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Brick and Glass Concrete

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Abstract: Glass is widely used in our lives through manufactured products such as sheet glass, bottles, glassware, and vacuum tubing. Glass is an ideal material for recycling. The use of recycled glass helps in energy saving. The recycled glass has significant contributions to the construction field for concrete production. The application of glass in architectural concrete still needs improvement. Many experiments were conducted to explore the use of waste glass as coarse and fine aggregates for both ASR (Alkali-Silica-Reaction) in concrete. The accumulation and management of construction and demolition waste, which increases along with the continuous spreading of urbanization and industrialization. Construction and demolition waste can be recycled and used as a raw material for new applications. Recycled brick aggregates recovered from demolished masonry structures can be utilized in the manufacture of new concrete mixtures. Hence, partial replacement of fine aggregate by the other compatible material like sintered fly ash, crushed rock dust, quarry dust, glass powder, recycled concrete dust, and others are being researched from the past two decades to conserve the ecological balance. additional plasticizers have been used for this project for improving their workability. In this project experimental studies on the concrete of M20 grade with partial replacement of fine aggregates by crushed brick powder (replacement by 5%, 10%, 15%,20%,30%) and crushed glass powder (replacement by 5%, 10%, 15%). The compressive strength of M20 grades of concrete at different days (3 days 7 days, 28 days) has been determined along with the measurements of workability in the slump test. The trial cubes were cast and tested at different stages. When fine aggregates are replaced by 30% crushed brick powder. The decrease in strength at the end of 28 days was found to be ranging from 22.2% and 9.81%. when fine aggregates are replaced by 20% crushed glass powder, decrease in the targeted strength at the end of 28 days was found to be ranging between 3.0%and 8.6%. The slump value was found to be decreasing in the case of crushed brick powder, while it was found increasing substantially in the case of glass of glass powder. A combination of both alternatives i.e., brick powder (20%) and glass powder (15%) were also studied and it was found that the compressive strength at the end of 28 days for M20 grade of concrete is 96.13%.

Keywords: Glass powder, brick powder, workability, fine aggregate; ASR (Alkali-Silica Reaction); Compressive strength

I. INTRODUCTION

During the last decades, it has been recognized with growing concern that wastes from construction are of large volume and that this volume is increasing year by year. The problem of waste accumulation exists worldwide. Such materials are dumped in landfills which becomes the environmental problem much of the glass produced in the world is discarded and dumped in landfills. Glass is widely used in our day-to-day life through manufactured products such as sheet glass, bottles, glassware, and vacuum tubing. The glass is used in a variety of applications such as construction, automobiles, tube lights, bulbs, soft drink bottles, nose-diving submarines, doors and windows, waste containers, windows, windscreen, electronic equipment, etc. Hence, the usage of glass increased considerably. Which increases waste disposal. Also, glass waste is considered as non-decaying material that pollutes the surrounding environment. The usage of Glass in powdered form as a partial replacement of fine aggregate in concrete is done in this case. The test results show that it increases strength compared to conventional concrete. If glass could be incorporated in cement products. It would greatly reduce the disposal of recycled glass and/or its use in lower-valued markets such as landfill material. There is considerable interest in the use of recycled glass with Portland cement in making a variety of different types of cement products. Advantages of glass powder in concrete are better resistance to sulphate attack, reduction in the effects of alkali-silica reaction, increase in compressive and flexural strength, long term strength. Increase the chemical attack resistance. To make concrete industries sustainable, the use of waste material in place of natural resources is one of the best approaches.

In India, 0.7% of total urban waste generated comprises glass. The UK produces over three million tons of waste glass annually. Waste glass is crushed into specified sizes for use as aggregate in various applications such as water filtration: girt plastering, and replacement in concrete. The use of river sand as fine aggregate leads to the exploitation of natural resources, lowering of the water table. Inking of bridge piers and erosion of river bed.

If the fine aggregate is replaced by waste glass by specific percentage and in a specific size range, it will decrease fine aggregate content and thereby reducing the effects of river dredging and thus making concrete manufacturing industry sustainable. The utilization of this waste is the need of the hour. There is huge potential for using waste glass in the concrete construction sector when waste glasses are reused in making concrete products, the production cost of concrete will go down. This move will serve two purposes, fest it will be environment friendly, second, it will utilize waste in place of precious and relatively costly natural resources.

