard specimen sizes.

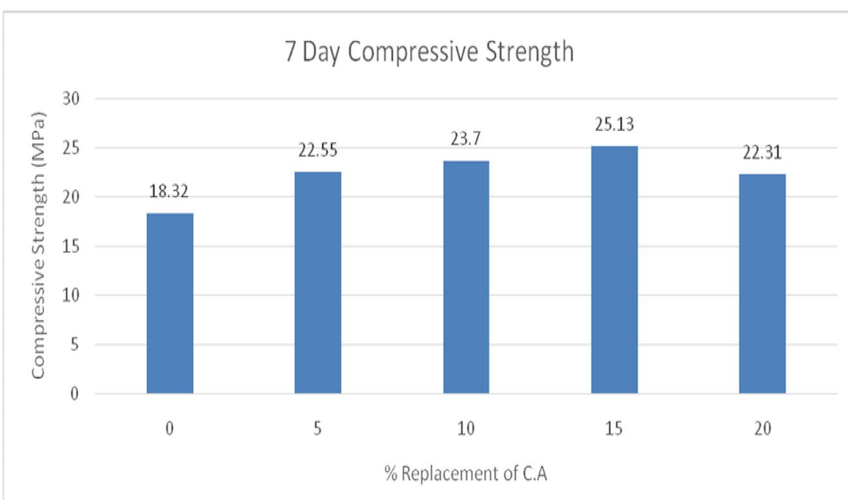
V. RESULTS

A. *Workability by Slump Test*



B. *Compressive Strength*

1) *After 7 Days Curing*



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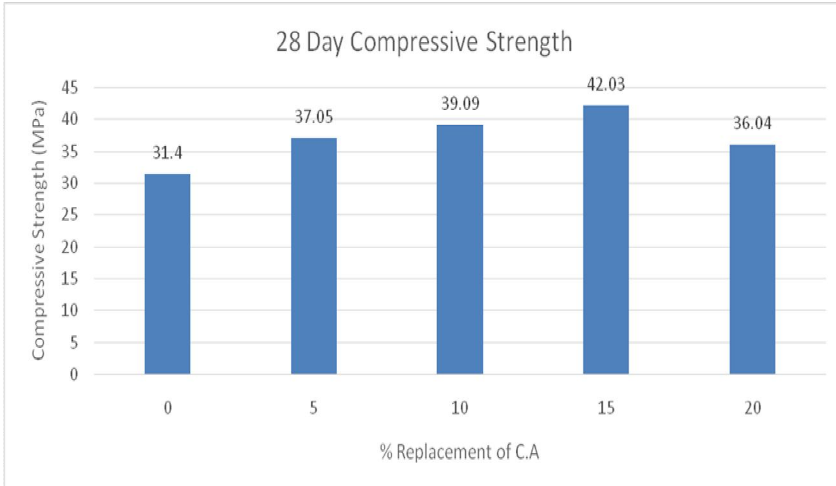
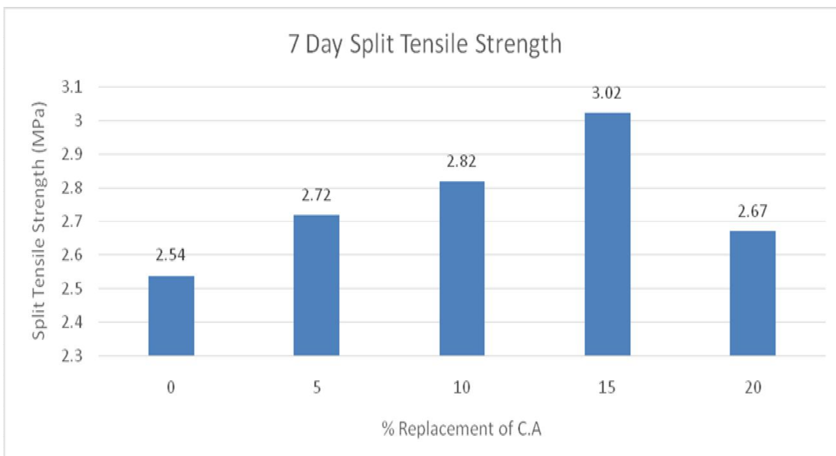
2) After 28 Days Curing

