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A Study on Workability and High Strength Concrete with Admixtures, Silica Fume and Micro Alumina Oxide

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Abstract: ***Concrete is mostly used material today. The use of large quantity of cement produces increasing CO2 emissions and consequence the green-house effect. Now a day's mineral admixtures are being generally used to replace cement, as an admixture in concrete and in the manufacture of cement. But the study on the use of micro-alumina has been very limited. The present study aim to determine the optimum percentage of replacement of cement with micro-alumina and some percentage of Silica fume. When Micro Alumina materials are added to concrete it fills pores present in the matrix to provide an exceptional surface area to volume ratio and improves the basic property and reactivity of the material. This is in turn enhances strength and durability of concrete. Strength parameters have been studied through compressive strength, split tensile strength and flexural strength on concrete specimens with Silica fume and Micro Alumina as replacement of conventional cement in varying percentages.***

In the present study, cylinders are cast keeping coarse aggregate and fine aggregate as constant and partial replacement of cement with several varying percentages of micro-alumina as 0%, 0.5%, 1.0%, 1.5%, 2.0% and 2.5% and Silica fume as 5%. The mix ratio plays an important role in determining the optimum replacement value of micro-alumina and Silica fume. A design concrete mix ratio according to IS code of 1:1.52:2.65 with a water cement ratio of 0.32 has been adopted throughout the project. Cylinders of 150mm diameter and 300 mm height have been cast in the laboratory and were cured for 28days. Experimental investigations were carried out to study the effect of use of micro-alumina and Silica fume as a replacement of cement in concrete. Split tensile strength of Micro Alumina and Silica fume modified concrete were determined at 3, 7 and 28 days. It is concluded that partial replacement of cement with Micro Alumina and Silica fume exhibits better compressive and split tensile strength in comparison with that of conventional concrete. However at higher percentages of replacement of cement with micro-alumina and Silica fume the above strength properties were found to decrease.

Keywords: cement, fine aggregate, coarse aggregate, Silica fume, Alumina oxide, super plastizers

I. INTRODUCTION

Concrete is generally classified as normal strength concrete, high strength concrete and ultra high strength concrete. However in the last 15 years concrete of very high strength entered the filed of construction in particular construction of high rise buildings and long span bridges. Concrete strength of 90 to 120Mpa is occasionally used. In high strength concrete usually we are using the super plastizers because they increase the water content for supporting workability test. High strength concrete is very useful for conventional concrete. It can be advantageously used for compression members like columns and piles and it can be also used for domes structures, folded plates, shells and arches. Using high strength concrete we can decrease the dead load weight on foundation. We can enhance the long term durability and performance of the structure made by high strength concrete. There are many applications of high strength concrete structure for example compressive strength of 62Mpa in columns, shear walls and transfer girders of the water tower place made in Chicago in 1975.high strength concrete has wide application from transmission poles to the tallest building on earth.

A. Ingredient Materials For High Strength Concrete

1) *Cement:* Strength will be depending upon both cement characteristic and cement content. The port land cement is very important role in high strength concrete. Cement is made by heating a mixture of lime stone and clay in kiln at about 1450 CN then grinding to fine powder with small addition of gypsum. Cement is normally grey in color.
2) *Water and water-cement ratio:* The water-cement ration is the ration of the weight of water to the cement used in a concrete

mix. A lower ration lead to higher strength and durability, but my make the mix difficult to work with and form.

3) *Aggregates:* Aggregate is a broad category of course particulate material used in construction, including sand, gravel, rushed stones, slag, recycled concrete and geo-synthetic aggregate. Aggregate are the most mined material in the world.
4) *Coarse aggregate:* Coarse aggregates having wide verity of construction application because they resemble standard rock partial as opposed to fine aggregates is more loosely resembles sand .do you know what makes the concrete that we walk and dry on every day while the finished product is uniform and strong concrete is made of many component but is mostly made of material is know as coarse aggregate.
5) *Fine aggregate:* That position of the aggregate using concrete is smaller than about 2/16 inch.
6) *Super plasticizers:* Super plasticizers are used for reducing the water content in high strength concrete by 12 to 30 percent. Usually we are the experimental performance is kavassu plast SP-431/shaliplastSP-431
7) *Silica fume:* Silica fume is replacement of cement for all proportions. But it is constant percentage of Silica fume for all proportions.
8) *Micro-alumina oxide:* Alumina oxide is replacement of cement for all proportions in various proportions.
9) *Mix proportion:* The concrete mix has been designed for M60 grade concrete as per the guidelines give in IS-10262. The design procedure is presented in Appendix A. The mix proportion obtained is 1:1.52:2.65with water cement ratio 0.32.