Fine recycled brick aggregates recovered from demolished masonry structures can be utilized in the manufacture of new concrete mixtures. The utilization of masonry waste and crushed brick as an aggregate in mortar and concrete would have a positive effect on the economy fire bricks used as a construction material are manufactured from plastic and non-plastic clays of high purity. The different raw materials are properly homogenized and pressed in high-capacity presses to get the desired shape and size.

Recycling is the reprocessing of old materials into the new products, prevent the waste of potentially useful materials, reducing the consumption of raw materials. Recycling or re-using of bricks is an environmentally friendly way of eliminating it from the waste stream fine recycled brick aggregates recovered from demolished masonry structures can be utilized in the manufacture of new concrete mixtures at this way, it is possible to reduce the problem of construction and demolition waste storage, and to reduce the consumption of natural materials. The utilization of masonry waste and crushed brick as an aggregate in mortar and concrete would have a positive effect on the economy also. Namely. Preservation of natural materials is significant for an ecologically responsible and sustainable building that would be cost-effective also. This kind of building implies the usage of low-cost materials that can be used without any negative impact on the environment

II. BACKGROUND

Concrete is the premier civil engineering material concrete manufacturing involve consumption of ingredients like cement, aggregates, water & admixtures. Among all the ingredients, aggregates form the major part. More than 50000 billion tons of aggregate are produced each year in the world. The use of natural aggregates in such a rate leads to a question about the preservation of natural aggregate sources. Besides, an operation associated with aggregates extraction and processing is the principal cause for environmental concern. The most widely used fine aggregate for the making of concrete is the natural sand mined from the riverbeds. However, the availability of river sand for the preparation of concrete is becoming scarce due to the excessive non-scientific methods of mining from the riverbeds, lowering of the water table, the sinking of the bridge piers, etc. are becoming common. The present scenario demands the identification of substitute materials for the river sand for making concrete. Recently in the environmental issues, restrictions of local and natural access or sources and disposal of waste material are gaining great importance. Today, it becomes more difficult to find a natural resource. The use of the waste materials not only helps in getting them utilized in cement, concrete and, other construction materials, but also has numerous indirect benefits such as the reduction in landfill cost saving in energy, and protecting the environment from possible pollution effect. It also helps in reducing the cost of concrete manufacturing. With increasing concern over the excessive exploitation of natural aggregates, synthetic lightweight aggregate produced from environmental waste is a viable new source of structural aggregate material. The uses of structural grade lightweight concrete reduce considerably the self-load of a structure and permit larger precast units to be Handled.

In light of this in the contemporary civil engineering construction, using alternative materials in place of natural aggregate in concrete production makes concrete sustainable and environmentally friendly construction material. Different alternative waste materials and industrial by-products such as fly ash bottom ash, recycled aggregates, foundry sand, China clay sand, crumb rubber, waste glass, coconut shells, brick powder, etc. can replace natural aggregates. The use of waste material in place of natural resources is one of the best approaches. In India, 0.7% of total urban waste generated comprised of glass. The UK produces over three million tons of waste glass annually. Waste glass is crushed into specified sizes for use as aggregate in various applications such as water filtration: girt plastering, sand cover for sports turf and replacement in the water table, the sinking of bridge piers, and erosion of river bed.

III. SCOPE OF THE STUDY

In a growing country like India, a huge amount of industrial waste is polluting the environment. With a view to the above, this study aims at the utilization of such materials for value-added application i.e., waste management. Also, the waste can improve the properties of construction materials. The high cost of conventional aggregate material affects the economy of a structure. With increasing concern over the excessive e exploitation of natural aggregates, synthetic lightweight aggregate produced from environmental waste is a viable news source of structural aggregate material.

