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Reuse of Waste Plastic in Manufacturing Paver Block

Shivprasad A. Babar[1], Rohan J. Bhandwalkar[2], Rushikesh R. Borate[3], M. R. G. S. Wayal[4]
Department of Civil Engineering, JSPM Rajarshi Shahu College of Engineering, Tathawade, 411033, India.

Abstract: The challenge of disposal of plastic waste and industrial by-products such as fly ash call for sustainable approaches to their effective utilizations. This research, therefore, undertakes an investigation into the possibility of reusing waste plastic and fly ash in the production of environment-friendly paver blocks. The plastic is shredded and used as a partial replacement together with fly ash replacing some portion of conventional materials such as cement and aggregates which are facing depletion with high consumption. This work carried out a study on physical, mechanical, and durability properties focusing on compressive strength, water absorption, and thermal resistance of paver blocks. It is indicated from the results that the incorporation of waste plastic materials alongside fly ash improves the strength and reserves water absorption properties to paver blocks thereby offering a cheap alternative traditional material. This new way helps with trash handling and building good homes, following circular economy ideas and nature caring aims.
Keywords: Green, Cheap, Plastic trash, strong ability

I. INTRODUCTION

The green and cheap benefits of using plastic trash in building stuff, mainly concrete and cement blocks. Plastics do not break down on their own hold importnance of being lightweight and thermally resistant. Studies indicate that replacing certain components of conventional concrete such as sand or aggregates with plastic waste can conserve resources while reducing plastic waste and costs.
Concrete, as the name implies, is a composite material having sand, coarse aggregates, and cement in its constituents and filled in a matrix of concrete which consumes a lot of natural resources. Research done on the commpressive strength of concrete with added plastic waste has provided inconclusive results. Adding some low replacement percentages of plastics like PET (polyethylene terephthalate) has sometimes improved compressive strength while in most cases higher percentages reduce it. The thermal resistance and sound insulation of the material, however, becomes better with increased amounts of plastic. For instance, adding PVC or polystyrene foam improves the material's corrosion resistance as well as its heat insulation properties.
This paper outlines a study where two types of recycled plastics (manually cut PET and mechanically recycled HDPE) will be compared as substitutes for cement, sand and aggregates in cement bricks. To improve the compressive strength of the material while optimizing thermal resistance, different replacement ratios (2.5 - 20%) will be tested. The objective is to produce sustainable materials with improved mechanical and thermal properties.

II. LITERATURE'S

1) *"Integration Optimization of Plastic Waste in Cement Bricks" (2023)*

Authors: Yara Metwally, Khaled Dewidar, Mostafa Ismail, Iman El Mahallawi
Summary: This research analyzes the effective use of plastic waste, particularly PET and HDPE, in cement bricks for the enhancement of their thermomechanical properties. It was found that HDPE was stronger and performed better thermally than PET. The optimal mix was observed when coarse aggregates were replaced by 7.5% HDPE for mechanical behavior and 20% HDPE for thermal resistance. Compressive and tensile strengths subsidized with increased HDPE up to 7.5% but higher values resulted in diminished performance. Thermal conductivity and bulk density dropped with plastic content which improved insulation. These assist in the improvement of the management of waste, renewable energy resources, and construction materials.

2) *Production of concrete paver blocks with byproducts and waste materials (2022)*

Habib Musa Mohamad, Nurmin Bolong, Ismail Saad, Lillian Gungat, Janus Tioon, Rosman Pileh, and Mark Delton
The key characteristics of paver block identification are the need for specific pedestrian walkway designs and parking areas, as well as flexible surface treatment for exterior pavement applications.

