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An Experimental Investigation of the Effect of Pervious Concrete by Various Shape and Sizes of Aggregate

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Abstract: For many projects water cutting on the highway and in parking lots is a big issue especially during heavy rains as the pavements and floors are often inadequate. This results in significant investments in repairing and deploying storm water drainage systems, which may be trapped during large-scale flow. Three compounds of PCs were prepared in different types of composites [stone, angular and stone]. The study concluded that the integrated type has a significant impact on PC properties. And finally review some of the exploratory methods currently being developed to find a continuous concrete and summarize the research methods under consideration.
Keywords: No fines concrete, Pervious concrete, Pebbles, flaky and elongates aggregate.

I. INTRODUCTION

Flushing concrete was first used in the 1800s in Europe as a street view. India became very popular in 2000. Endless concrete (also called porous concrete, leaking concrete, no finite concrete and porous pavement) is a special type of high-porous concrete used for flatwork concrete applications that allow rainwater and other sources to pass directly, thus reducing flow. from the area and allow groundwater recharge. The advantages of this type of concrete are low density, low cost due to low cement content, low thermal conductivity, low drying, no separation and movement of capillary water. It has better protective properties than conventional concrete due to the presence of large voids. Although dirty concrete has been around since the mid-19th century, it was not until the 1980's that dirty concrete became popular in the United States. When it gained popularity in the US, saturated concrete was used in road systems as a rainwater management solution. The high penetration of flowing concrete creates the ability to significantly reduce the flow of floodwaters.

No-fines concrete has many advantages that cover its main lightweight area and there is no separation due to its porous nature that avoids the need to vibrate during its production. Due to its compact nature it has many systems such as flexible pavements, water purification plants, and parking for lightweight vehicles. The pitted condition of the NFC causes a decrease in performance. The w / c ratio therefore plays an important role in the production of NFC and its power. This mixture is made of cement, coarse volume and water with almost zero volume. , and holes with a diameter of 2 mm to 8 mm) of this material, resulting from the use of rough adhesive joints, the ratio of low water cement (w / c) and usually the absence of good measurements, allow. the transport of water by its structure, thus helping to reduce the negative effects of storm water flow. . Also, due to the high void content, pervious concrete weighs less (approximately 1600 to 1900kg / m3). in flexible concrete, the magnitude of the compressive strength varies from 3 to 25 MPa. The penetration rate of concrete will fall within a range of 80 to 720 liters per minute per square meter. paste cement just enough to cover the coarse particles while maintaining voids. Consistent concrete is widely used in non-paved systems, limited use in pavement systems. Therefore, many applications of flowing concrete are paved parking lot, pedestrian path, bike path, and areas where concrete pressure is not important. Next, a survey of pervious concrete books is provided. This is a test of the suitability of the Accredited concrete that will be used for the construction of the paved road.

In this study, the performance of conventional concrete was investigated by performing various tests (i.e., machine test, water penetration, strength, and unit weight test) by changing parameters, including combined size and type, and a w / c of 0.35 commitment (filling gaps between). of aggregates). This study also examined the impact of solid and common components with a different compound strength in compressive strength and penetration of concrete cubes. This was recommended for solid concrete tests which included the following: compressive strength, indirect strength of durability. After that there is a comparison made between the two types of concrete.

It has been found that permitted concrete pavements have good features such as increased skiing and high accessibility but do not have the high strength required in high traffic areas. Consistent concrete has proven to have properties suitable for use in areas of low volume traffic. The detected properties may change depending on the aggregate particle selected, but this feature requires further investigation.

II. LITERATURE REVIEW

To The basic properties of the pervious concrete have been studied by researchers. Pervious concrete has large void ratio 15-40%, lower compressive strength, higher permeability and lower unit weight 70% than conventional concrete.

In 2020, GANGA V atl. studied about the pervious pabbles concrete with partial replacement of cement by GGBS, Based on the analysis obtained result that the compressive strength of the GGBS small rock mass is very similar or equal to ordinary concrete. It may be due to the slow growth of the initial energy due to mixing. Flexible concrete with composite stone and cement instead of 50% GBBS provides equal compressive strength compared to conventional flowing concrete. I the efficiency of joint access is increased by concrete and stone concrete by GGBS by 9% if compared with ordinary concrete. Concluding with the use of 50% GBBS stone concrete, we can reduce the cost of storm water management .Therefore it reduces the cost of the project and its inflow the rate is also very high, which is why it reduces the entry time again. It only takes a few minutes to browse through everything water in the soil and prevents spillage of water in parking lots and garden areas during heavy rains leading to an increase in the water table level.