II. PROCEDURE

Initially the ingredients of concrete viz., coarse aggregate, fine aggregate, cement, fly ash and bottom ash were mixed and then required quantity of water is added to the dry mix and mixed thoroughly. To start with, all the materials were weighed in the ratio of 1:1.52:2.65. First, cement and sand were mixed thoroughly and then coarse aggregate was mixed with them. All the three ingredients were mixed thoroughly by hand mixing. Then required quantity of water was measured exactly and then added to the dry mix and it was thoroughly mixed until a mixture of uniform color and consistency were achieved which is then ready for casting.

III. BASIC TESTS

A. *Specific gravity of cement*

Specific gravity is determined by measuring the weight of a cement sample and its volume by measuring the liquid displaced by the cement sample. The liquid which is to be used should be such that it does not have any chemical reaction with cement otherwise the volume would include that of products the reactions. Also the liquid which is to be used, should be such that it does not have any physical reaction such as absorption with the cement, particle surface will be more than of the free liquid away from the surface of particles. Also the cement should not have any agglomerated particles with internal voids otherwise only average apparent density will be measured. Specific gravity of the cement is the ratio of the mass of the given volume of the cement to that of an equal volume of water at the same condition of temperature. The specific gravity of Portland cement is generally about (3.12 to 3.19). Cement will react with water, so to prevent this reaction kerosene should be used instead of water to be mixed with cement. Specific gravity of cement test conduct used the le-chatelier flask capacity of 250ml.
Specific gravity of cement =3.13

B. *Consistency of Cement*

For finding out initial setting time, final setting time and soundness of cement and strength parameter known as standard has to be used. The standard consistency of a cement paste is defined as that consistency which will permit a vicat plunger having 10mm diameter and 50mm length to penetrate to a depth of 33- 35mm from the top of the mould. The test will be conducting with help of vicat apparatus. This apparatus is used to find out the percentage of water required to produce a cement paste of standard consistency. The standard consistency of the cement paste is some time is called normal consistency.
Consistency of cement sample taken = 33%

C. *Initial setting time*

In actual construction dealing with cement, mortar or concrete, certain time is required for mixing, transporting and placing. During this time cement paste, mortar or concrete should be in plastic condition. The time interval for which the cement products are remain in plastic condition known as setting time. Initial setting time is regarded as the time elapsed between the movements that the water is added to the cement to the time that the paste starts losing its plasticity. The final setting time is the time elapsed between the

moment the water is added to the cement, and the time when the paste has completely lost its plasticity and has attained sufficient firmness to resist certain pressure the constituents and the fineness of cement is maintained in such a way that the concrete remains in plastic condition for certain minimum time. Once the concrete is placed in the final position, compacted and finished it should lose its plasticity in the earliest possible time so that it is least vulnerable to damages from external destructive agencies. This time should not be more than 10 hours which are referred to as final setting time. Initial setting time should not be less that 30 minutes.
Initial setting time obtained = 60 minutes

D. Fineness of cement

The fineness of cement has an important bearing on the rate of hydration and hence on the rate of gain of strength and also on the rate of evolution of heat. Finer cement offers a greater surface area for hydration and hence the faster and greater the development of strength. Increase in fineness of cement is also found to increase the drying shrinkage of concrete. Fineness of cement is tested either by sieving or by determination of specific surface by air-permeability apparatus. Specific surface is the total surface area of all the particles in one gram of cement. This tested conducted using the 90 micron sieve IS:460-1965.
Fineness of cement = 2.4%

E. Specific gravity of coarse aggregate

Specific gravity is the weight of aggregate relative to the weight of equal volume of water. The specific gravity of an aggregate is generally required for calculations in connection with cement concrete design work for determination of moisture content and for the calculations of volume yield of concrete. The specific gravity also gives information on the quality and properties of aggregate. The specific gravity of an aggregate is considered to be a measure of strength of quality of the material. Stones having low specific gravity are generally weaker that those with higher specific gravity values. This test conducted using the pycnometer apparatus.
Specific Gravity of 20 mm coarse aggregate = 2.89
Specific Gravity of 12 mm coarse aggregate =2.76