Conventional materials like sand, cement, and aggregate are no longer as important. In order to guarantee the sustainability and usability of new building materials, research-based paver blocks have been produced. The purpose of this study is to examine the possibility of using waste materials to partially replace aggregate in the production of concrete paving blocks (CPB). In summary, there is a lot of potential for using waste materials to make concrete paver blocks. The use of waste materials to make paver block products has increased due to advancements in recycling technologies. Overall, the paper increases the usability of waste materials in the concrete manufacturing process. Excellent use is made of a variety of waste materials, including plastic, steel slag, and crumb rubber. By using elastic cushions and varying the amount of waste steel aggregates, paver blocks' compressive strength can be up to 50% higher than that of conventional paver blocks. The percentage of cement weight that can be substituted with industrial waste materials depends on the comparative volume category of the paving block aggregate; for example, 0%, 5%, 10%, &15% are more appropriate.

3) Sustainable, environmentally friendly fly ash brick made from plastic bottles fille d with soil (2021)

Authors:B.Anuradhaand P.V. Vignesh War

In this experimental study, fly ash bricks for temporary residential structures are made by creatively reusing PET (polyethylene terephthalate) bottles. The study tackles the twin issues of disposing of waste plastic and the lack of conventional building materials by filling used plastic bottles with soil and strengthening them with steel mesh on the outside. The resultant plastic bottle bricks exhibit qualities like improved compressive strength, low water absorption, smooth finishing, affordability, and acid resistance.Because of these qualities, they are a viable and sustainable substitute for traditional building materials, which are in high demand, while also supporting environmental sustainability.

4) "Using Plastic Waste to Make Plastic Bricks" (2019)

Authors: Kiran Shipkule and R. S. Kognole

In conclusion, plastic waste is one of the biggest environmental problems of our time, endangering both ecosystems and people. High-Density Polyethylene (HDPE) and Polyethylene Terephthalate (PET), as well as plastics smaller than 50 microns, are among the most dangerous forms of plastic waste. These substances harm the environment, especially when they combine with soil and lower its fertility.

Furthermore, the massive amounts of plastic that are dumped into the oceans pollute the seawater and have a negative impact on aquatic life. To solve this problem, creative and effective solutions are needed. Recycling plastic waste into bricks for use in building is one such strategy. In addition to lowering plastic pollution, this approach offers the construction sector an economical and sustainable substitute. By incorporating waste plastic into bricks, we

5) "An Experimental Study on Paver Blocks Using Plastic Waste to Replace Some of the Coarse Aggregates." (2018)

Writers: R. Aswini and C. Balaji

In brief: Pre-cast blocks called paver blocks are frequently used to build pavements. Usually, cement, coarse aggregates, and fine aggregates are used to make them. However, a different strategy has been investigated because raw materials are becoming more scarce and more expensive. This technique uses shredded plastic waste in place of some of the coarse aggregates. In addition to addressing the problem of expensive raw materials, this offers a practical means of recycling plastic waste, which is otherwise challenging to handle and is quickly building up in the environment.

In a lab, the paver blocks created using this partial replacement are cast and allowed to cure. These blocks undergo a variety of strength tests to assess their performance, and the outcomes show that this sustainable strategy is feasible.

6) "Using Fly Ash in Concrete Instead of Cement" (2016).

Authors: Sulagno Banerjee and Jayanta Chakraborty

In brief: Since the early 19th century, fly ash has been considered as a possible cement substitute in the concrete industry. Fly ash functions as a cementitious material and affects the compressive strength of concrete when added in amounts between 15% and 25% by mass. A number of variables, including its characteristics, application techniques, location, and climate, affect the precise percentage of fly ash replacement. According to research, fly ash can significantly enhance the performance of concrete, particularly lower-grade concrete. Experiments were carried out to measure compressive strength at 7, 28, and 60 days with different Fly Ash proportions in order to better understand its effect on high-grade concrete. The compaction factor and mechanical characteristics of both fresh and hardened concrete were also used in the study to assess workability.

According to the results, replacing fly ash increases compressive strength to a certain extent, making it a cost-effective and environmentally friendly choice. This analysis sheds light on how varying Fly Ash percentages affect the strength of different concrete grades and offers suggestions for how best to use it for long-lasting and reasonably priced construction.