In 2014, Tun Chi Fu atl. Studied about the influence of aggregate size and binder material on the various properties of pervious concrete The water coefficient and the associated porosity decreased with increasing binder values however increased with increasing combined size.

Continuous concrete with low w/c value bonds is high viscous, which helped to cover aggregates. This allows for sufficient bonding between the particles and effectively reduces excess bonds from blocking access to water, thus having an impact water infiltration. Under the same connected porosity, specimens with small particles they had small areas of parts inside connected voids, producing circular channels of water inlet. Examples include large ones the particles had large areas of parts and vertical paths. Therefore, the speed of the water entering the image varied, giving variations of flow volume. flowing water from the model.

Power machine model with commitments containing 10% silica fume were the best those of the control sample. This effect was not available Responsible samples of 20% were recognized or 30% silica fume, probably because of too much money silica smoke was added. So, right addition the amount of silica fume in binders can improve the overall operating capacity of full concrete.

Percentage of weight loss of continuous concrete sulfate attacks increased as a w/c ratio cement paste increased. Percentage of weight loss was exactly equal to the combined size, because the accumulation of large aggregates creates large voids, which created ways for sulfate to enter the images and create a reaction. Examples made of activated alkali of slag binder have shown higher resistance to sulfate attacks than those involving cement paste. he did.

In 2018, Barnali Debnath and Partha Pratim Sarkar studied Pervious concrete as an alternative pavement material, in this paper reconnects the general situation related to the discovery and use of continuous concrete a paved area. Flowing concrete, fighting the current environmental concerns, play an important role to decorate a sustainable drainage system and become best management practice for rainwater management. I the purpose of this study was to compile all of the past researches in a paved concrete floor with a view to provide in-depth information on development illegal concrete for some researchers and developers who may be motivated by its prominence as a new paved way site. It is seen in the literature that there is a shortage of suitable way to design mix for pervious concrete mix and can is considered an important research gap. Most of this the researchers used different measurements of the mixing considerations the various factors that make the subjects unmatched planning to integrate the design method. So, there is a need specificity of the design of the standard mix and the structural strength design a way to improve the relationship between different lessons by considering all design variables. Stressful the strength and flexibility of a fixed concrete mixture usually ranges from 1.06–27.7 MPa to 0.5–2.95 MPa, respectively; However, it has also been shown to be compressive the power and flexibility can be increased to 46.7 MPa and 7.4 MPa, respectively, when adjusted for additional accessories. As a result, the choice of building materials, combining measurements or the use of additional materials it needs to be upgraded and should be clarified in order to increase the durability, efficiency and longevity of the concrete pavement. Several practices once methods are summarized in this associated paper to prepare an advanced method of designing development mixes honesty.

Researchers have suggested the use of only concrete floor slab for basic and low volume road networks due to inefficiency under heavy loads. The improved design combination can also be helpful to expand the use of flexible concrete with medium / heavy volume road networks.

In addition, there is a very limited amount of research available related to the relationship of the laboratory field. Therefore, accepted design method needs to be associated with how to install the field, as well as an analysis of the total pavement cost also needs to be done, which is considered research spaces. There are several ways to identify the feature of the concrete slab and various possible methods can also be used to correct a porous condition.

However, there is a ban on the proper way to exposing the porous nature is also considered a study gap. Continuous concrete is intended to serve as a sustainable drainage system and a few studies have been included in this paper demonstrating its penetration capacity and water benefits. However, this penetration capacity can be disrupted due to blockage of the pores, so the normal retention is very high. it is important to consider periodic cleaning and disassembly hollow concrete to withstand the efficient and long-term performance of the mortar. Several ways to unlock the stone pavement is mentioned in this paper, however, Further research is needed in this regard to determine its effectiveness and cost-effective recovery strategies. Lots of research they have already been made to identify improvement water level using these non-concrete and studies proved the effectiveness of continuous concrete in removing i polluting and suspended substances. However, a combination between this discharge position and the pore structure needs to be provided for the purpose of getting better results it can be an important future hope. pervious concrete too capable of calming Urban Heat Island (UHI) and noise the result is due to this hollow nature. But they are in comparison a few books available about this UHI control as well acoustic resistance of continuous concrete. Reading these pores features to control the effect of UHI and noise reduction it can also be a wide range of future research activities.