F. Water absorption of coarse aggregate

Water absorption gives an idea of strength of aggregate. Aggregates having more water absorption are more porous in nature and are generally consider unsuitable unless they are found to be acceptable based on strength, impact and hardness tests.
Water absorption of 20 mm coarse aggregate = **0.296%**
Water absorption of 12 mm coarse aggregate = **0.19%**

G. Specific gravity of fine aggregate

Specific gravity is the weight of aggregate relative to the weight of equal volume of water. The specific gravity of an aggregate is generally required for calculations are connection with cement concrete design work for determination of moisture content and for the calculations of volume yield of concrete. The specific gravity also gives information on the quality and properties of aggregate. The specific gravity of an aggregate is considered to be a measure of strength of quality of the material. Stones having a low specific gravity are generally weaker than those with higher specific gravity values
Specific Gravity of fine aggregate =2.68

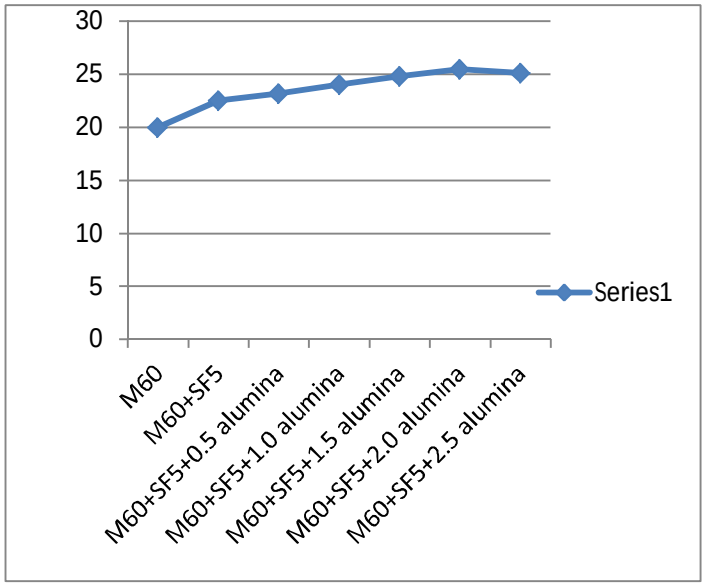
H. Sieve analysis of fine aggregate

The grain size analysis is widely used in classification of soils. The data obtained from grain size distribution curves is used in the design of filters for Earth dams and to determine suitability of soil for construction, air field etc. Information obtained from grain size analysis can be used to predict soil water movement although permeability tests are more generally used to predict soil water movement through permeability.
Sieve analysis of fine aggregate = 3.05

IV. WORKABILITY TESTS

A. Slump cone test

After the mix has been prepared, the minimum qualities of the mix can be determined by using this test. The concrete in fresh state is placed in the slump cone and then the slump cone is lifted. The concrete shows a certain shape after settling under the influence of gravity. This shape of the concrete is used to determine the workability based on the codal values. Based on the shape of the slump the concrete mix can be distinguished as the leaner mix or the rich mix.