A. Problem Statement

Plastic consumption has significantly increased due to recent decades of rapid urbanization and industrialization, creating a global waste management crisis. Because plastic waste is not biodegradable, it is a persistent environmental hazard that contributes to air, water, and land pollution. Conventional disposal techniques, like incineration and landfilling, are either unsustainable or detrimental to ecosystems and public health. Concurrently, the building sector is largely dependent on non-renewable resources, such as aggregates, sand, and cement, all of which are rapidly running out. Because raw materials must be extracted and processed, the production of traditional paver blocks adds to carbon emissions and environmental deterioration. An eco-friendly, sustainable, and creative solution is desperately needed in this situation to address two urgent Challenges include minimizing dependency on conventional building materials and efficiently recycling waste plastic materials. The purpose of this project is to examine the viability and efficiency of replacing binding agents or aggregates in the production of paver blocks entirely or in part with waste plastic. The main goal is to create a structurally sound, environmentally sustainable, and economically feasible alternative building material.

B. Objectives

1) To reduce the pollution caused by plastic waste by using waste as building materials.
2) To assess how well waste plastic works as a filler or binder in the production of paver blocks.
3) To create and manufacture affordable, ecologically friendly paver blocks.
4) To evaluate the durability and mechanical qualities of traditional and plastic-based paver blocks.
5) To conduct a cost-benefit analysis in preparation for future commercialization and scale-up.

III. MATERIALS AND METHODS

A. Plastic

1. Polyethylene Terephthalate (PET/PETE): Applications: Commonly utilized for clothing fibers, food packaging, and beverage bottles.
Its exceptional strength, clarity, and barrier qualities make it appropriate for use in food and drink packaging.

2. Milk jugs, shampoo bottles, cleaning product containers, and certain toys are made of high-density polyethylene, or HDPE.
Characteristics: robust, long-lasting, and easily recyclable.

3. Polyvinyl Chloride (PVC): Applications include medical devices, cling film, and pipes and window frames used in construction.
Characteristics: Adaptable, robust, and resistant to flame.

4. Low-Density Polyethylene (LDPE): Applications include stretch film, shrink wrap, food packaging, and plastic bags.
Properties: Adaptable, strong against chemicals and moisture.

5. Polypropylene (PP): Applications include textiles, automobile components, and food containers.
Features: Strong, lightweight, and resistant to high temperatures.

6. Polystyrene (PS): Applications include packaging, insulation, takeout containers, and disposable cups.
Properties: Lightweight and rigid.
7. Other (Including Miscellaneous Plastics): This category covers non-standard plastics like acrylic and polycarbonate.
Properties: Vary according to the kind of plastic.

8. Thermosets: Applications include melamine (floor tiles), bakelite (electrical switches), and other long-lasting materials.
Properties: When heated, they become irreversibly hard, making them non-recyclable and heat-resistant.

Fig.1 Plastic Waste

Fig.2 Shredding Machine

Fig.3 Cement

Fig.4 Aggregate

Fig.5 Crush Sand

The following supplies are needed for the methodology: • Shredded plastic, which is typically gathered from waste plastic such as PET bottles or other plastics.

• Fly ash, a byproduct of power plants burning coal.

• Cement: Ordinary Portland cement is frequently utilized.

Sand is referred to as fine aggregate, and tiny stone chips are known as coarse aggregate.