At present, the disposal of waste glass and brick is becoming a major waste management problem in the world. It is estimated that 1.2 billion of waste glass and brick waste produced globally per year. In this context, our present study aims to investigate the optimal use of waste glass and brick powder as fine aggregate in a concrete composite

IV. OBJECTIVES

The main objective of the study is to use the glass powder and brick powder as a partial replacement of fine aggregate for the positive variations in the properties of the mix and also its impact on the economic growth of the construction industry and to explore the use of replaced materials. Further, the effect of materials used as an admixture is to be determined by testing workability, tensile strength, compressive strength, durability, etc. Of cement mortar. These tests will enable a complete characterization and an evaluation of application possibilities

The main objectives of the study are summarized below;

A. The main objective of this study is to investigate the effect of the addition of glass powder and brick powder into the Portland cement concrete in three different replacement levels i.e., 5%, 10%, and 15% by mass of fine aggregates and evaluate the fresh and hardened B.G concrete properties.
B. Utilization of waste glass and brick in the concrete construction sector hence eliminating the need for landfill disposal of this non-biodegradable waste.
C. To evaluate the utility of crushed brick as a partial replacement of sand in concrete.
D. To study and compare the performance of conventional concrete.
E. To understand the effectiveness of brick in strength enhancement

V. MATERIALS AND METHODS

A. Materials Used

Following materials are used for preparing concrete

1) *Cement:* cement is a binder, a substance that sets and hardens independently, and can bind other materials together. The ordinary Portland cement of grade 43 will be used in the study.
2) *Sand:* fine sand is to be used after proper sieving. Sand is mainly used as an inert material to give volume in concrete for the economy.
3) *Coarse Aggregate:* well-graded gravel which passes 20 mm sieve and is retained 4.75 mm, naturally occurring crushed stone used in the work
4) *Brick Powder:* brick powder is used as a fine aggregate for making concrete. The waste bricks as obtained from the garbage of a broken building were collected and pulverized to get the particle passing 4.75 mm sieve and retained on 0.075 mm sieve to get the grading of fine aggregate 5, 10, and 15% brick powder is used as a replacement of sand in the experiments.
5) *Glass Powder:* glass is widely used in our day-to-day life and is an ideal material for recycling. The waste glass was obtained from the dump of broken windows and doors panels. It was pulverized to get the particles ranging 4.75 mm and 0.075 mm to achieve the grading of fine aggregate. The different percentage of sand replaced by glass powder was 5%, 10%. & 15%.
6) *Water:* the binding property of cement activates in the presence of water and thus mortar is prepared. The portable water was used here for making a concrete mix.

B. Methodology

For this Project, bricks were collected from the construction site in the college campus and waste glass was collected from a hardware shop and crushed with a hammer in a concrete laboratory.

Material Testing

Following tests were conducted on the materials used:

1) *Cement Tests:* Consistency test, determination of initial and final setting time, compressive strength test.
2) *Tests for Fine Aggregate:* (Sand tests) Determination of specific weight, sieve analysis.
3) *Tests for Coarse Aggregates:* Tests for gravel Sieve analysis, crushing test, impact test, abrasion test, water absorption test.

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S.NO	Test Performed
1	Consistency Test for Cement
2	Initial and Final Setting Time
3	Abrasion Test for Coarse Aggregates
4	Water Absorption Test for Aggregates
5	Workability Test
6	Compression Test
7	Flexure Test

C. Mixing

Cement sand to the aggregate ratio of 1:1.5:3 was taken and the calculations of each constituent were done by weight analysis for replacements, the aggregate replacement % age was taken as in Table: 4.1. The water/cement ratio was kept as 0.45 for all samples. The proportioned mix was blended by hand, and then water was added to it in small quantities. The mixture was mixed continuously by hand using trowels until the appropriate concrete workability is reached

Fig showing mixing of concrete

Mix id	Cement (kg/m3)	sand	Brick powder	Glass powder	C.Agg (kg/m3)	% Replacement	w/c
PC	400	600	-	-	1200	0	0.45
G5C	400	570	-	30	1200	5	0.45
G10C	400	540	-	60	1200	10	0.45
G15C	400	510	-	90	1200	15	0.45
B5C	400	570	30	-	1200	5	0.45
B10C	400	540	60	-	1200	10	0.45
B15C	400	510	90	-	1200	15	0.45
B5G5C	400	540	30	30	1200	5	0.45
B10G10C	400	480	60	60	1200	10	0.45
B15G15C	400	420	90	90	1200	15	0.45

