iJRASET
International Journal For Research in Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 10 **Issue:** XII **Month of publication:** December 2022

DOI: https://doi.org/10.22214/ijraset.2022.48069

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International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 10 Issue XII Dec 2022- Available at www.ijraset.com

Effect of Use Sugarcane Bagasse Ash and Rubber Tyre as A Partial Replacement of Cement and Coarse Aggregate in Concrete

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Abstract: ***Recycling and usage of waste products can be a viable option in the waste management of many materials. The present study focuses on the utilization of Sugarcane Bagasse Ash(SCBA) as replacement material for cement and rubber tyre as replacement material for coarse aggregate in concrete production. Noting the increasing volumes and difficulty in the disposal of wastes from rubber tyres and SCBA, this paper discusses test results of use of SCBA and recycled tyres in concrete for possible application in the construction industry. Sugarcane Bagasse ash contains high amorphous silica content and aluminium ion. For experimental investigations, Sugarcane bagasse ash and its chemical properties are obtained from Sakthi sugars private ltd, Aapakoodal, Tamilnadu. Ordinary Portland cement was partly replaced by sugarcane bagasse ash in the ratio of 0%, 10%, 20% and 30% by weight. The results indicate that inclusion of Sugarcane Bagasse Ash in concrete up to 20% level significantly enhanced the strength of concrete. In 2008, around one billion end-of-life tyres (ELTs) were being produced globally each year. As a possible means of disposing the tyres, it is proposed to use rubber tyres as coarse aggregate in concrete. Tyres cut into pieces with maximum size of 20 mm to use as coarse aggregate.It were used in the replacement of 15% of the normal gravel. Grade of concrete used in this paper is M30.Compressive strength, splitting tensile, and flexural strength tests were conducted according to the various BS codes. This paper also demonstrated the variation in the compressive strength of the non-conventional concrete when the BS and ACI methods are used in the design of the mix.***
Keywords: Sugarcane Bugasse Ash, Rubber tyre, M30, BS and ACI methods.

I. INTRODUCTION

GENERAL

As the population of the nation is increasing, the industrialization and pollution level is also increasing. Therefore it is our foremost duty to reduce the pollution and make the planet healthy for living. Air pollution is not only caused due to release of toxic gases from the factories but also due to minute particulate materials (fly ash) which are produced because of burning of coal and other materials. The production of sugar and jaggries released huge amount of bagase ash. In India there are about 443 operating sugar mills where after extracting juice from sugarcane. Portland cement is the major construction material throughout the world. Today researchers are focusing on utilizing industrial or agricultural waste, as a source of raw materials for industry which results in foreign exchange earning and environmental pollution. Industrial wastes, such as blast furnace slag, fly ash and silica fumes are being used as supplementary cement materials. The utilization of bagasse ash is more, the residue from an in-line sugar industry and the bagasse-biomassfuel in electric generation industry. When this waste is burned under controlled conditions, it also gives ash having amorphous silica, which has pozzolanic properties. The study of pozzolanic activity and their suitability as binders, have been carried out on the ashes in replacing cement..There is a possiblility in using sugarcane bagasse ash as cement material to improve quality and reduce the cost of construction materials such as mortar, concrete pavers, concrete roof tiles and cement interlocking block. Concrete is the most common construction material in the world because it combines very good mechanical and durability properties, workability and relative low cost. cement production emits greenhouse gases, mainly CO2, being responsible for about 5% of global anthropogenic CO2 emissions in the world. The use of low emission pozzolans as cement replacement is one of the possibilities to reduce greenhouse gases emissions. The bagasse is an important by-product of the sugar cane industry and most of it is used to produce steam and electricity in a co-generation plant at the ethanol plant . After the bagasse combustion, a new by –product is the Sugar Cane Bagasse Ash (SCBA). It consists mainly of silica (SiO2), which indicates its potential as mineral admixture for use in concrete.

The results of this research program indicated that SCBA can be used as a pozzolan and substitute cement. Since durability is a very important issue for implementing new construction materials, in this Thesis, the results of tests of sulphate attack on concrete cubes made with SCBA. These tests indicated that SCBA improves the durability of a reference.

