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Use of PET Plastic Waste in Manufacturing and Testing of Plastic Sand Bricks

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Abstract: ***Plastic is a non-bio-degradable substance which takes thousands of years to decompose. The quantity of plastic waste in Municipal Solid Waste (MSW) is expanding rapidly. The utilization of earth based clay material resulted in resource depletion & environmental degradation. As amount of clay required for brick is huge, an attempt is made to utilize PET waste plastic in manufacturing of plastic sand bricks. The plastic sand bricks were prepared by using PET waste plastic and also by using 600µm or 4.75mm sand. Various tests were conducted on these plastic sand bricks and results were compared with locally available conventional clay bricks. Compressive strength was found more for plastic sand bricks with 4.75mm sand. Water absorption was found negligible. Plastic sand bricks also gave good results in impact test, soundness test, & hardness test. Plastic sand bricks can be a good alternative to a locally available conventional clay bricks to reduce the consumption of natural resources such as clay and for efficient & effective utilization of waste plastic.***

I. INTRODUCTION

The term “plastic’’ is derived from the Greek word "plastikos", meaning fit for moulding. Plastic can be divided into two major categories Thermosetting and Thermoplastic. They are formed from polymers, the word “poly” means many & “mers” means monomers simply many monomers. Plastic are formed by polymerization. Most common types of synthetic organic polymers are Low-Density Polyethylene (LDPE), High Density Polyethylene (HDPE), Polyvinyl Chloride (PVC), Polypropylene (PP), Polystyrene (PS), and Polyethylene Terephthalate (PET). The benefits of plastic are undeniable. The material is cheap, lightweight and easy to make. These qualities have led to a boom in the production of plastic over the past century and make it ubiquitous, resulting in one of our planet’s greatest environmental challenges. Our oceans have been used as a dumping ground, choking marine life and transforming some marine areas into a plastic soup. In cities around the world, plastic waste clogs drains, causing floods and breeding disease. Consumed by livestock, it also finds its way into the food chain. Plastic packaging accounts for nearly half of all plastic waste globally, and much of it is thrown away within just a few minutes of its first use. Much plastic may be single-use, but that does not mean it is easily disposable. When discarded in landfills or in the environment, plastic can take up to a thousand years to decompose. The most common single-use plastics found in the environment are cigarette butts, plastic drinking bottles, plastic bottle caps, food wrappers, plastic grocery bags, plastic lids, straws and stirrers, other types of plastic bags, and foam take-away containers. According to recent estimates, 79% of the plastic waste ever produced now sits in landfills, dumps or in the environment, while about 12% has been incinerated and only 9% has been recycled.

II. AIM AND OBJECTIVES

A. To develop an efficient way to effectively utilize the PET waste plastics for construction materials
B. To reduce the consumption of clay for manufacture of bricks that results in resource depletion and environmental degradation

III. MATERIAL AND METHODOLOGY

1) *Waste Plastic:* Plastic are categories as: Polyethylene Terephthalate (PET), High Density Polyethylene (HDPE), Polyvinyl Chloride (PVC), Low Density Polyethylene (LDPE), Polypropylene (PP), Polystyrene (PS), Others (Polycarbonates). Plastic drinking water bottles (PET waste plastic) were used in the manufacturing of plastic sand bricks.
2) *Sand:* Sand is a granular material composed of finely divided rock and mineral particles. It is defined by size, being finer than gravel and coarser than silt. Natural River sand passing through 600µm sieve and also passing through 4.75mm sieve was used in manufacturing of plastic sand bricks.