• Steps for Water:1. Raw Material Preparation:

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Plastic Shredded: Shred waste plastic into tiny pieces, ideally between 2 and 4 mm. Moisture and impurities must not be present in the plastic.
Fly Ash: Prior to use, fly ash needs to be dry and fine. To get rid of any coarse particles, it needs to be sieved.
Aggregate: The mix design determines the pre-measured fine and coarse aggregates, which must be pure and devoid of contaminants.
2. Mix Design: The amount of fly ash and shredded plastic that is used will determine the mix design. A typical place to start is:
10% to 15% of the total weight is made up of cement.
25–40% of the total weight is fly ash.
5–10% of the total weight is made up of shredded plastic.
Aggregates: The remainder, modified to ensure consistency.
3. Combining the Ingredients:
Dry Mix: Using a concrete mixer, thoroughly combine the cement, fly ash, and fine and coarse aggregates. Shredded Plastic: To the dry mixture, add the shredded plastic. The plastic helps to increase the strength and durability of the block by partially substituting aggregates.
Water: To get the right consistency, gradually add water to the dry mixture. A superplasticizer can be added if needed to increase the mix's workability.
4. Moulding(Mould Size 300x250x60mm)
Get the molds ready: To stop the mixture from sticking, clean the molds and apply a release agent.
Casting the Blocks: Make sure the mixture is evenly distributed by pouring the prepared mix into the molds.
Compaction: To guarantee adequate material consolidation and to get rid of air voids, compact the mixture using a mechanical compactor or vibrating table.
5. Curing: After the blocks are cast, let them sit at room temperature for a full day. Once the blocks have set, take them out of the molds and cure them by soaking them in water or misting them with water.
To guarantee the paver blocks satisfy the necessary criteria, test their strength (compressive strength), water absorption, and other pertinent characteristics. Depending on the outcomes, change the mix design.
The mix design is done using the Indian Standard (IS) approach for concrete, so guaranteeing a suitable balance between workability and strength.

Table No.1 Mix Proportion

Sr No.	Description	Cement	Fly Ash	Fine Aggregate	Coarse Aggregate	Plastic waste
1.	Fly Ash 5% & Plastic waste 5%	2.28 kg	0.12 kg	2.7 kg	5.93 kg	0.3 kg
2.	Fly Ash 10% and Plastic Waste 7.5%	2.16 kg	0.24 kg	2.7 kg	5.61 kg	0.62 kg
3.	Fly Ash 15% and Plastic Waste 10%	2.04 kg	0.36 kg	2.7 kg	5.3 kg	0.93 kg

Waste plastic is included at varying replacement rates of 05%, 10% and 15% by weight of the fine aggregate, or sand.
• Concrete Mixing: Together, the needed ratios of cement, plastic waste, fly Ash, fine aggregates, coarse aggregates, and water.

All components are guaranteed consistent mixing by a mechanical mixer.
• Concrete specimens are cast in standard cube molds for testing.
The molds are level and compacted to guarantee consistency in the samples.
The cast concrete specimens are seven days cured in order to guarantee appropriate hydration and strength development.

• Testing: Seven days of samples make up the Compressive Strength Test.
The capacity of the concrete to withstand water is evaluated by means of the water absorption test