Where
- G5C represents a 5% replacement by glass powder.
- B5C represents a 5% replacement by brick powder.
- B5G5C represents a 5% replacement by brick powder and 5% replacement by glass powder
- PC represents plain concrete

D. Molding

1) *For Cubes:* The cubes for testing compressive strength of mortar are made of cast iron with a side of 15 cm. These moulds were first cleaned and then greasing was done. The freshly mixed concrete was then brought for filling into the moulds. Moulds were overfilled with fresh concrete and continuously compacted to minimize voids. The tops of the overfilled moulds were smoothed with a trowel and then the excess was sliced off the cubes were then kept undisturbed for 24 hours. After 24 hours the samples were removed from the mould. For each replacement, two samples were prepared for 7 and 28-day testing

Fig showing compaction and surface finishing of the cube

2) *For Beam:* The moulds used for flexure testing were, built of mild steel with four sides fitted together on the bottom plate. The size of the mould is 50cm x 10cm x 10cm. The moulds were cleaned and coated with grease. Moulds were then overfilled with fresh concrete and continuously compacted to minimize voids. The tops of the overfilled moulds were smoothed with a trowel and then the excess was sliced off. These beams were then kept undisturbed for 24 hours. For each replacement, two samples were prepared for 28-day testing.
3) *For Cylinder:* The cylinders for testing the tensile strength of concrete are made of cast iron with a diameter of 18cm and height 15cm. These moulds were first cleaned and then greasing was done. The freshly mixed concrete was then brought for filling into the moulds. Moulds were overfilled with fresh concrete and continuously compacted to minimize voids. The tops of the overfilled moulds were smoothed with a trowel and then the excess was sliced off. The cylinders were then kept undisturbed for 24 hours. After 24 hours the samples were removed from the mould. For each replacement, one sample was prepared for 28-day testing.

E. Curing

It is an important part of the concreting process. After the concrete is in place, it begins to dry as the moisture in it evaporates. The more slowly this process happens, the stronger the resulting concrete is. Curing methods help to slow down the drying of the concrete, resulting in a stronger bond and more durable structure

Curing is thus the process in which the mortar is protected from loss of moisture and kept within a reasonable temperature range. After 24 hours the cubes and beams were removed from the moulds and kept for curing in buckets, plastic jars and in curing tank, The curing was done for a period of 7 days and 28 days in case of 7-day and 28-day tests respectively.

Fig showing curing tank and cured sample

F. Testing

The testing program includes a variety of tests that address the workability of the fresh concrete and compressive and flexural strengths of the samples. The compressive strength was checked using a compression testing machine in which the samples were tested for 7 days and 28 days. The UTM (universal testing machine) was used to check the flexural strength of samples 28 days. A slump test was performed for each mix design of concrete to check the workability of concrete on every partial replacement of coarse and fine aggregates. Another test le tensile split strength test was done using CTM (compression testing machine)

VI. RESULTS

A. Standard Consistency Test

For standard cement

Sample	Consistency	Mean
PC	26	27.6
PC	29	
PC	28	

B. Initial And Final Setting Test

For standard cement

Initial setting time (hrs)	Final setting Time (hrs)	Mean of initial Setting time	Mean of final Setting time
0.52	5.72	0.55	5.57
0.55	5.41		
0.59	5.58		

C. Abrasion And Crushing Tests For Coarse Aggregates

Tests	Natural aggregate	Mean of natural aggregate
Abrasion value %	2.0 1.9 1.7	1.87
Crushing value %	7.1 6.5 5.8	6.46

D. Water Absorption Test For Coarse And Fine Aggregates

Sample	Water Absorption value (%).		Mean
Coarse Aggregates	Gravel	0.73	0.66
		0.65	
Fine Aggregates		0.61	
	River Sand	0.29	0.31
		0.34	
		0.31	
	Glass powder	0.11	0.1
		0.12	
		0.09	
	Brick Powder	33	28.3