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Fig. 1: PET waste plastic


Fig. 2: Sand passing through 600µm sieve

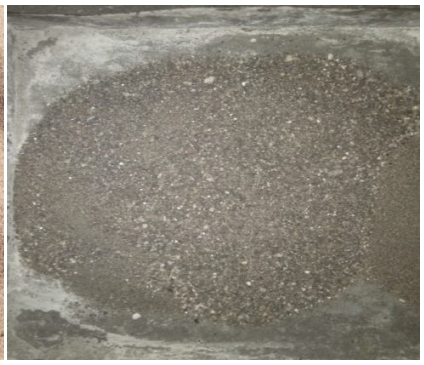
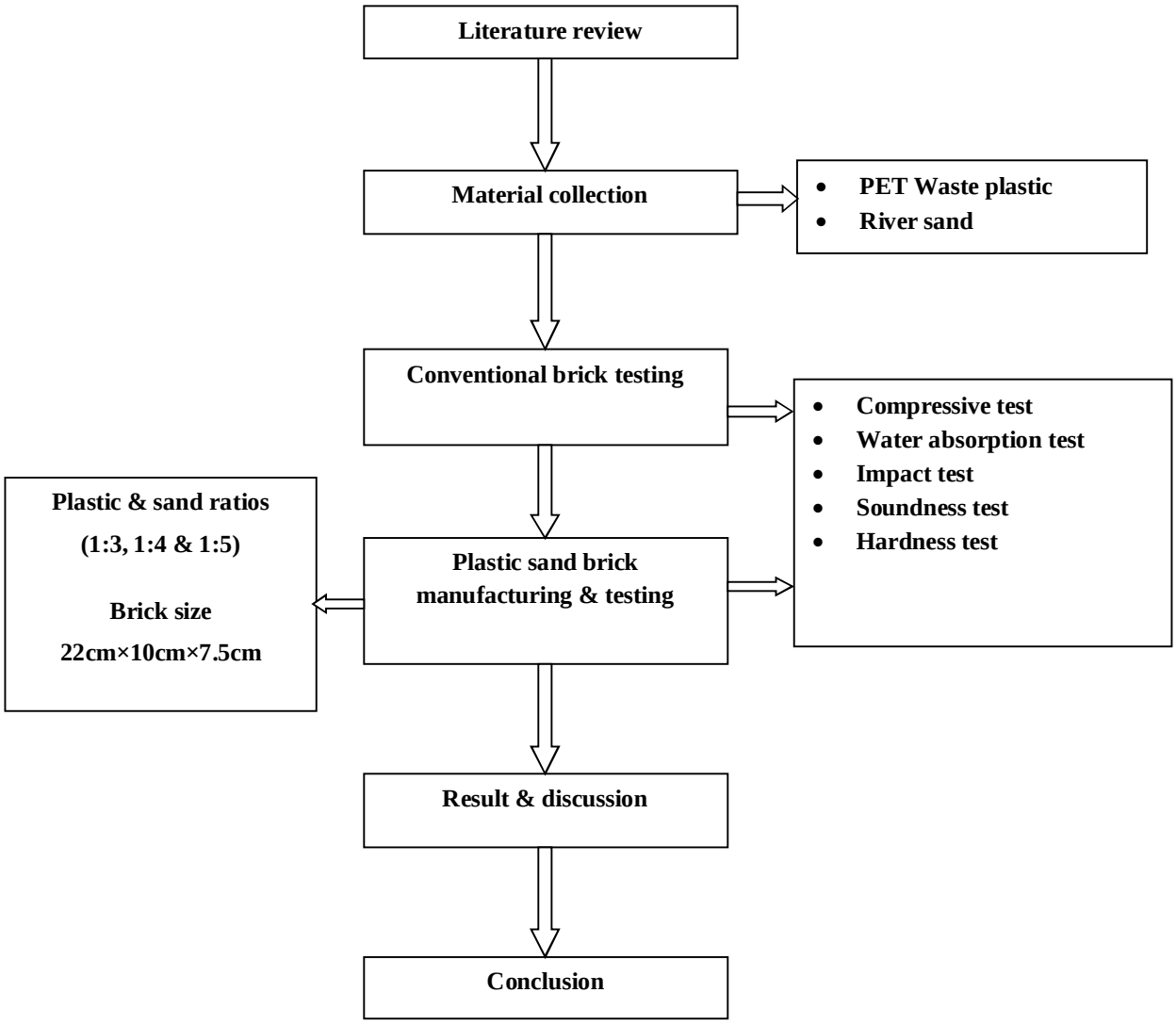
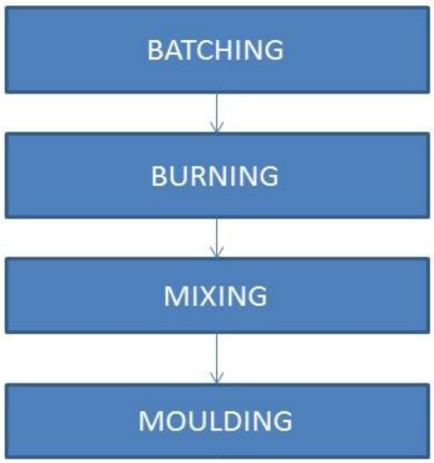


Fig. 3: Sand passing through 4.75mm sieve

PET Waste plastic and river sand (600µm /4.75mm) were used as material for manufacturing of plastic sand bricks of size 22cm×10cm×7.5cm. Frog of size 14cm×4cm×1cm is provided on one of its flat side. The plastic sand bricks were prepared in proportion of 1:3, 1:4 and 1:5 with 600µm and 4.75mm sand & with PET plastic waste. Compressive strength test, Water Absorption test, Impact test, Soundness test, Hardness test were performed on plastic sand bricks & results were compared with locally available conventional bricks.





