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Experimental Study on Strength Parameters of Roofing Tiles Incorpating Pumice Powder

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Abstract: Our experimental investigation is being carried out to find out an alternative for tiles made from terracotta, because these tiles get easily cracked having less in strength. This drawback is likely motivated to conduct investigation to deliver the product by not this limitation. So, we have implemented work by using material called 'pumice'. Naturally it will absorb the heat and emit cooling to the atmosphere.
At early stage pumice powder were added in the range 2.5%, 5%, and 7.5%. Conventionally available materials do not offer acceptable solutions. Prices of corrugated G.I. sheets are continuously escalating, and their use in not preferred because of thermal discomfort. Use of cement sheets is not recommended because of health hazards associated with asbestos. In India there is an acute shortage of locally available cheap roofing materials. Home-builders particularly the poor, are in dire need of cost-effective materials to build their homes with.
In addition, mass rural housing programmers supported by Central and State Governments are increasingly looking at low-cost building techniques.
Keywords: Clay, Red soil, Pumice powder, white soil replacements, Flexural strength test (M.O.R testing machine)

I. INTRODUCTION

A. General

Roof tiles are designed mainly to keep out rain, and are traditionally made from locally available materials such as terracotta or stone slab tile. Modern materials such as concrete and plastic are also used and some clay tiles have a waterproof glaze.
Roof tiles are 'hung' from the framework of a roof by fixing them. The tiles are usually hung in parallel rows, with each row overlapping the row below it to exclude rainwater and to cover the nails that hold the row below. There are also roof tiles for special positions, particularly the planes of the several pitches meet. They are including ridge, hip and valley tiles. These can either be needed and pointed in cement mortar or mechanically fixed.
Where however to roof tiling, tiling has been used to provide a protective weather texted to the sides of timber frame buildings. These are hung on laths nailed to wall timbers, with tiles specially molded to cover corners and jambs. Most of the times these tile are shaped at the exposed end to give a decorative effect.
It is called mathematical tile. which was hung on laths, nailed and then grouted. This form of tiling gives an imitation of brickwork and was developed to give the origin of brick, but avoided the brick taxes of the 18th century. Stone slab roof tiles were traditional in some areas near sources of supply, and give thin and light tiles when the stone slab was split into its natural layers. It is no longer a cheap material, however, and is now less common.

B. Motivation

To study focus on terracotta roof tiles worldwide used it. Tiles have been around for centuries proving their long lasting style, durability and sustainability. With natural thermal mass insulation properties, clay and concrete roof tiles contribute to the overall thermal performance and energy savings of a well designed home.

1) *Environmentally Friendly Material:* Tile roofs are made from earth minerals, not chemicals, and they can be pulverized and recycled when they are removed

II. MATERIALS AND METHODS

A. Materials

The following material were used for this project,
1. Clay soil, 2. Red soil, 3. White soil, 4. Light weight aggregate (pumice powder), 5. Portable water.

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1) *Pumice Powder:* Pumice is a light colored, extremely porous igneous rock that forms during explosive volcanic explosion. It is used as light weight aggregate in used light weight material, it is natural aggregate. The size of pores micrometer and more rough pores with size up to (2 to 3mm) the pumice material with size of grains smaller than 2 mm.

Weight of pumice powder (W) = 100gms

Percentage weight resistance on the sieve = 6.7%

Table 1

Fineness modulus of pumice powder

Sieve No	Weight of Pumice Powder retained (W_1)
125µm	6.7g
Pan	93.37g

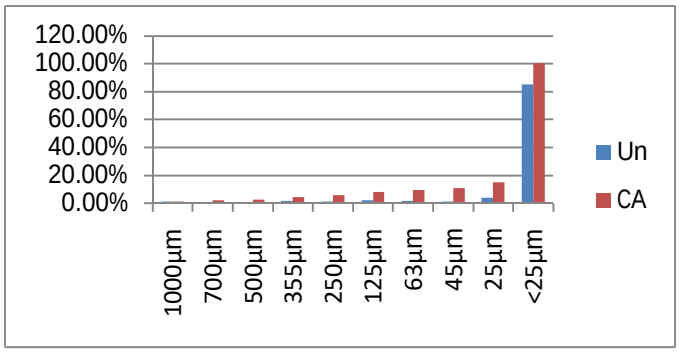
2) *Clay Soil:* Clay soil is soil that is comprised of very fine mineral particles and not much organic material. The resulting soil is quite sticky there is not much space between the mineral particles, and it does not drain well. (Un-Un passed sample)