II. LITERATURE REVIEW

Mohananganga Raju Puppala, M K M V Ratnam., Andhra Pradesh, India. December 2014- Sugarcane bagasse is a fibrous waste product of sugar refining industry. This product causes severe environmental pollution, which calls for urgent ways of handling the waste. Bagasse ash mainly contains aluminum ion silica, iron &calcium oxides. The ash therefore becomes an industrial waste and poses disposal problems. So few studies have been reported that sugarcane bagasse ash as good pozzolanic material in partial replacement of cement. In this project objective is to study the influence of partial replacement of Portland cement with sugarcane bagasse ash in concrete subjected to different curing environments. Experimental investigation on acid resistance of concrete in mgso4 solution. The variable factors considered in this study were concrete grade of M35 & curing periods of 7days, 28days, 60days, 90days, 180days of the concrete specimens in 1%, 2%, 3%, 4%, and 5% MgSO4 solution. Bagasse ash has been chemically & physically characterized & partially replaced in the ratio of 0%, 5%, 10%, 15%, and 20% by weight.

T.R.Patil T.1, N.R.Gautam., Maharashtra, India - In this study, the feasibility of using Sugarcane Bagasse Ash (SBA), a finely ground waste product from the sugarcane industry, as partial replacement for cement in conventional concrete is examined. The disposal of this material is causing environmental problems around the sugar factories. On the other hand, the boost in construction activities in the country created shortage in most of concrete making materials especially cement, resulting in an increase in price. The percentages selected for this study are 0%, 5%, 10% and 15% by the weight of cement in concrete. Based on the experimental tests, it can be concluded that SBA, an agro waste product, can be utilized effectively in partial replacement of cement, thus reducing CO2, emissions and disposal problems to some extent. The properties for fresh concrete are tested like slump cone test, spilt tensile strength and for hardened concrete compressive strength at the age of 7, 14 and 28 days. The test result indicate that the strength of concrete increase up to 10% SCBA replacement with cement. Keywords: bagasse ash, cement, concrete, strength .

DR.K.YUGANDHAR REDDY, Gudur, SPSR Nellore, A.P, India- On the hand materials wastes such as Sugar Cane Bagasse Ash & Fly Ash is difficult to dispose which in return is environmental Hazard. The Bagasse ash & Fly ash imparts high early strength to concrete and also reduce the permeability of concrete. The Silica present in the Bagasse ash reacts with components of cement during hydration and imparts additional properties such as chloride resistance, corrosion resistance etc. Therefore, the use of Bagasse ash in concrete not only reduces the environmental pollution but also enhances the properties of concrete and also reduces the cost. It makes the concrete more durable. This project mainly deals with the replacement of cement with Bagasse ash and fly ash in fixed proportions. The concrete mix designed by varying the proportions of Bagasse ash and fly ash for 0%, 5%, 10%, 15%, 20%, 25% the cubes are been casted and cured in normal water for ages of 7, 14 and 28 days. This Study represents the experimental methodology and experimental results related to strength, Mix ratio and water absorption. Cubes of size 100 mm*100mm*100mm are prepared to investigate the maximum percentage attained with maximum compressive strength. This investigation is carried out at the end of 7days,14 days and 28 days.

K. Lakshmi Priya, R.Ragupathy,. PSG College of Technology, Coimbatore, India- The present study focuses on the utilization of Sugarcane Bagasse Ash as replacement material for cement in concrete production. Sugarcane Bagasse ash contains high amorphous silica content and aluminium ion. For experimental investigations, Sugarcane bagasse ash and its chemical properties are obtained from KCP sugar factory, Andhra Pradesh. Ordinary Portland cement was partly replaced by sugarcane bagasse ash in the ratio of 0%, 5%, 10%, 15%, 20% and 25% by weight and the influence of Sugarcane bagasse ash as a partial replacement material has been examined on fresh concrete tests by Compaction factor test and Slump cone test as well as on hardened concrete with tests for Compressive strength, Split tensile strength, Flexural strength and Modulus of Elasticity. The results indicate that inclusion of Sugarcane Bagasse Ash in concrete up to 20% level significantly enhanced the strength of concrete. The highest strength was obtained at 10% Sugarcane bagasse ash replacement level.