Waste plastic water bottles (PET) were cleaned with water and dried in air. The sand was washed with water and then sieved by using 600µm sieve & bricks were prepared by using PET plastic waste. Similarly washed river sand was sieved through 4.75mm sieve & bricks were prepared by using PET plastic waste.

Burning process includes the arrangement of stones, drum and the required firewood. The stones are arranged to hold the drum and the firewood is placed in the gap between stones and it is ignited. The drum is placed over the setup & it is heated to remove the moisture present in it. Small pieces of PET Plastic waste were put into the drum and allowed to melt.

The waste plastic were added into the drum until the entire plastic content required for making bricks of one mix proportion is added into it. The whole waste plastic should get melted properly & then sand is added into it. Mix the molten plastic & sand properly with the help of trowel.

The mixture is then poured into the brick mould and is compacted by using tamping rod or steel rod. The surface is finished by using trowel. Before placing the mixture into the mould, the sides of the mould are oiled to easy removal of bricks. Mould removed after 24 hours.

IV. OBSERVATIONS AND GRAPHS

A. Compressive Strength Test

1) Locally available conventional brick (22cm×10 cm×7.5 cm)

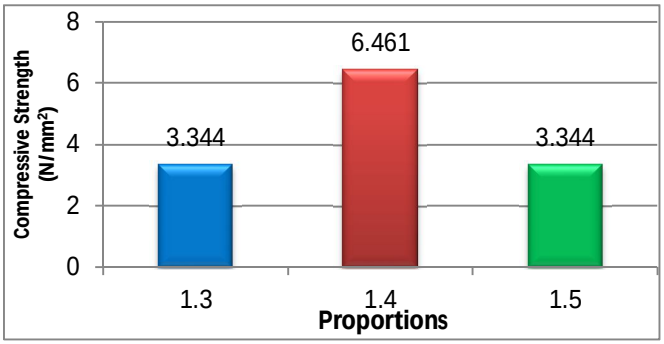
Table 1: Compressive Strength of Conventional brick

Sample	Load at failure (T)	Compressive strength (N/mm^2)	Average compressive strength (N/mm^2)
Conventional Brick	4.00	1.78	1.685
	3.50	1.56	

2) PET Plastic sand brick with 600µm sand of size of (22cm×10 cm×7.5 cm)

Table 2: Compressive strength of PET plastic sand brick with 600µm sand (without frog)

Sample proportions	Load at failure (T)	Compressive strength (N/mm^2)	Average compressive strength (N/mm^2)
1:3	10	4.459	3.344
	5	2.230	
1:4	14	6.242	6.461
	15	6.680	
1:5	5	2.229	3.344
	10	4.460	



Graph 1: Compressive strength of PET plastic sand brick with 600µm sand for different proportions

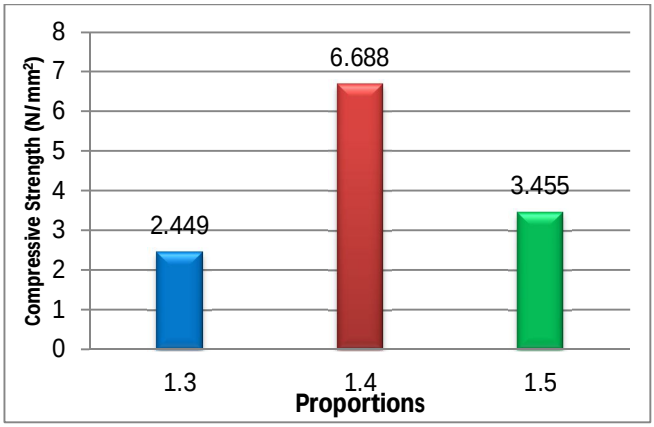
Table.3: Compressive strength of PET plastic sand brick with 600µm sand (with frog)

Sample proportion	Load at failure(T)	Compressive strength (N/mm^2)	Average compressive strength (N/mm^2)
1:4	13	5.796	6.019
	14	6.242	

3) PET Plastic sand brick with 4.75 mm sand

Table 4: Compressive strength of PET plastic sand bricks with 4.75 mm sand (with frog)