(CA-Cumulative % retained)

Weight of the clay soil taken for testing (W) = 100g

Chart 1

Sieve analysis of clay soil

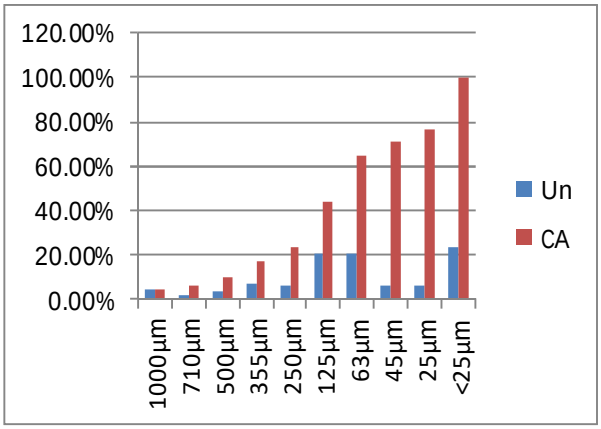


3) *White Soil:* White soils deposits with lime knot are found in the wrong horizons of soils that formed on loess and loess-like. In the soil profile, the knot stands out as bright spots with a clear and rounded shape. The word ‘’White eye’’ is sometimes used for a synonym for loess loam.

Weight of the red soil taken for testing (W) = 100gms

Chart 2

Sieve analysis of white soil



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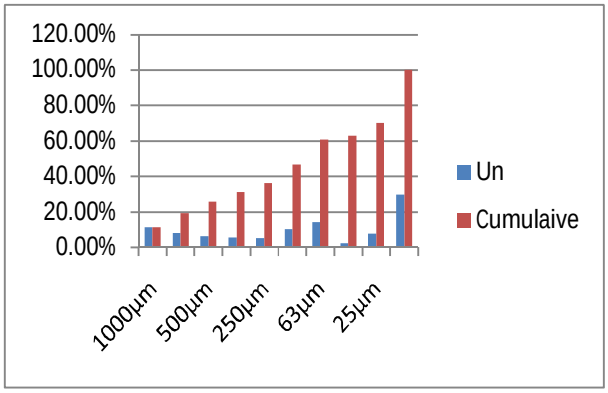
4) Red Soil: Red soil, is a group of soils that develop in a warm, temperate, moisture climate under autumn or mixed forests and that have thin organic and organic-mineral layers overlying a yellowish-brown leaked layer resting on an wrong red layer.(CA-Cumulative %)

Weight of the red soil taken for testing (W) = 100gms

Chart 3
Sieve analysis of red soil



B. Mix proportion

The studies were carried out on four major mixes, one ordinary control mix to compare other mix strength second one PRT 2.5%i.e... 97.5% white soil with PRT 5%, 95% replacement white soil, Third PRT 7.5% i.e. 92.5% replacement white soil.

Weight of the soil taken = 2500g/per tile

Weight of the soil taken=830g (for 1 tile)

Note: All units are in g.