Mr. Dilip Srinivas., B.E. Civil Engineering NIE Mysore .,- Geo polymer is a amalgam of waste products with alkaline solution to form useful product. A Geo polymer Concrete is characterized by its ecofriendly nature. This paper is intended to understand the use of bagasse ash in Geo polymer Concrete. Bagasse ash is a by-product from sugarcane industry , which is widely available in the world. Moreover , the use of bagasse ash is more environmental friendly which reduces the final cost of Geo polymer Concrete. Bagasse ash is a rich in silicate and alumina, hence react with alkaline solution to produce aluminosilicate gel which will bind the fine and coarse aggregate in a suitable manner, which also provide good resistance against adverse conditions.

An attempt has been made to check the possibility of reuse of bagasse ash in Geo polymer Concrete by investigating compressive strength of M25 grade plain concrete and flexural behavior of RC member for 25 and 30 percent replacement by bagasse ash.

Tooba Akber, Aneel Kumar., Mehran UET, Jamshoro, Sindh, Pakistan. March-2022- In this Research study, Aim is to find out the effect of Sugarcane bagasse ash on concrete. The total 30 concrete samples were prepared with mix proportion of 1:1.5:3 at 0.5 water/cement ratio. SCBA were used as substitute for cement such as 0%, 5%, 10%, 15% and 20% in concrete. Three cylinders were prepared for checking split tensile strength to get optimum split tensile strength when replacing cement with sugarcane bagasse ash. In this experimental work, sugarcane bagasse ash was replaced with cement for curing period of 7 days and 28 days to achieve the optimum split tensile strength. With the replacement of 10% cement with Sugarcane bagasse ash maximum split tensile strength of 3.43MPa at 28 days curing period was observed with an increment of 27.5% as compared to 2.69MPa at control mix further increment in replacement of sugarcane bagasse ash with cement was resulted in decrement of split tensile strength. so replacement of 10% of cement with sugarcane bagasse ash in concrete was found optimum. On the other end workability of concrete is decreased from 58mm at controlled mix to 37mm at 20% replacement of cement with sugarcane bagasse ash.

Amit R. Nishad, Rahul R. Patle, Ariba K. Hamidi, Mangesh Urade- In this paper bagasse ash sample was collected from Purti Power plant (Bela) which was sieved through 125 micron IS sieve size. Ordinary Portland Cement was replaced by the bagasse ash sample in the percentage of 0%, 10%, 20% and 30% for M25 mix. The properties of concrete such as workability i.e. slump cone and compaction factor test, compressive strength along with the test on bagasse ash individually such as moisture content, volatile matter, carbon content, consistency test, initial and final setting time were tested. The cubes casted for compressive strength result were tested for 7 days, 14 days as well 28 days of tank curing. The outcomes in the test signifies that it will be beneficial to use the sugarcane bagasse ash as a replacing material of cement up to 20% of its replacement.

Mohammed Ismail Khan , Tauseef Munawar Ali , Lords Institute Of Engineering And Technology Sy.No.32 Himayath Sagar , Hyderabad -500091 - This experimental and analytical study investigates the strength performance of concrete using Ordinary Portland cement and Sugarcane Bagasse Ash as well as Coconut Husk Ash. India produces some 24- 25MEGATON of sugar these days and also same is approximately the estimated sugar cane bagasse ash (SCBA), where as unwanted hairy coconut shells are burnt or thrown in water bodies which creates about 17MEGATON of (CHA) waste every year. Therefore it is essential that a useful method of utilization of this sugar factory waste and coconut husk waste should be found and used. As the demand and consumption of cement raising, researchers and scientist are in search of developing binders that are eco-friendly and contribute waste management. The utilization of industrial and agricultural waste has been focus of waste reduction research for economic and environmental reasons. This waste product is already causing serious environmental pollution, which calls for urgent ways of handling the waste. It has limited life span and after use its either stock piled or sent to landfills. In these project sugarcane bagasse ash and coconut husk ash has been chemically and physically characterized and partially replaced in the ratio of 0%, 5%, 10%, 15% and 20% and coconut husk ash is partially replaced in the similar ratios throughout the project i.e., 5% by weight of cement, after the hardening of M25 grade concrete the test for compressive strength is conducted at the age of 7 and 28 days and the strength was obtained.