Sample proportions	Load at failure (T)	Compressive strength (N/mm^2)	Average compressive strength (N/mm^2)
1:3	6.5	2.898	2.449
	4.5	2.000	
1:4	16	7.134	6.688
	14	6.242	
1:5	7	3.121	3.455
	8.5	3.790	



Graph 2: Compressive strength of PET plastic sand brick with 4.75 mm sand for different proportions

B. Water Absorption Test

1) Locally available Conventional Brick

Table 5: Water absorption test of conventional brick

Sample	Weight in dry condition W_1 (kg)	Weight in wet condition W_2 (kg)	$\% = (\frac{W2-W1}{W1})\times 100$
Conventional brick	2.354	2.914	23.789

2) PET Plastic sand brick with 600 µm sand

Table 6: Water Absorption Test on PET Plastic sand brick with 600µm sand (without frog)

Sample proportions	Weight in dry condition W_1 (kg)	Weight in wet condition W_2 (kg)	$\% = (\frac{W2-W1}{W1})\times 100$
1:3	3.116	3.203	2.79
1:4	3.356	3.400	1.31
1:5	3.280	3.340	1.829

Table 7: Water Absorption Test on PET plastic sand brick with 600µm sand (with frog)

Sample proportion	Weight in dry condition W_1 (kg)	Weight in wet condition W_2 (kg)	$\% = (\frac{W2-W1}{W1})\times 100$
1:4	2.948	2.988	1.356

3) PET Plastic sand brick with 4.75 mm sand

Table 8: Water Absorption Test on PET plastic sand brick with 4.75 mm sand (with frog)

Sample proportions	Weight in dry condition W_1 (kg)	Weight in wet condition W_2 (kg)	$\% = (\frac{W2-W1}{W1})\times 100$
1:3	3.264	3.363	3.349
1:4	3.216	3.294	2.425
1:5	3.193	3.376	5.731

C. Impact Test

The plastic sand bricks with 600µm sand & with PET plastic waste were tested for impact test, No brick was found broken after drop from 1m height. The plastic sand bricks with 4.75mm sand & with PET plastics were also not found broken after drop from 1m height.

D. Soundness Test

The plastic sand bricks with 600µm & 4.75mm sand with PET plastic waste were tested for soundness test and all the bricks produce clear ringing sound.

E. Hardness Test

The plastic sand bricks with 600µm & 4.75mm sand with PET plastic waste were tested for hardness test and no scratches were found on the brick surface.

V. RESULT AND DISCUSSION

The plastic sand bricks were prepared by using PET, HDPE and Mix plastic in proportion of 1:3, 1:4 and 1:5 with 600µm and 4.75mm sand respectively. Various tests were conducted on these plastic sand bricks and following results were observed.

A. Compressive Strength Of The Bricks

1) The compressive strength of locally available conventional clay brick was found to be 1.685N/mm^2.

2) Plastic sand bricks (without frog) with 600µm sand & with PET plastic were prepared & tested. The compressive strength was observed 3.344 N/mm^2, 6.461 N/mm^2 & 3.344 N/mm^2 respectively for proportion 1:3, 1:4 & 1:5. Proportion 1:4 gave better results. Compressive strength of Plastic sand bricks (with frog) for proportion 1:4 was 6.019 N/mm^2.

3) Plastic sand bricks (with frog) with 4.75mm sand & with PET plastic were prepared & tested. The compressive strength was observed 2.449 N/mm^2, 6.688 N/mm^2 & 3.455 N/mm^2 respectively for proportion 1:3, 1:4 & 1:5. Proportion 1:4 gave better results.

B. Water Absorption Test

1) Water absorption of locally available conventional clay brick was observed 23.789% which is greater than the IS limit of 20%.

2) Plastic sand bricks (without frog) with 600µm sand & PET plastic were tested for water absorption. Water absorption was observed 2.79%, 1.31% & 1.829 % respectively for proportions 1:3, 1:4 & 1:5. Proportion 1:4 gave comparatively better results. Water absorption of Plastic sand bricks (with frog) for proportion 1:4 was 1.356%.

3) Plastic sand bricks (with frog) with 4.75mm sand & PET plastic were prepared & tested. The water absorption was observed 3.349%, 2.425% & 5.731% respectively for proportions 1:3, 1:4 & 1:5. Proportion 1:4 gave better results.

The plastic sand bricks with 600µm sand/4.75mm sand & with PET plastic waste were found to have good performance in Impact test, Soundness test and Hardness test.

VI. CONCLUSION

From the experimental investigation it can be concluded that

A. The compressive strength of PET plastic sand bricks was found greater than compressive strength of locally available conventional clay bricks. Compressive strength was found maximum at 6.688 N/mm^2 for PET plastic sand bricks with 4.75mm sand.