Table 2 Mix proportion

Clay	Red soil		White soil	Pumice Powder
CRT	830g (2500 g)	830g (2500g)	830g (2500g)	-
PRT 2.5%	830g (2500 g)	830g (2500g)	809.25g (2427.75g)	20.75 For 3 tile(62.25g)
PRT 5%	830g (2500 g)	830g (2500g)	788.5g (2500g)	41.5 (124.5g)
PRT 7.5%	830g (2500 g)	830g (2500g)	767.75g (2500g)	62.25 (186.75g)

C. Specimens for Test

The testing like flexural strength testing was conducted on tile size 228.6 x 228.6 x21mm but I will take size of mould because 247mm x 247mm x 21mm tile will be shrinkage, volume $1m^3$- $0.0128m^3$, The logo over the tile top face of the tile is printed using a hydraulic jack machine by applying load 10 to 15 ton (or) 13 ton over the tile. Flexural test on tile size 228.6mm x 228.6 x 18mm was performed on 7 days give perfect flexural strength 197kg in 2.5%. All specimens were hand mixed with portable water. Water absorption test and shrinkage test is important on tile was also conducted on tile specimens

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D. Test Procedures

Type of tiles: CRT - Control roof tile, PRT
2.5% - Pumice roof tile, PRT5% -Pumice roof
Tile, PRT-7.5%-Pumice roof tile

1) Collect Clay soil -2500g, Red soil-2500g, White soil-2500g in same trays.
2) Put them together into a tab containing water half level of the tab. Let it stay for 2 hours.
3) Mix them with bare hand after 2 hours.
4) Take a 1mm sieve.
5) Using sieve filter the mixture which you mixed previously and divided them into 3 equal part set them 3 trays.
6) Place the trays in dryer for 12 hours set the reading to 120^{o}C, fan50, flap50 units.
7) It will be set firmly without any water left over after 12 hours collect the dried mixture.
8) Collect them in a sac and crush them finely with a hammer, Let the finely grounded sand mixture be set a side in a tub.
9) A 200ml peaker (Borosilicate glass) take let us fill the water up to the nozzle (opening) and the peaker, So that the quantity of the water we take because approximately 250ml.
10) Total 7500g-The overall water quantity should 25% of the weight of the sand mixture.
11) Total 7500g, water quantity 25%
=7500x0.25
=1875g
=1875/250=7.5 times
Total =1875ml
12) Add water to the tub using the 250ml peaker 7.5 times fill the overall quantity of water is poured or added wait till the sand mixture absorb the water.
13) Roughly after 16 hours the sand mixture clayey.
14) Place the clayey mixture over a polythene sheet.
15) Using the hammer compact the clayey mixture, so that bond together.
16) Bring the mixture to a square shape over the time it is setting.
17) Now the clayey mixture is collected in a air tighted cover and let it stay for 2 days completely.
18) After 2 days using a scale (ruler). Divided the compacted mixture into 3 segments.
19) Roughly this 3 segment won't be equal in weight, take their
20) Weight as average and make them equal.
21) Now, again collect them in 3 different polythene air tight cover repeat the compaction process with hammer one by one.
22) Take a mould apply lubricants. Place the tile now on the mould and adjust them to get fit with shape and size of the mould.
23) The tile placed over the mould and cover it polythene sheet and plywood in placed over them, So that when the hammer is hammered over the plywood the tile will attain the size and shape of the mould.
24) Let them dry for 3 days this done by placing the tile over the paper.
25) After 3 days remove the tile over the paper dry the tile moisture condition for 3 days.

E. Pree Heating Process (100^{O}C /24 hrs):

We have to keep those tiles which dry for 7 days in dryer at temperature 100°C, flap 40 and fan 30 then we have to heat it for 24 hours after 24 hours we have to ensure that whether it is cooled down to normal temperature. If yes, we have to fire and take it.

F. Firing Process (850^{O}C/ 36 hrs):

After taking those tiles from it we have to put it in over for further heating process at 850°C for this process to complete it takes 36 hrs and we have to wait for it.