IV. FINAL RESULTS

A. *Calculation*

Example

If 5% Waste plastic used then result of block at 28 Days

Load= 1720 kN

Area of paver Block= 300x250mm

Strenght of Block= Load/Area

$=(1720x10^3)/300x250$

$=22.93N/mm^2$

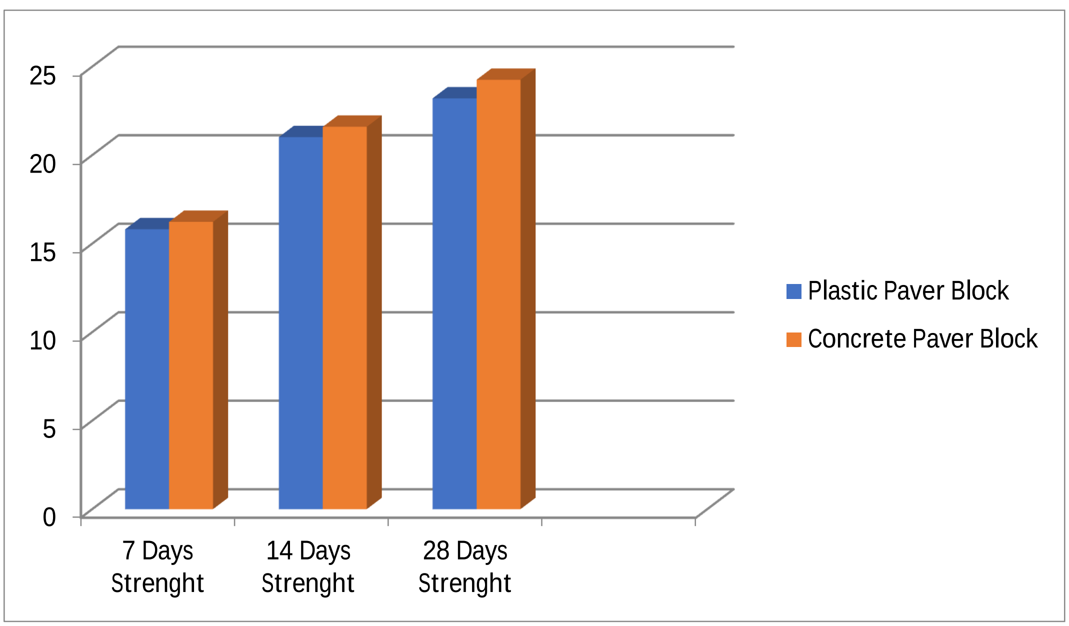
percentage	7 days (N/mm^2)				14 days (N/mm^2)				28 days (N/mm^2)			
	1	2	3	Avg	1	2	3	Avg	1	2	3	Avg
5%	15.73	16.24	15.46	15.81	19.73	20.72	22.4	21.01	22.93	22.98	23.73	23.21
10%	15.33	15.6	15.86	15.59	19.2	20.2	20.8	20.06	22.26	22.91	22.2	22.45
15%	15.13	15.2	14.53	14.95	20.33	19.06	19.93	19.77	22.53	23.2	22.26	22.66