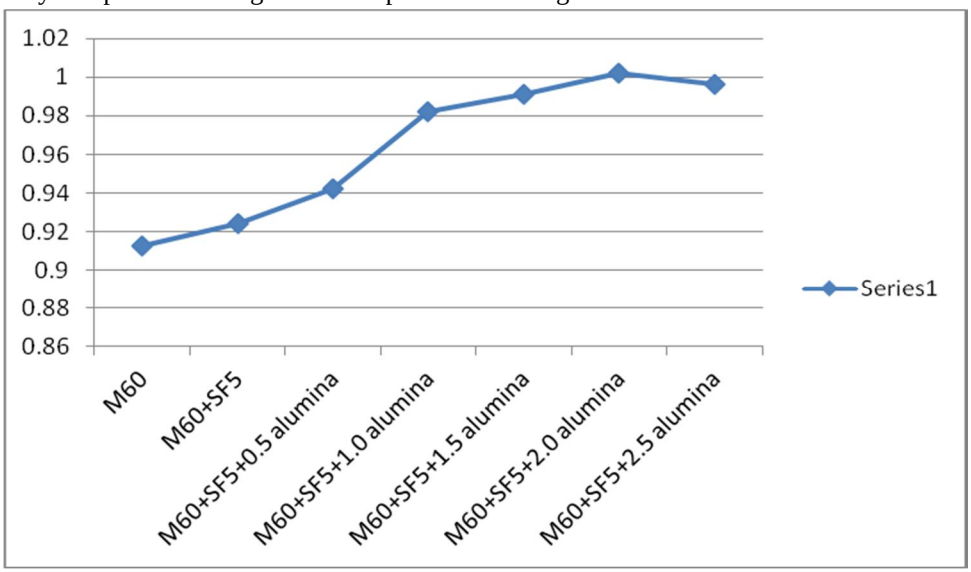


B. Compacting factor test

The higher the compaction that can be achieved at a particular water-cement ratio, the higher will be the workability of concrete and also the other properties of the concrete[24]. The compaction of concrete is determined by using the compacting factor of concrete. The weight of partially compacted concrete and also the weight of fully compacted concrete are determined. Then the difference in the weights give the compaction of concrete achieved at a particular w/c ratio.

The defects in the concrete mix are to be observed at this point of fresh state of the concrete. The chances of occurrence of segregation and bleeding of concrete are more at this stage and so proper conditions are to be maintained.

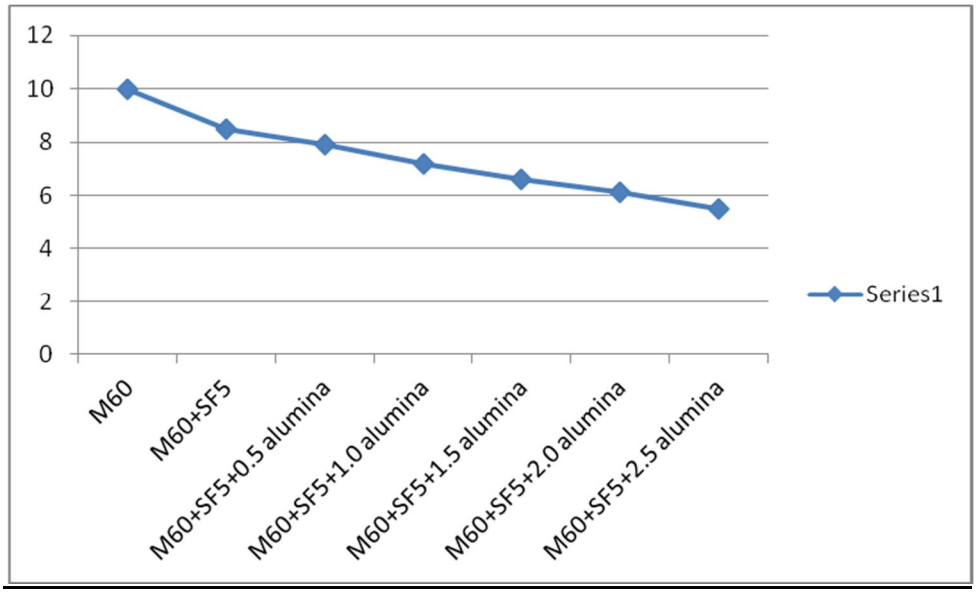
The concrete mix slowly starts losing its plasticity and gets converted in to the hardened state. Then the hardened properties of concrete are to be determined. The most important property of hardened concrete is the strength of the concrete. The strength of the concrete is determined by compressive strength and the split tensile strength.