III. RESULTS AND DISCUSSIONS

A. Flexural Strength Test(M.O.R Testing Machine)

We have to take other tiles which is heated already and we have to keep on the roller of a machine for flexural strength testing
Setting (50kg and 500kg process)
We have to give new load option and we should set slow speed of 3Hz from 0 to some value, we have to keep note that at what peak did that tile had broken down and we have to measure the thickness of that broken pieces

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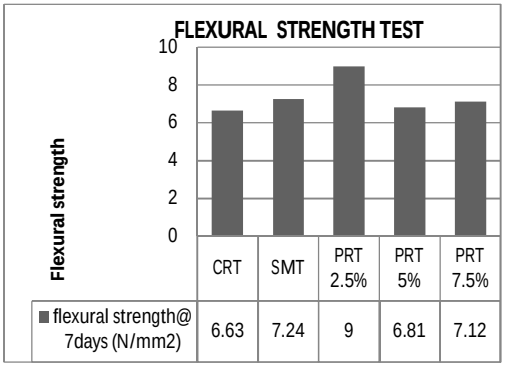
Modular of rupture denote as (MR) MPa or psi. Using either three point load test (ASTM C78) or center point load test (ASTM C2930. Give 2.5% strength (197kg) when the tile check is done after 7 days.

Table 3
Flexural strength test

SAMPLE	FLEXURAL STREGTH TEST (TEMPERATURE 850^{O}C)				Flexural strength ($3xNxI_2$/ $2xbh^2$)	Flexural strength (1.5 WS)/ (bt^2)
	SPAN (mm)	LOAD (kg)	WIDTH (mm)	MINIMUM THICKNES(mm)	N/mm^2	Kg/ cm^2
CRT	200	187	227.2	19.1	6.63	67.54
2.5%	200	197	228.3	16.8	9.00	91.72
5%	200	152	227.0	17.0	6.81	70.0
7.5%	200	158	225.3	17.06	7.12	72.61

Chart 4
Flexural Strength @ 7days



B. Water Absorption test

We have to do water absorbing test on tiles for that we have to take water first and weigh those tiles (before immersed water weight (A) and we have to put those tiles in water for 24 hours and take those tiles from water and we have to weigh those tile (after immersed water weight (B).

Water absorption rates are the most important measurement of a tile. Water absorption measures how much moisture a specific type of tile is likely to absorb on an ongoing basis. Some types of tile may crack if the moisture penetration is too high. The water absorption percentage reflects the density of the tile body.

Table 4
Water absorption test

SPECIMEN	WATER ABSORPTION IN TILE (%)
CRT	12.5%
PRT 2.5%	13.0%
PRT 5%	13.2%
PRT 7.5%	13.6%

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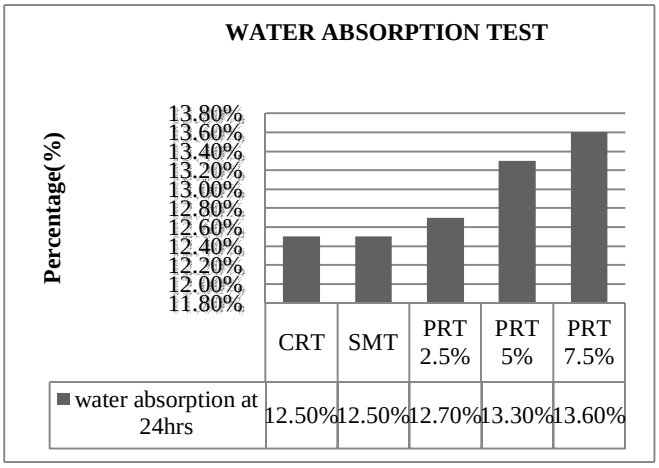
Chart 5
Water absorption at 24hrs



C. Shrinkage Test

To measure shrinkage test we have to take 7 days dried tiles and we have measure (before dry shrinkage) and we have to heat it for 24 hours and we have to measure (after dry shrinkage) then we have to take those tiles and fire it for 36 hours then we have to measure (after firing shrinkage) - this is shrinking test on tiles.

This is a comprehensive test to evaluate the drying shrinkage, firing shrinkage and the porosity of clay bodies and clay materials (these physical properties are the key indicators of fired maturity.