In this paper, the structure and specification of complete concrete, its mechanical strength and durability, in-situ use and hydrological and environmental features defined and accurate care features. Previous research suggests research gaps in this issue that are considered the future prospects of this study. If these the gaps can be adjusted correctly considering its general use, it can improve the design of the prepared mixture easily that can help to implement pervious concrete to functioning as a dual stable footwork system the use of pervious concrete can also be improved from low volume to medium / high volume traffic networks. What research spaces are considered fully, continuous concrete it may be a world-famous strategy and perhaps one of the best ways to build green infrastructure. In 2021 Ma. Patricia Leriezz J atl. this study was able to produce flexible concrete that can be used for low traffic paved applications such as parking lots and sidewalks. The concrete was 17.94 MPa compressive strength with an acceptable input of 1.35 mm / s obtained from 9.5 mm for single level, angular aggregates with 70.90% PV / IPV. It was also confirmed that as in vain the content of flexible concrete increases, water infiltration increases but compressive strength decreases and with a 95% confidence level, no significant interaction among others boundaries. As a result of the admixture, adding a VMA to the samples resulted in a high variance of 2.69%. content, 35.49% reduced entry level and 23.74% increased compression strength. The penetration and the empty content both satisfy the common characteristics of flexible concrete, therefore can be concluded that with the addition of VMA, it is possible to compress strength can be increased in the use of continuous concrete.

III.MATERIALS AND METHODOLOGY

The pervious concrete consists of only Cement & Coarse aggregate. Cement is the only binder material used in the project and hence OPC53 grade cement is used. Typically pervious concrete has little or no fine aggregate and has just enough cementing paste to coat the coarse aggregate particles while preserving the interconnectivity of the voids. From The Experimental Results It Is Found That The Compressive Strength And Permeability Is Satisfactory At Adding Of 5% Sand As A Fine Aggregate And Combination Of 50% S1 And 50% S2 As Coarse Aggregate In The Pervious Concrete. Three PC mixtures were prepared with different aggregate types [flaky, angular and pebbles].This research aim to investigate the influence of different type of aggregate and shape (flaky) on PC properties. Pervious concrete (PC) is a cheap and effective drainage system for reducing storm-water runoff in urban centers.

A. Cement

OPC 53 grade was used in this work. It conforms to IS 12269:2013, Ordinary Portland cement is the most common type of cement in general use around the world as a basic ingredient of concrete, mortar, and most non-specialty grout. It developed from other types of hydraulic lime in England in mid 19th century and usually originates from limestone. It is a fine powder produced by heating materials to form clinker. After grinding the clinker we will add small amounts of remaining ingredients. Many types of cements are available in market. The colour of OPC is grey colour and by eliminating ferrous oxide during manufacturing process of cement we will get white cement also. Ordinary Portland Cement of 53 Grade of brand name Ultra Tech Company, available in the local market was used for the investigation. Care has been taken to see that the procurement was made from single batching in air tight containers to prevent it from being effected by atmospheric conditions.

Table 2: Physical Properties of Cement

Test	Result
Specific gravity	3.09
Standard consistency	35%
Initial setting time	44 min
Final setting time	590 min
Bulk density	1440 kg/ m^3
Fineness of cement	2.36 %

B. Coarse Aggregates

Crushed aggregates produced from local crushing plants and local available pebbles were used. The aggregate exclusively passing through 20mm sieve size and retained on 10mm sieve and passing through 10mm sieve and retained on 4.75mm sieve is selected. The aggregates were tested for their physical requirements such as gradation, fineness modulus, specific gravity and bulk density in accordance with IS: 2386-1 (1963). The individual aggregates were mixed to induce the required combined grading.

Table-3 Properties of coarse aggregates

Size	Specific Gravity of coarse aggregate	Types of aggregate
Passing through 20mm IS Sieve	2.73	Flaky
	2.62	Pebbles
	2.78	Angular

C. Flaky Particles

Flaky aggregates are defined as “Particles with a minimum size of 0.6 medium diameter(or 60%)”. Where the size of the merger is defined as the definition of two screen sizes, in which particles are stored. Scales that fall to a specific size can have circular, cubical, angular, vertical or long particles. Obviously, thin and long particles will have less strength and durability compared to cubical, angular or circular particles of the same aggregate. Open and long aggregate is avoided in making quality concrete. The presence of strong and long aggregates beyond certain limits increases the deterioration of concrete mixtures. The presence of high percentage of strong and long aggregates makes the mix difficult and difficult to work with. An effort has been made in this research study to determine the feasibility of using such an amount in cement concrete. the impact of long aggregates is higher than green aggregates, in terms of the compressive strength of the concrete. The composite structure used in the flow of concrete has a significant impact on the compressive strength and penetration of flowing concrete. Cubical particles were desirable for increasing internal combustion and improved resistance to corrosion. Scattered aggregates influence the combined measurements by reducing the decorative features. the flakiness index and elongation index are important visual components of mineral aggregates that affect the quality of concrete mixtures.