E. Workability Test For Varying Rubber Content As Aggregate

Sample	Slump (mm)	%age reduction of slump
PC	50	0
B5G5C	48	4
B0G10C	47	6
B15G15C	42	16

F. Compression Test

1) 7 days Compressive strength concrete with 5, 10, 15% replacements of coarse aggregate by tyre rubber

Sample	Stresses (N/mm^2)
PC	19.11
B5G5C	22.5
B10G10C	21.62
B15G15C	17.01

2) 28 days Compressive strength concrete with 5, 10, 15 % replacements of coarse aggregate by tyre rubber

Sample	Stresses (N/mm^2)
PC	27.33
B5G5C	32.22
B10G10C	30.88
B15G15C	24.3

G. Flexural Test

Sample	Stress(N/mm^2)
PC	8.1
B5G5C	8.4
B10G10C	8.45
B15G15C	8.35

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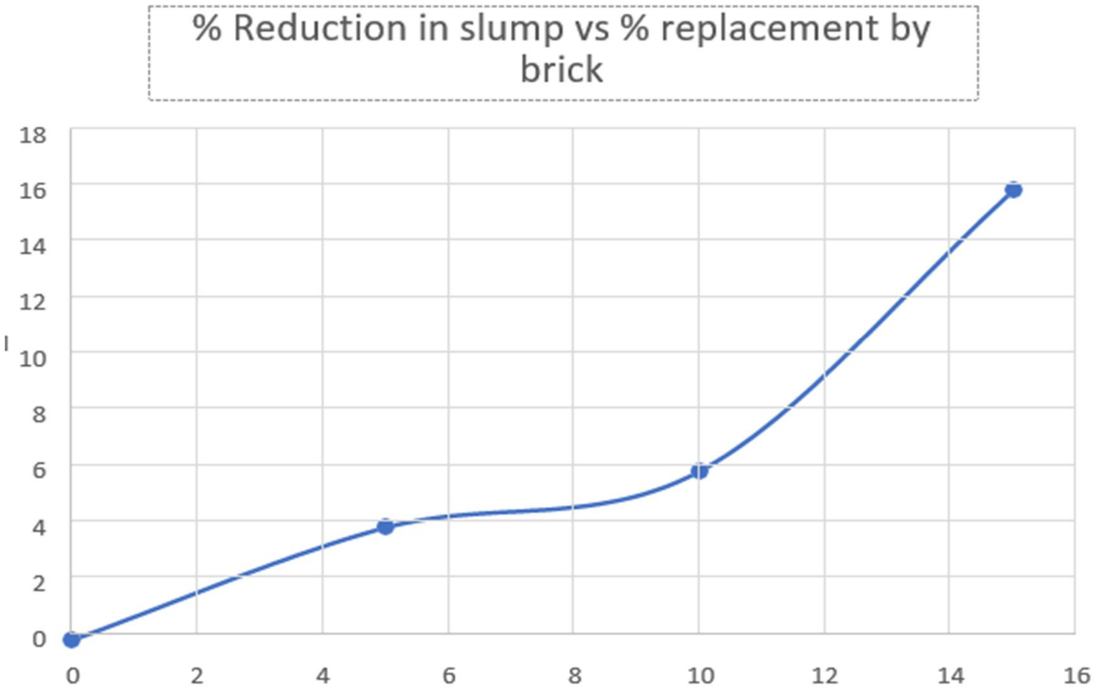
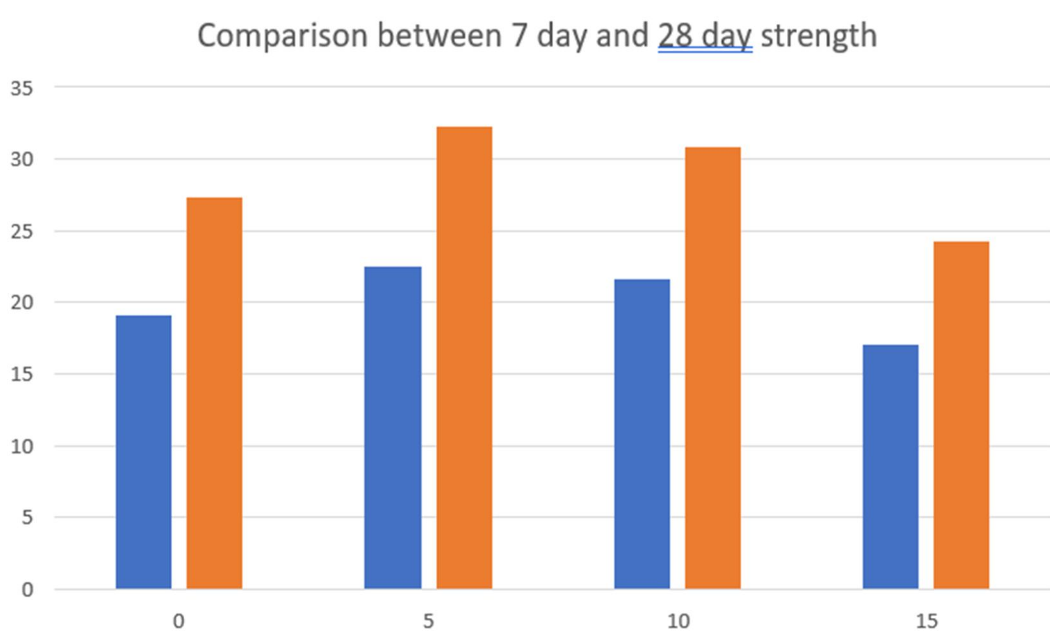
H. Split Tensile Strength Test