Table 5
Shrinkage test

	FIRING SHRINKAGE AT (850^{O}C)	
	After oven dry	After firing
	Percentage of shrinkage (Average)	Percentage of shrinkage (Average)
CRT-1	0.09	1.27
CRT-2	0.13	1.22
CRT-3	0.15	1.20
PRT 2.5%-1	0.14	1.07
PRT 2.5%-2	0.06	1.31
PRT 2.5%-3	0.09	1.38
PRT 5%-1	0.41	0.73
PRT 5%-2	0.18	1.71
PRT 5%-3	0.57	1.25
PRT 7.5%-1	0.11	1.55
PRT 7.5%-2	0.17	1.42
PRT 7.5%-3	0.14	1.38

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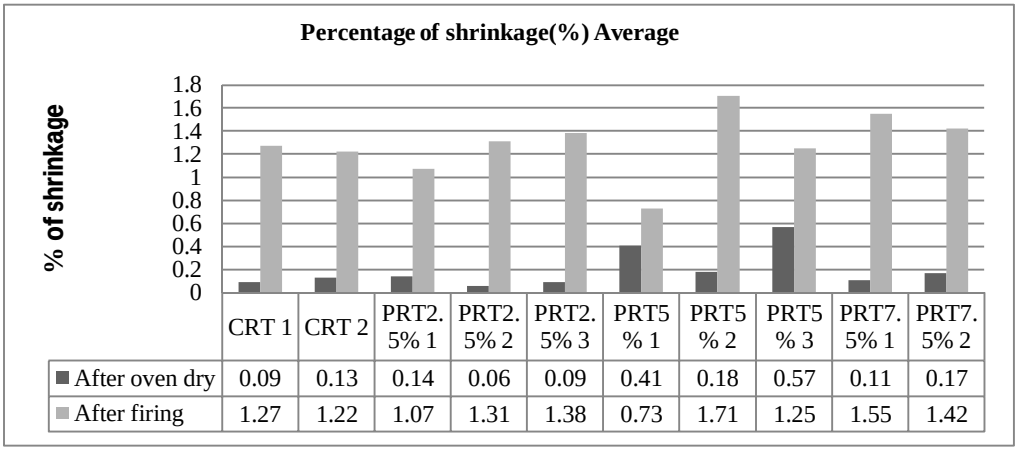
Chart 6
Shrinkage Test on Tile



	CRT 1	CRT 2	PRT2.5% 1	PRT2.5% 2	PRT2.5% 3	PRT5% 1	PRT5% 2	PRT5% 3	PRT7.5% 1	PRT7.5% 2
After oven dry	0.09	0.13	0.14	0.06	0.09	0.41	0.18	0.57	0.11	0.17
After firing	1.27	1.22	1.07	1.31	1.38	0.73	1.71	1.25	1.55	1.42

IV CONCLUSIONS

From the experimental data, the following conclusions can be drawn:

A. From the above experiments the strength parameter were found using (M.O.R Testing machine) on comparing the strength values tile which has 2.5% of pumice powder shows absolute results, because at 5% of pumice powder water absorption is higher.

B. On comparing with industrial tiles thickness of PRT 2.5% is 2mm higher, which influence strength parameters 5% and 7.5% the water absorption ratio is higher, which because of high porous pumice found and so the water absorption is higher.

C. Which increase the expansion of tiles with expansion of tile decreases the strength. To reduce the strengthen property of roof tiles using pumice powder.

D. One of the most benefits of pumice aggregate concrete is its lightweight quality up to the third is lighter conventional sand and gravel concrete.

E. This material attribute to a decrease in structural steel cost and, because of this job costs, less labors required, The roof tile is used red soil material easily cracked and lightweight material and naturally heat gain So, we are use pumice powder is alternative material in red soil pumice powder commercially available.

F. On PRT-2.5% load carrying capacity is 197kg. Which comparatively feasible. PRT- 5% and PRT-7.5% are higher in water absorption is not suitable.