C. Vee bee consistometer

The Vee bee consistometer (Bartos 1992; Scanlon 1994; Bartos, Sonebi, and Tamimi 2002) Measures the remolding ability of concrete under vibration. The test results reflect the amount of Energy required remolding a quantity of concrete under given vibration conditions. The Vee bee consistometer is applicable to concrete with slumps less than 2 inches. Consists of a metal cylindrical container mounted on a vibrating table, which produces a sinusoidal vibration. In the version of the test standardized in

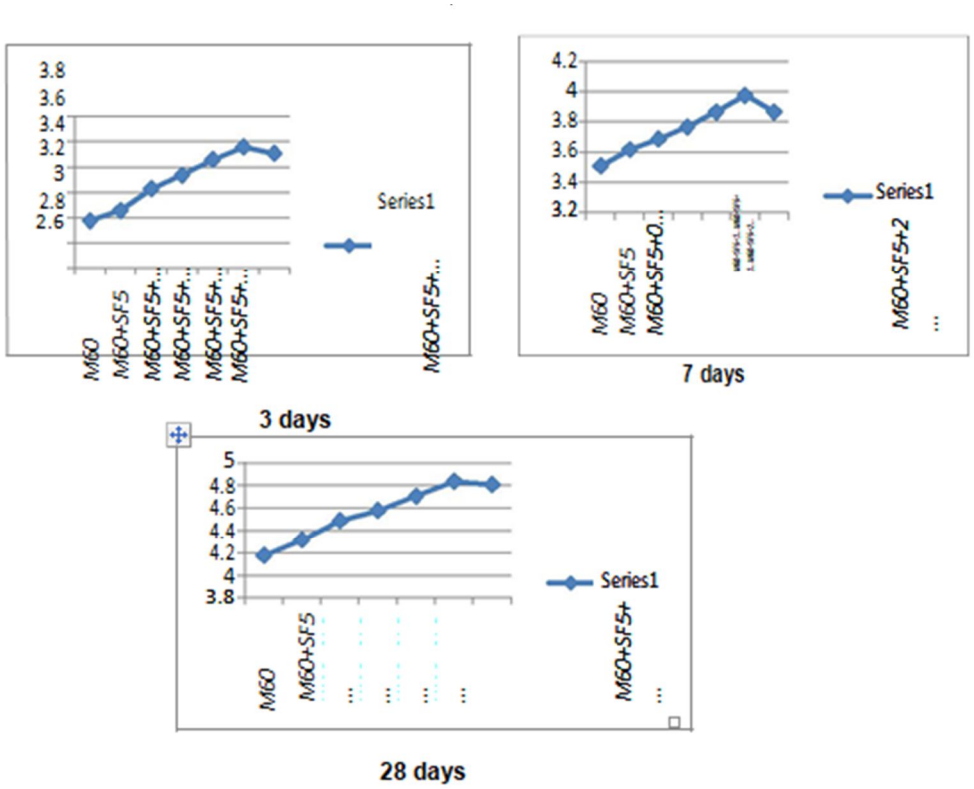
Europe as EN 12350-3, a slump cone is placed in the center of the cylinder and filled in the same manner as in the standard slump test. After the slump cone is removed, a clear plastic disk is set atop the fresh concrete. The Vee bee table is started and the time for the concrete to remold from the slump cone shape to the shape of the outer cylindrical container is recorded as a measure of consistency. The sliding clear plastic disk facilitates the determination of the end of the test.



V. EXPERIMENTAL RESULTS

Split tensile strength for cylinder from 3, 7 and 28 days in partial replacement of Micro Alumina oxide and Silica fume.

S.no	Mixed design M60with silica fume and alumina oxide	Percentage of Silica fume	Percentage of micro-alumina oxide	Split tensile strength for cylinders		
				3 days	7 days	28 days
1	M60	5	0	2.98	3.55	4.18
2	M60+SF5	5	0	3.06	3.62	4.32
3	M60+SF5+0.5 Al2O3	5	0.5	3.23	3.69	4.49
4	M60+SF5+1.0 Al2O3	5	1.0	3.34	3.77	4.58
5	M60+SF5+1.5 Al2O3	5	1.5	3.46	3.87	4.71
6	M60+SF5+2.0 Al2O3	5	2.0	3.56	3.98	4.84
7	M60+SF5+2.5 Al2O3	5	2.5	3.51	3.87	4.81



Spilt tensile strength for cylinder from 3, 7 and 28 days results representing in graphs:-

VI. CONCLUSIONS

A. The density of concrete is found to decrease with increasing in parentage replacement cement by Micro Alumina oxide and also follows replacement of cement by mineral admixture Silica fume natural aggregates by Silica fume Micro Alumina oxide..