Table No.2 Result

B. *Concrete Paver Block*

Days	Compressive Strength (N/mm^2)
7 days	16.23
14 days	21.6
28 days	24.26

Table No.3 Orignal concrete Block Result



Graph No.1 Compare 5% Plastic Block & Concrete Block

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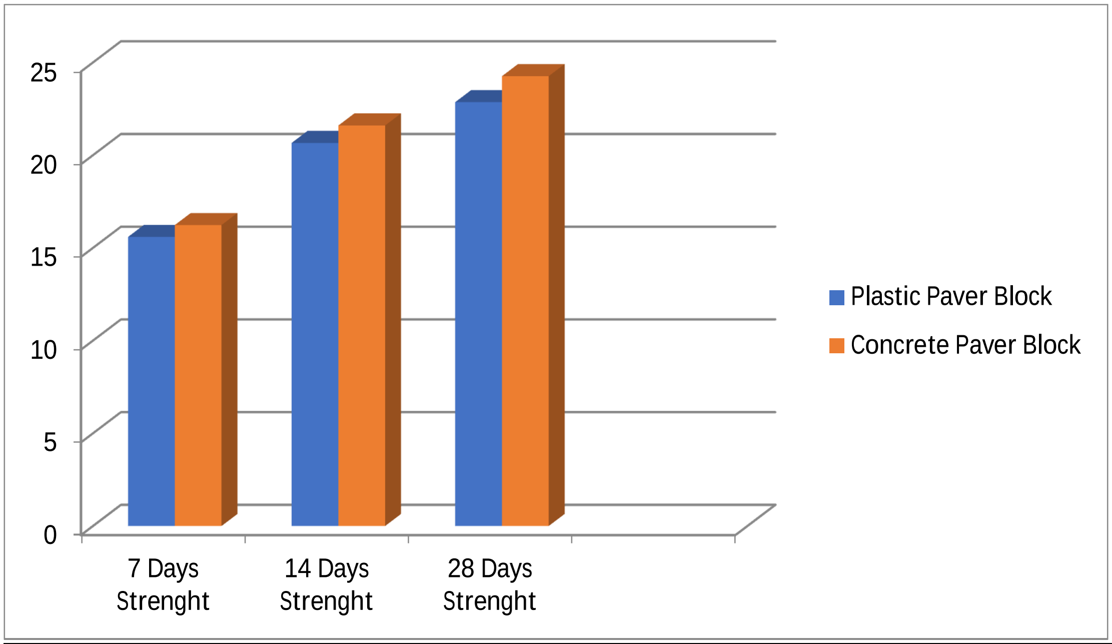
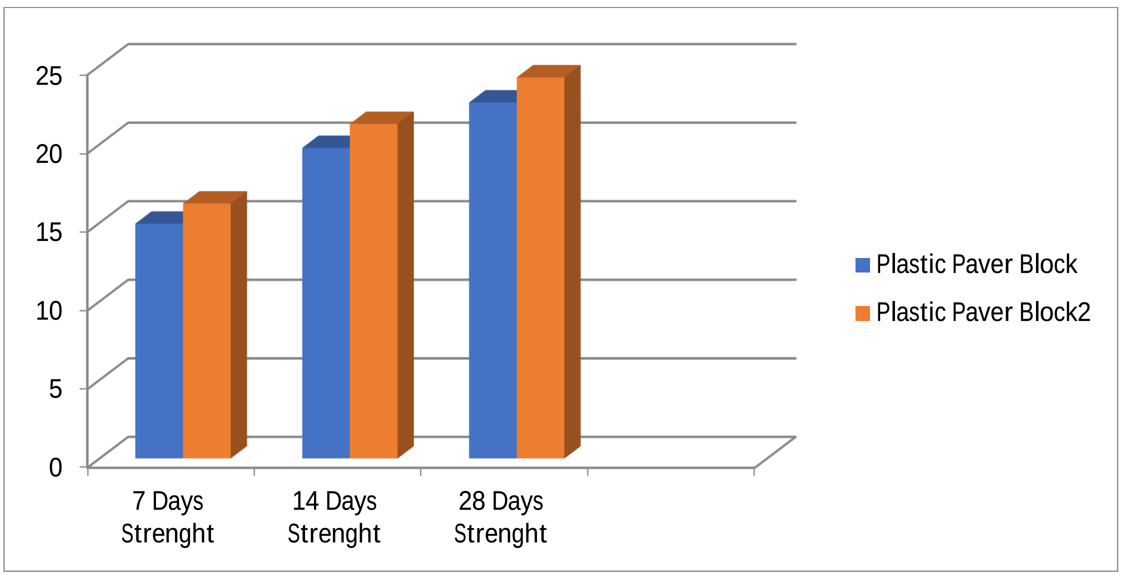


Graph No.2 Compare 10% Plastic Block & Concrete Block



Graph No.3 Compare 15% Plastic Block & Concrete Block

V. CONCLUSION

1) Environmental Benefits: By turning non-biodegradable materials into practical building products, it helps to reduce the pollution caused by plastic waste.
2) Strength and Durability: Waste plastic can be combined with other materials, such as aggregates, cement, and sand, to increase the strength and durability of paver blocks.
3) Cost-Effective: It is a cost-effective alternative for construction since it lessens reliance on traditional raw materials.
4) Water Resistance: Compared to conventional concrete blocks, plastic-based paver blocks are more water resistant, which makes them appropriate for outdoor use.
5) Lightweight: Compared to traditional paver blocks, these blocks are lighter, which facilitates installation and transportation.
6) Sustainable Construction: By lowering carbon footprints and encouraging eco-friendly materials, this approach supports the idea of green building.