Mrityunjay Kumar., Shivani Singh Dhriyan., Graphic Era University, Dehradun (India) January-2018- Nowadays the main focus of research is to reduce the industrial and agricultural waste for eco friendly environment. Sugar-cane bagasse ash (SCBA) is a fibrous waste product obtained from sugarcane industry. After extracting juice from the sugarcane, the remaining of sugarcane known as bagasse is burnt at high temperature in uncontrolled condition to produce the ash. This waste product is already causing serious environmental pollution. In the present study the effect of bagasse ash on the strength of concrete is investigated. The addition of bagasse ash not only helps in reducing pollution but also leads to sustainable development of the country. From the literature it has been observed that bagasse ash significantly increases the strength of concrete and it can be used as a partial replacement of cement in the concrete

Abubaker M. Almaleeh , Stanley M. Shitote and Timothy Nyomboi, -this paper discusses test results of use of recycled tyres in concrete for possible application in the construction industry. In 2008, around one billion end-of-life tyres (ELTs) were being produced globally each year. As a possible means of disposing the tyres, it is proposed to use rubber tyres as coarse and fine aggregate in concrete. Tyres cut into pieces with maximum size of 20 mm to use as coarse aggregate, and crumb rubber tyres used as fine aggregate. The replacement of the rubber tyres aggregates in concrete was done in three phases. In the first phase, fine rubber tyres aggregates were used to replace 50% of the normal sand. Secondly, coarse rubber aggregates tyres were used in the replacement of 50% of the normal gravel. Finally, both fine and coarse rubber tyres aggregates were used to replace the sand and gravel by 25, 50, 75 and 100%. Compressive strength, splitting tensile, and flexural strength tests were conducted according to the various BS codes.

Although concrete made from tyres had lower strength than the normal concrete, it had elastic failure behaviour. It did not collapse completely when tested. The cohesiveness was an advantage for using it in places such as landscaping, sports field ground, architectural finishing, and other engineering applications. This paper also demonstrated the variation in the compressive strength of the non-conventional concrete when the BS and ACI methods are used in the design of the mix.

Audrius Grinys , Henrikas Sivilevičius , Mindaugas Daukšys,-This article describes the observed and examined effect of crumb rubber on the strength (compressive, bending and splitting tensile) of concrete. The tests have shown that the change in the strength of concrete with crumb rubber waste additives can be forecasted from exponential equations. These relationships enable to foresee the regularities of strength properties when a certain amount of crumb rubber of a certain size fraction is added to concrete. The obtained exponential equations show that concrete compressive, flexural and splitting tensile strengths decrease with increasing crumbed rubber additive amount. The testing has also shown that the addition of a small amount of crumbed rubber slightly increases (7%) the tensile splitting strength. The reason is better adhesion of the cement stone with rubber particles compared to the adhesion of sand, which was replaced by crumbed rubber. With higher content of crumbed rubber additive in the concrete, the tensile splitting strength decreases due to the significant increase of entrained air content and lower density.

Dr. Stergios Mitoulis , Ataria Robert Bennett, -This paper studies the influence of shredded rubber from waste tyres on concrete strength .These shredded particles from waste tyres were used to replace the 20mm size aggregate in different percentages (5%, 10% and 15% in volume). Concrete mixtures without these additives were also tested. The experimental results show a reduction of the compressive strength as the percentage of rubber particles increases. Four point bending test conducted on six samples of each specimen also unveil a reduction in the flexural strength and bending capacity of concrete as the rubber content increases. Deflection at failure of the rubberized concrete is more than that of the plain concrete which unveils the ability of the rubberized concrete to withstand larger deformations than the plain concrete.

C.Vigneshkumar, N.Ponmalar, -The disposal of waste tyres is becoming a major waste management problem in the world at the moment. It is estimated that 1.2 billions of waste tyre rubber produced globally in a year, in which 11% of post consumer tyres are exported and 27% are sent to landfill, stockpiled or dumped illegally and only 4% is used for civil engineering projects. Hence efforts have been taken to identify the potential application of waste tyres in civil engineering projects. In this essence, our present study aims to investigate the optimal use of waste tyre rubber crumbs as fine aggregate in concrete composite. A total of 72 cubes and cylinders specimens were cast with the replacement of fine aggregate by rubber crumbs with the proportion of 3%, 6%, 9% by weight and compared with the conventional specimens. Hardened properties of concrete such as compressive strength and tensile strength were carried out .From the test results, it is recommended that 3% replacement level of waste tyre rubber aggregate will be optimum replacement in concrete composites.