B. The split tensile strength of cylinder concrete is found to be 28days of decrease with increase in Micro Alumina oxide and constant of Silica fume. It is found to decrease from 4.84 to 4.81 Mpa as the Micro Alumina oxide is decreased from 0 to 2.5%.

C. However the spilt tensile strength of cylinder of Micro Alumina oxide is seen to constant with the Silica fume content at reaches on optimum values is 2% and afterwards gets decreased for various percentages of Micro Alumina oxide

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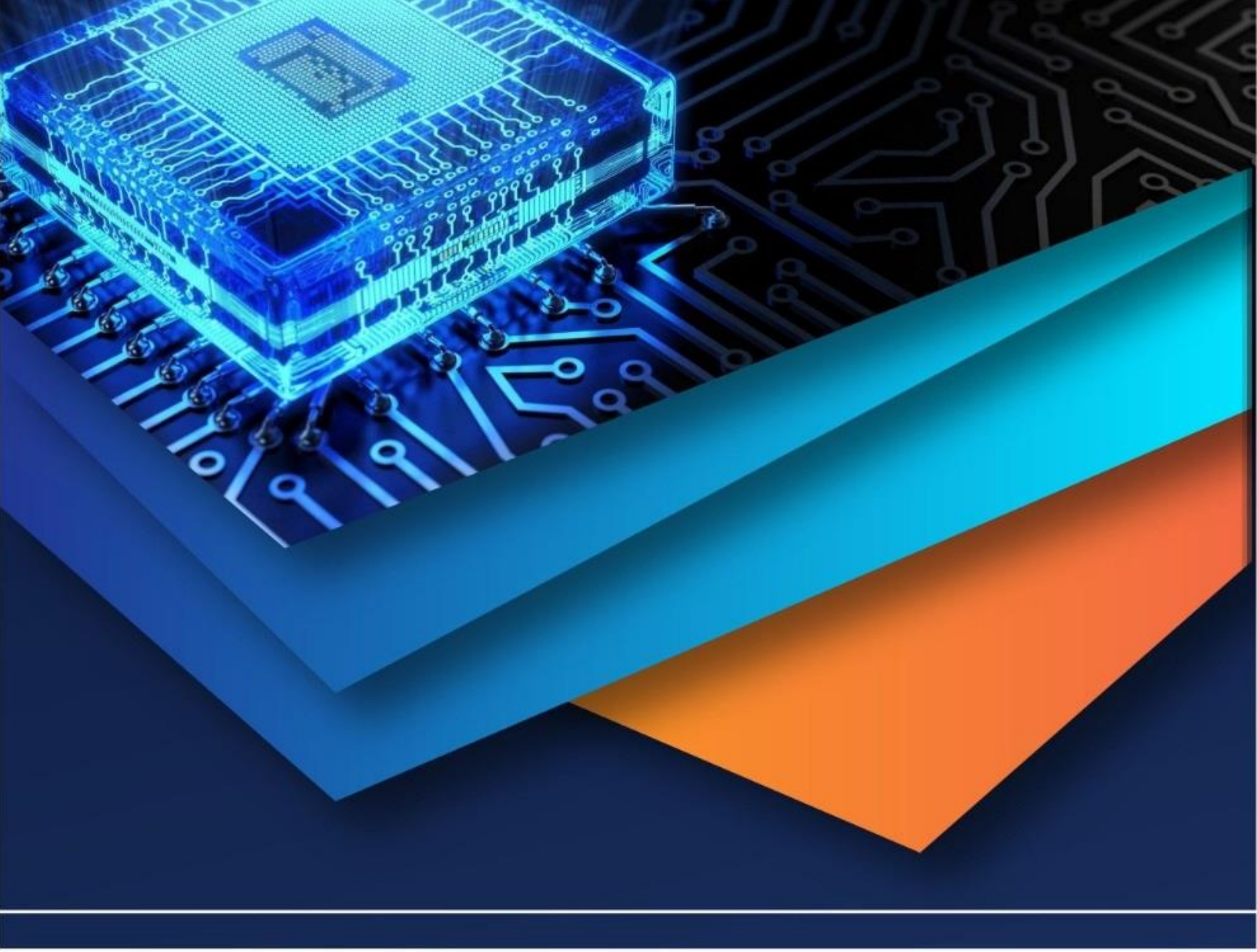

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