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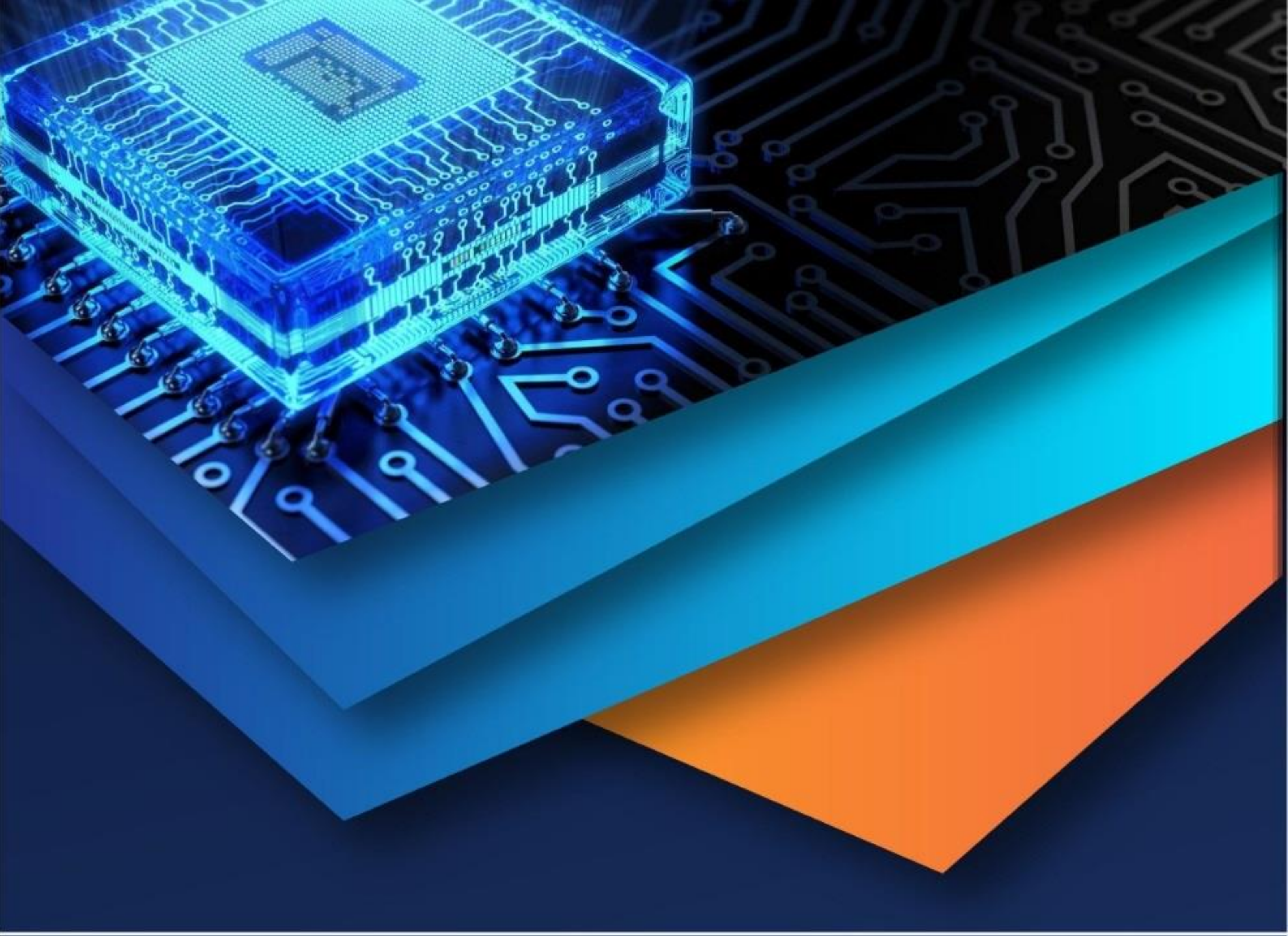

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