III. MATERIAL AND METHODS

This experimental procedure covers all preliminary tests, including analysis of aggregates, specific gravity and water absorption of the cement to ensure the quality of the material and its limitations within the technical specifications.

1) *Cement:* Cement is a powdery substance consisting of limestone and clay, it is mixed with water, sand and large stones to produce concrete. Cement is a binder that hardens and hardens, and can also bind other substances into aggregates. Cement acquires strength through a chemical reaction with water. This process is called hydration.As a rule, cement loses 10% of its strength within one month from the date of manufacture. The fineness of cement was measured through standard determination of fineness of cement (IS: 4031 - Part - 3) method.
   specific gravity : 3.1
   Consistency : 32%
   Initial setting time: 40min
   Final setting time : 300min
2) *Coarse aggregate:* Collected coarse aggregates from local stores. It was produced in a place near Naziabad, which has a good reputation when it comes to rough aggregates of the Pakistani construction industry. The sample of a 20 mm size coarse aggregate were analysed for various tests including specific gravity, water absorption and fineness modulus.
3) *Fine aggregates:* The fine aggregate is called the material that will pass through the No. 4 sieve and will remain on the No. 200 sieve. The main purpose of the fine aggregate is to ensure that the concrete works, so it must have a round shape. Another goal is to fill the voids caused by a large population. Although all small aggregates have similar sizes, they differ in many ways. Small units come from local stores.

It is derived under the name Bolari sand, which is commonly used in local buildings. This quarry is considered the best in Sindi career. Many experiments have been conducted to detect the various properties of small aggregates, such as specific gravity, modulus of fineness and water absorption.

Specific gravity of sand: 2.65
Fines modulus of sand: 3.45
Sand confirming Zone as per IS 383-1970: Zone III
Water absorption: 0.6%

4) *Sugarcane Bugasse Ash:* The SCBA used for this investigation was obtained from KCP Sugar factory, Vuyyur, located in Krishna district, Andhra Pradesh. SCBA contains approximately 25% of hemicellulose, 25% of lignin and 50% of cellulose. Each tonne of sugarcane generates approximately 26% of bagasse (at 50% moisture content) and 0.62% of residual ash. The residue after combustion gives a chemical composition dominated by silicon dioxide [10]. The Specific gravity of SCBA was found to be 2.17. Chemical properties of SCBA are shown.

a)	Silica	(SiO_2)	71.0
b)	Alumina	(Al_2O_3)	1.9
c)	Ferric Oxide	(Fe_2O_3)	7.8
d)	Calcium Oxide	(CaO)	3.4
e)	Magnesium Oxide	(MgO)	0.3
f)	Potassium Oxide	(K_2O)	8.2
g)	Sodium Oxide	(Na_2O)	3.4
h)	Phosphorus Pentoxide	(P_2O_5)	–
i)	Manganese Oxide	(MnO)	0.2

Fig:1 Sugarcane Bugasse

5) *Rubber Tyre:* This study has concentrated on the performance of a single gradation of rubber prepared by manual cutting (Pic1). The maximum size of the rubber aggregate was 20 mm.

The properties of the rubber used as aggregate is given below;

Acetone extraction 5-10%
Ash contetnt 4%
max. Bulk density 0.30 - 0.45 gm / cc
sieve analysis passing 40 mm sieve % 99 sieve analysis passing 2 mm sieve % 1

Fig:2 Rubber aggregate

IV. METHODOLOGY

It is the method followed to perform the experiment. In this section we have made step wise procedure to perform experiment which is briefly described as follows:

1) Mix designed
2) Batching
3) Experimental programmed of casting
4) Mixing
5) Compaction
6) Curing
7) Testing

V. CONCLUSION

From the present analysis, I've come to the following conclusion. Up to 20% of OPC can be replaced optimally with well-burnt SCBA and Rubber tyre without any contrary effect on the desirable properties of concrete.