B. Water absorption was found in the range of 1.31% to 5.731 % which is less as compared to water absorption in locally available conventional clay bricks

C. Plastic sand bricks also gave good results in impact test, soundness test & hardness test.

D. Considering the cost of waste plastic & sand, plastic sand bricks might be costlier than conventional clay bricks. But from waste plastic disposal point of view, plastic sand brick is more advantageous. Hence plastic sand bricks can be a good alternative to a locally available conventional clay bricks to reduce the consumption of natural resources such as clay and for efficient & effective utilization of waste plastic.

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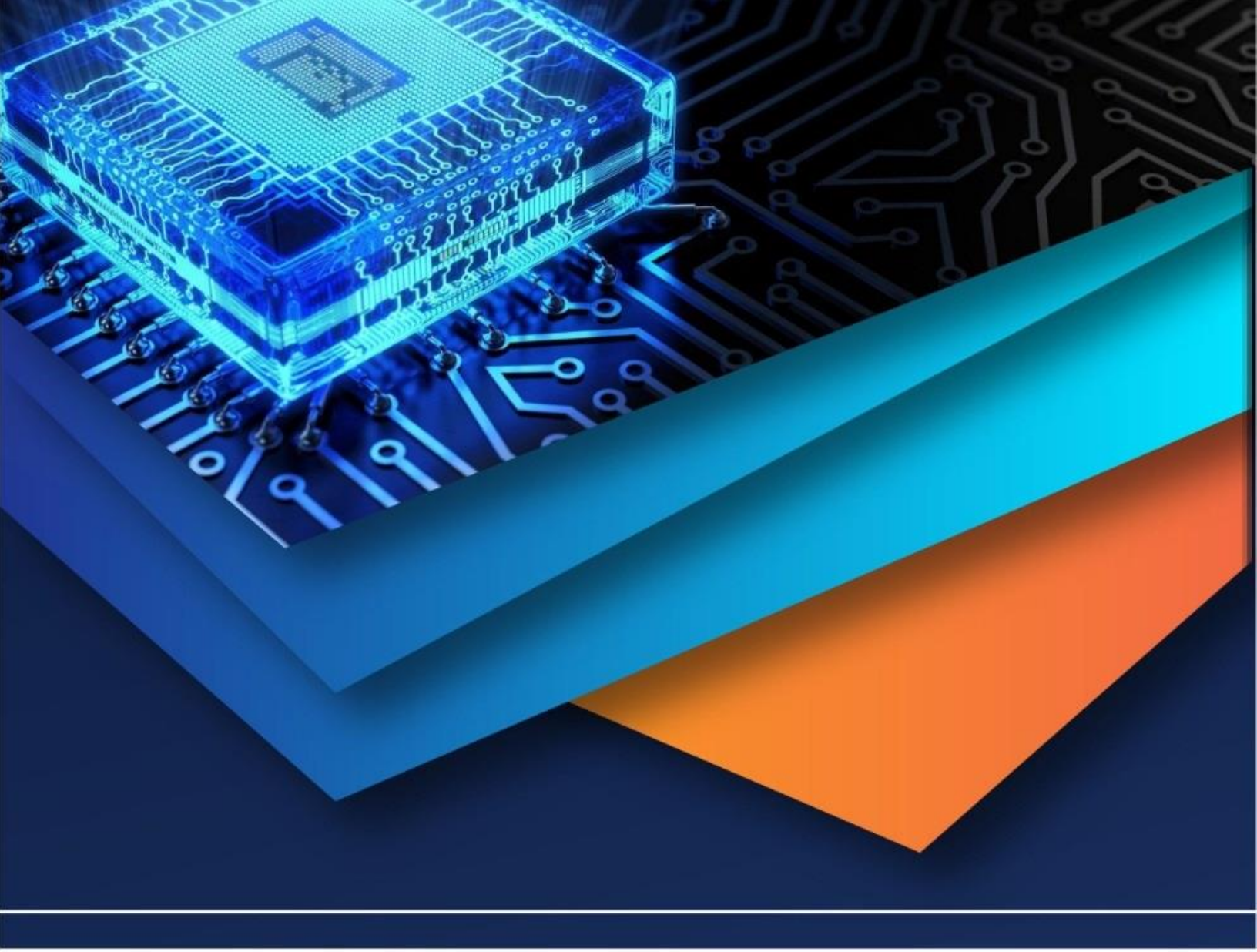

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