Sample	Stress(N/mm^2)
PC	2.38
B5G5C	2.2
B10G10C	1.21
B15G15C	0.7





VII. CONCLUSION

In the contemporary civil engineering construction economy of any construction project depends upon its construction, advancement, and sustainability Using alternative materials in place of natural aggregates in concrete production makes concrete as sustainable and environmentally friendly construction material Use of solid waste can achieve the economy in construction. This study concluded that the utilization of brick waste and glass solid waste as aggregates in concrete not only helps in getting them utilized in concrete but also has numerous indirect benefits such as reduction in landfill cost and protecting environment from possible pollution effect With increasing concern over the excessive exploitation of natural aggregates, this environmental waste compromising of brick waste and waste glass is a viable new source of structural aggregate material The study concluded that up to 10% replacement of fine aggregates by brick waste and waste glass, compressive strength increases Also there is an increase in the flexural strength of concrete up to 15% replacement of fine aggregates Hence, brick waste and waste Glass can be effectively used as fine aggregate placement up to 15% to improve the strength of concrete Among various mixes compressive strength is maximum for the mix in which fine aggregates are replaced by 10% Its strength has increased by about 13% compared to the conventional M_{20} concrete Flexural strength is also maximum for the mix in which fine aggregates are replaced by 15% Its flexural strength has increased by 3.085 percent compared to conventional M_{20} concrete. Partially replaced concrete is relatively lightweight than conventional concrete which is economical, eco-friendly, and used in a lightweight structure where we have to minimize dead loads especially in earthquake-prone zones Brick waste can be grouped under lightweight aggregate. There is no need to treat the brick waste before use as an aggregate except for water absorption Brick waste is compatible with the cement The 28 - day air-dry densities of brick waste aggregate concrete are less than 2000 kg/m3 and those are within the range of structural lightweight concrete Due to the replacement of by waste brick workability decreases but due to the replacement of fine aggregates by waste glasses, workability increases So the study concluded that when both brick waste and glass waste are used, there is not much effect on workability compared to conventional concrete as the effects are counterbalanced in these mixes. When the percentage replacement by brick waste is higher, some plasticizers or superplasticizers can be used to have good workability.

VIII. FUTURE SCOPE OF WORK

A. Studies can be made to investigate the various properties of the partially replaced concrete with brick waste and waste glass by varying the aggregate sizes up to acceptable limits Study can also be made to check the split tensile strength of such partially replaced concrete
B. Brick waste as partial replacement of fine aggregates can be effectively executed in areas where brick waste is present in abundant quantity
C. Provisions should be made to convert brick and waste glasses into a suitable aggregate form on a large scale in order to make the concrete industry more sustainable.
D. It is appreciable to replace fine aggregates by 10% to 15 % glass waste and waste brick in the areas of their availability to make concrete sustainable in terms of economy and more eco-friendly.