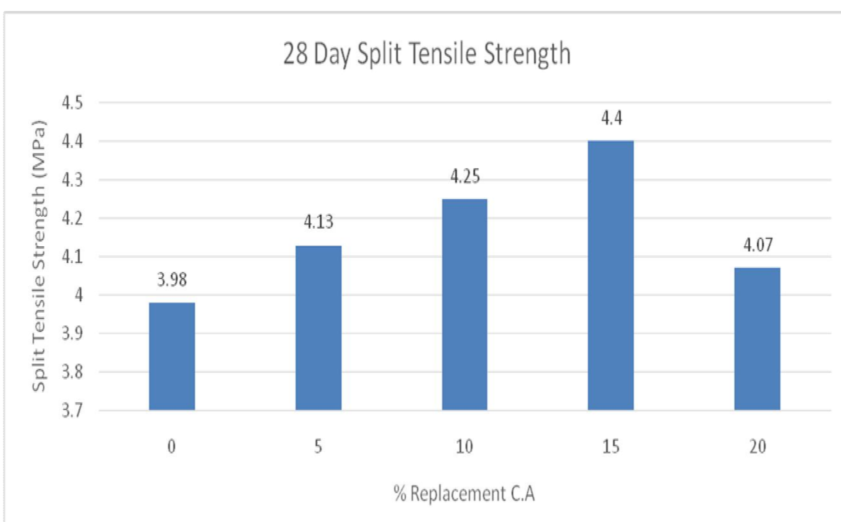


C. Split Tensile Strength

1) After 7 Days Curing

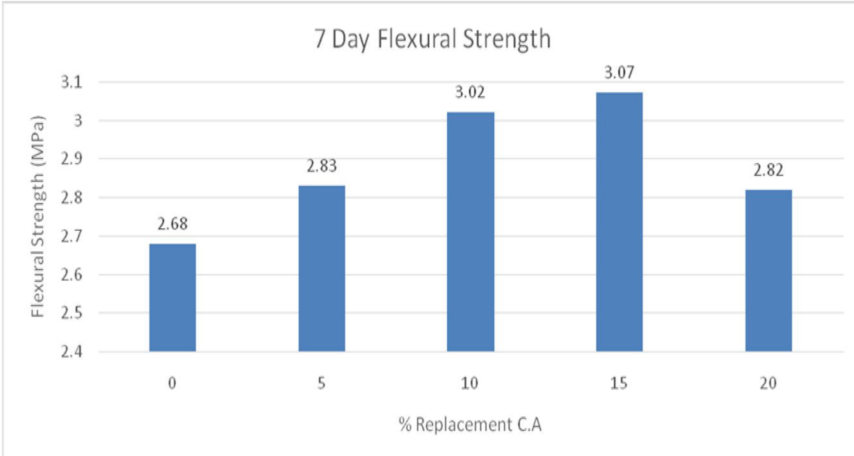


2) After 28 Days Curing

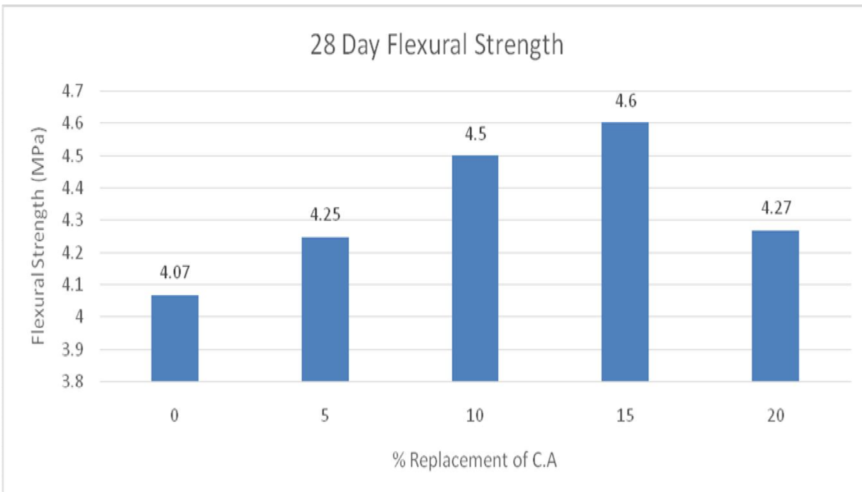


D. Flexural Strength

1) After 7 Days Curing



2) After 28 days Curing



VI. CONCLUSIONS

A. The Compressive strength of concrete increased up to 15% of slag replaced in coarse aggregate and then gradually decreases after further increment.