1) Partial replacement of cement by SCBA boosts workability of fresh concrete; therefore use of super plasticizer is not essential.
2) The results showed that, the concrete with 10% SCBA replacement after 28 days of curing, showed maximum strength when compared to concrete with other percentage replacement mixes.
3) As the flexural tensile strength of SCBA concrete is more it can be used in slabs, beams etc., where higher flexural tensile strength is required.
4) In the economic point of view, the cement replaced by SCBA saves money
5) It is observed that the compressive strength, split tensile strength as well as the flexural strength decreases as the addition of percentage of rubber increases.
6) 15% replacement of rubber aggregate may achieve the compressive strength as that of the normal concrete with some few alterations like adding extra silica or by replacing cement with more fine particles such as GGBS.
7) Adding admixture can increase the strengths slightly

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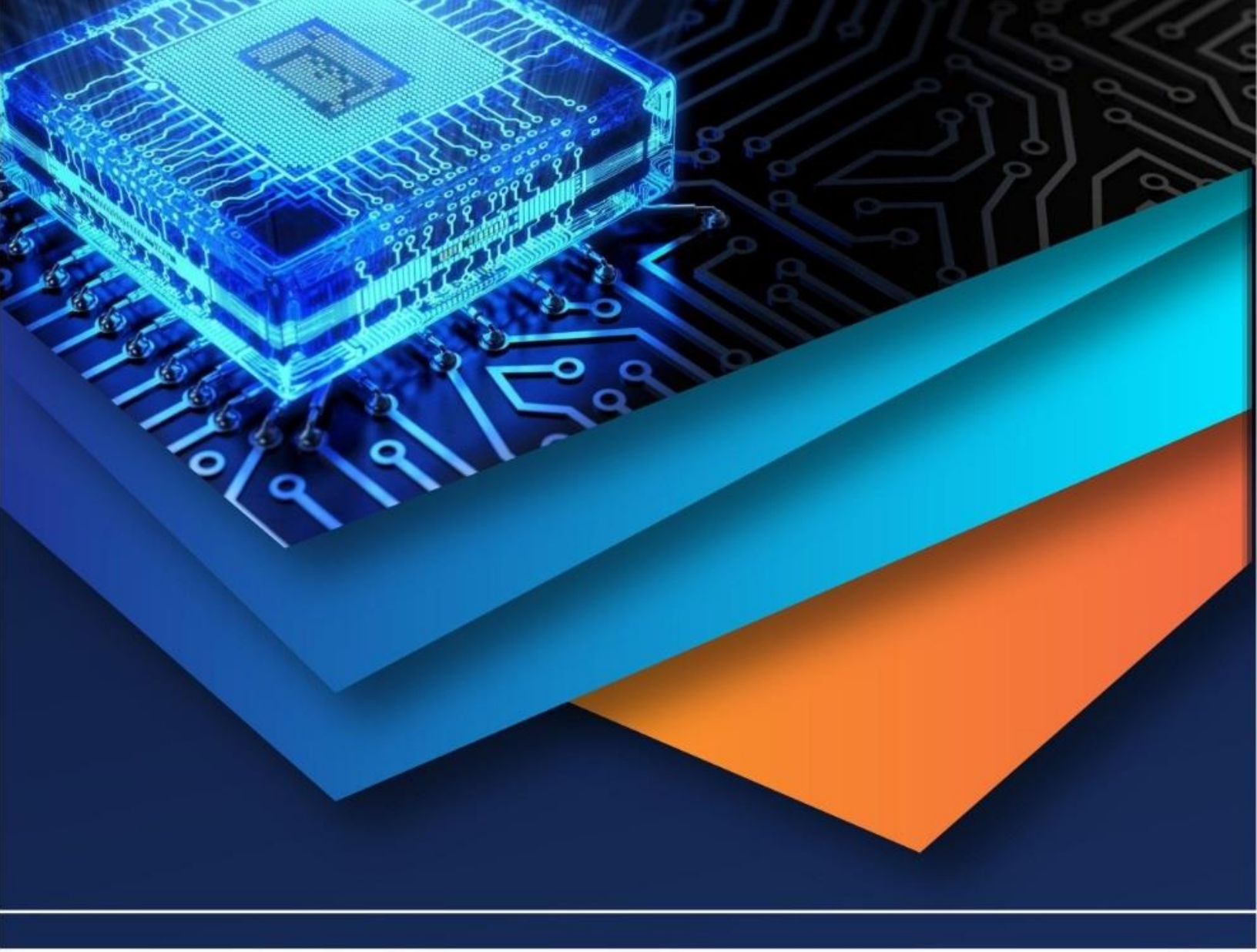

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