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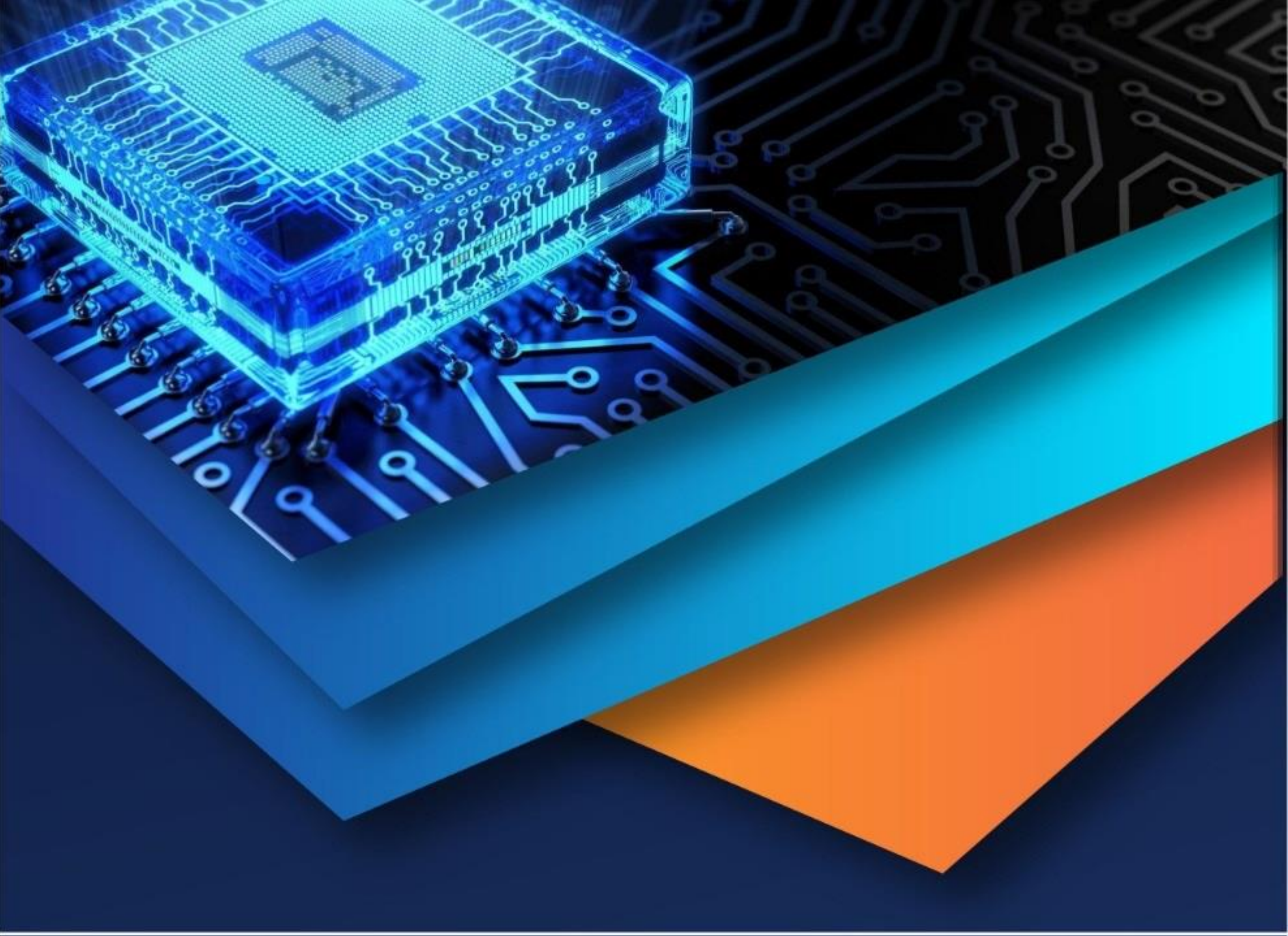

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