D. Elongated Aggregate

If the length of the aggregate is greater than the other two sizes then the elongated aggregate or aggregate length is greater than 180% of its average size.

Figure :Flaky aggregates

E. Pebble

A stone slightly smaller than a stone. They are round or elliptical in shape, with a diameter of 10mm to 150 mm. As a result of soil erosion, these pieces of rock naturally fall into the water of the river that flows from the mountains to the planes, making their surface smooth. The sea is made up of rocky outcrops called shingle beach. This type of ocean has weapons features in relation to wave erosion, as well as natural habitats that provide habitat for animals and plants. The shingle shoreline (large number of pebbles) is present in some places, such as the entrance to the River Ore, where active shingle shoots present major navigation challenges. Stones come in a variety of colors and textures and can have stripes, known as veins, quartz or other minerals. The rocks are very smooth but, depending on how often they meet the sea; they may have signs of contact with other stones or other stones. Stones left above the surface water mark may have the appearance of lichen-like organisms, indicating a lack of contact with seawater.

Fig -: Pebbles

F. Sources of Pebbles

Pebbles come in various colors and textures and can have streaks, known as veins, of quartz or other minerals. Pebbles are mostly smooth but, dependent on how frequently they come in contact with the sea; they can have marks of contact with other rocks or other pebbles. Pebbles left above the high water mark may have growths of organisms such as lichen on them, signifying the lack of contact with seawater.

G. Water-to-cement

0.35are used successfully. The relation between strength and water-to-cement ratio is not clear for pervious concrete, because unlike conventional concrete, the total paste content is less than the voids content between the aggregates. Therefore, making the paste stronger may not always lead to increased overall strength. Water content should be tightly controlled. The correct water content has been described as giving the mixture a sheen, without flowing off of the aggregate. A handful of pervious concrete formed into a ball will not crumble or lose its void structure as the paste flows into the spaces between the aggregates (see Figure 5).

Pervious concrete is often placed at very low water-to-cement (w/c) ratios (0.27 to 0.34) compared to conventional concrete. For a given type and size of aggregate, there is an optimum W/C ratio which produced balanced mix. Less than this optimum ratio have produce a mix having dull surface appearance leading to unsatisfactory performance of the pervious concrete, whereas more W/C ratio may cause the problem of paste draw down resulting to chocking of the pores at bottom leading to the functional failure of the pervious concrete. Low w/c ratios allow the paste to completely coat the aggregate particles without draining into the hydraulic channels. In porous concrete sufficient paste, which is created by controlled amounts of water and cementation materials, coats and binds the aggregate particles and create a highly permeable and well drained system. In most cases, below w/c = 0.27 to 0.29 the paste is not sufficiently wetted enough to allow paste bridging between particles for load transfer. As a general rule, Potable water fit for drinking is required to be used in the concrete and it should have pH value ranges between 6 to 9

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Pervious concrete Mix proportions for Different Size of Aggregate

Mix Name	Aggregate Size	Aggregate Type	Water/cement Ratio	Aggregate/Cement Ratio	Cement (kg/m^3)	Coarse Aggregate (kg/m^3)	Water (kg/m^3)
Mix F1	4.75 to 10 mm	flaky	0.35	4	350	1400	123
Mix F2	10 to 20 mm						
Mix F3	4.75 to l0 (50%) +10 to 20 (50%)						
Mix P4	4.75 to 10 mm	pebbles	0.35	4	330	1322	117
Mix P5	10 to 20 mm						
Mix P6	4.75 to l0 (50%) +10 to 20 (50%)						
Mix 7	4.75 to 10 mm	Normal (angular)	0.35	4	340	1360	119
Mix 8	10 to 20 mm						
Mix 9	4.75 to l0 (50%) +10 to 20 (50%)						

Coarse Aggregates

Locally available(shivnath river,durg) crushed angular , flaky and pebbles coarse aggregates have been used inthe present study. The physical properties (from table 5)

Properties Of Aggregate Samples Used In Experiment

Aggregate Type(Sample)	Aggregate as retained between the pair of Sieves	Compacted Unit Weight (kg/m3)	Voids(%)	Flakiness Index (%)	Average Angularity Number
F (Flaky)	4.75 to 10 mm	1454	47.36	40	13
	10 to 20 mm	1472	46.15		
	4.75 to l0 (50%) + 10 to20 (50%)	1463	46.75		
P (pebbles*)*	4.75 to 10 mm	1669	37.14	0	0
	10 to 20 mm	1695	35.89		
	4.75tol0 (50%) + 10 to 20 (50%)	1682	36.36		
Normal (angular)	4.75 to 10 mm	1511	43.57	7	10
	10 to 20 mm	1603	41.34		
	4.75tol0 (50%) + 10 to 20 (50%)	1561	42.45		

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IV. RESULTS

The results obtained by the experimental work have been discussed in this chapter. This chapter also includes results discussion in the form of tables and graphs.