B. The flexural strength of concrete increases up to 15% of induction furnace slag replaced in coarse aggregate in coarse aggregate and then gradually decreased after the further increment.

C. The split tensile strength and flexural strength of slag concrete mix gives good results compared to conventional concrete mix because of slag contains about 10- 15% of metals.

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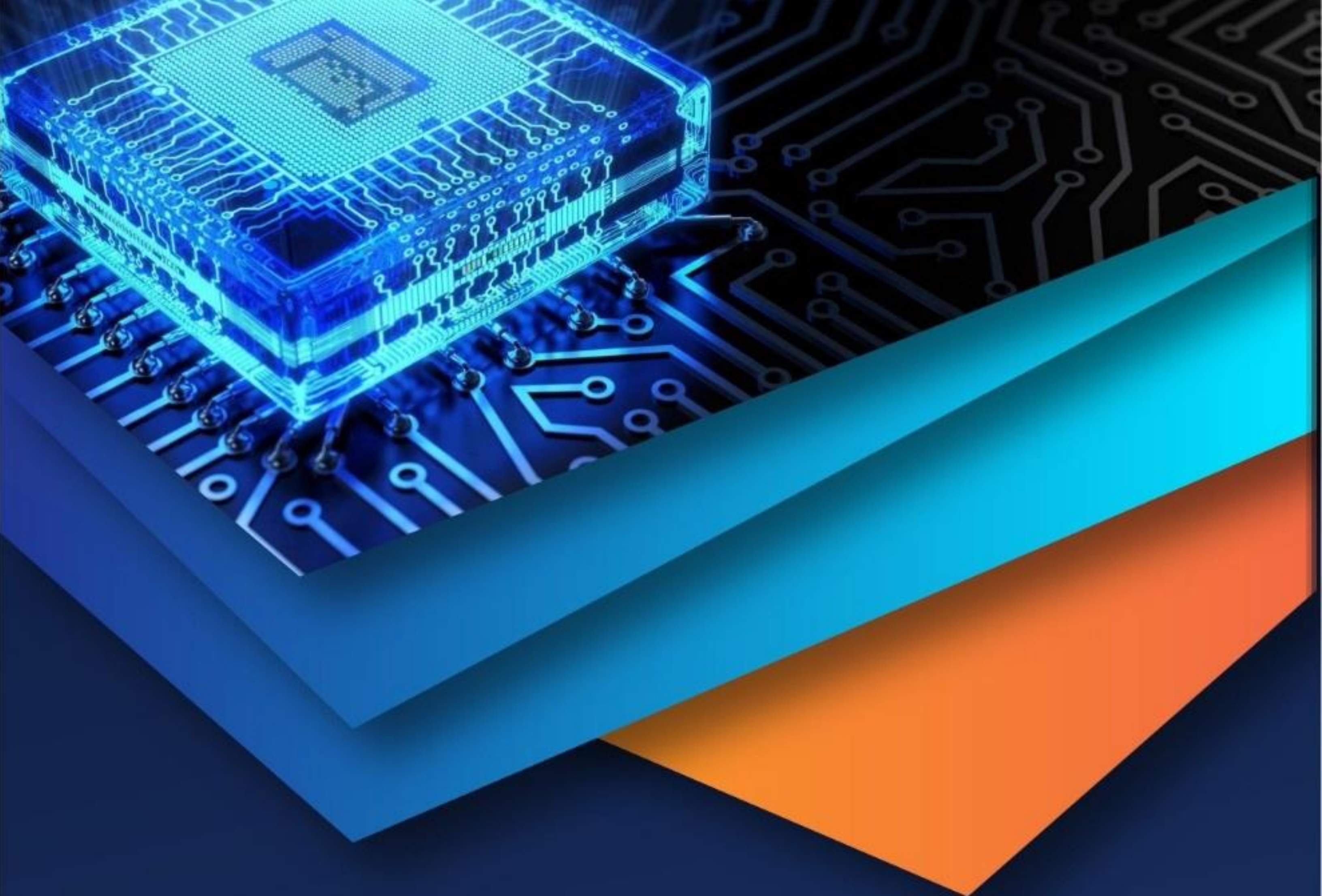

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