G. PRT-2.5%adopted for further implementation.

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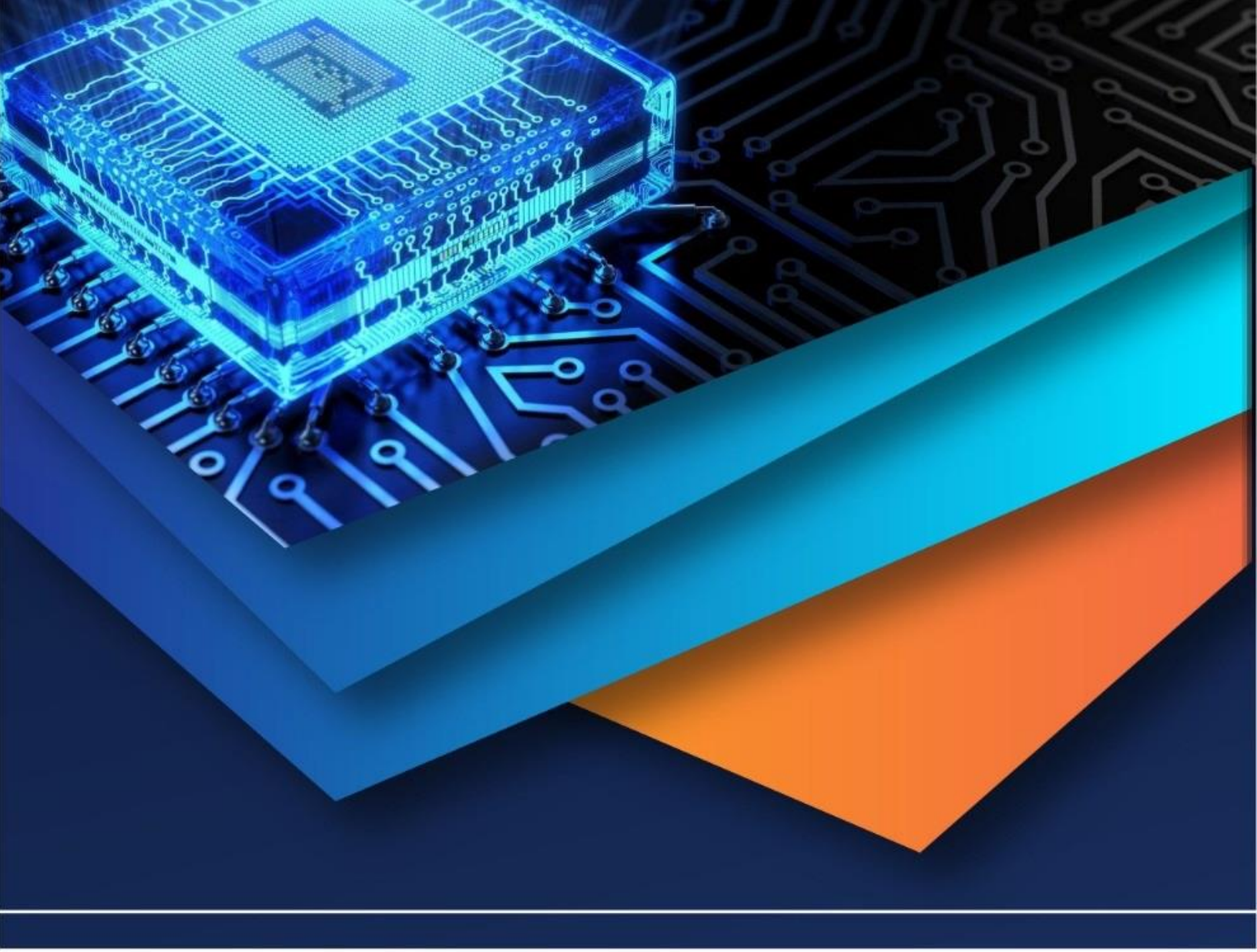

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