A. *Workabilty*

Results obtained from slump test showing that the workability of concrete pebbles aggregate is better workable as compared to flaky and angular agg. Because pebbles are completely shaped by attrition and that's why minimum % of voids available results gives better workability. Results of workability of PC of all mix proportions with water-cement ratio 0.35have been shown in Table below.

B. *Compressive Strength*

Results of compressive strength of cubes of all mix proportions with water-cement ratio 0.35have been shown in Table below.

The cubes 150 mm x 150 mm x 150 mm were tested in the Compression Testing Machine (CTM). During Initial loading, cubes were un cracked and stiff. With further loading, cracks occurred at the edges. As the applied load is further increased, the cracks were also increased. A large number of minute cracks developed in the specimens.

The compressive strength of M7, M8 and M9 was more than MP4, MP5 and MP6 and MF1, MF2 and MF3comparetively because pervious concrete made with 50% of 4.75 to 10 and 50% of 10 to 20 sizes aggregates has high strength in comparison to pervious concrete made with all-in-aggregates and with large size aggregates.

The compressive strength of all the mix proportion with constant water cement ratio 0.35 at 7and 28 days has been shown in fig.4.5 to 4.8.The compressive strength of M9 is maximum and minimum at MF2 at 28 days. The compressive strength of pervious concrete of MF3 & MP6 decreased by 15%& 11% respectively in comparison to M9 @ 28 days.

C. *Split Tensile Strength*

The split Tensile strength of all the mix proportions with water cement ratio 0.35 at 7and 28 days have been shown in table no 7.

The split tensile strength of pervious concrete with small size aggregates (4.75 to 10 mm) was high in comparison to pervious concrete made with all-in aggregates and large size aggregates (4.75 nun to 20 mm and 10 to 20 mm). The split tensile strength of pervious concrete was less than the conventional concrete because the fine aggregates were eliminated from the concrete mix.

The split tensile strength of all the mix proportions with water cement ratio 0.35 at 7 and 28 days have been shown in fig.4.15 to 4.18splittensile strength of flaky(MF1) and pebbles(MP4) decreased approximately by 33% and 22% respectively at 28 days with respect to (M7) normal(angular) aggregate. split tensile strength of concrete of flaky(MF2) and pebbles(MP5) decreased approximately by 30% and 21%respectively at 28 days with respect to (M8). split tensile strength of concrete of flaky(MF3) and pebbles(MP6) decreased approximately by 27% and 18%respectively at 28 days with respect to (M9).

The final results spilt tensile strength of pervious concrete of various shape and size aggregate is

(MF2<MF3<MF1) < (MP5<MP6<MP4) < (M8<M9<M7)

D. *Flexural Strength*

The results of flexural strength of beam of all pervious concrete mix proportions have been shown in the table below.

The flexural strength of all the mix proportions with water cement ratio 0.35 at 7and 28 days have been shown in fig.4.15 to 4.18Flexural strength of flaky(MF1) and pebbles(MP4) decreased approximately by 35% and 23% respectively at 28 days with respect to (M7) normal(angular) aggregate. Flexural strength of concrete of flaky (MF2) and pebbles (MP5) decreased approximately by 30% and 21%respectively at 28 days with respect to (M8). Flexural strength of concrete of flaky(MF3) and pebbles(MP6) decreased approximately by 28% and 18%respectively at 28 days with respect to (M9).

The flexural strength of pervious concrete is less than that of conventional concrete due to absence of fine aggregates. The final results flexural strength of pervious concrete of various shape and size aggregate is

(MF2<MF3<MF1) < (MP5<MP6<MP4) < (M8<M9<M7)

E. *Permeability*

These results are obtained by testing the total 9 specimens for conventional and no fines concrete at 28 days by falling head method and Permeability values for different aggregate size and shape of aggregate is given values used to prepare the mixes the results are tabulated in the table below.

Table: Test results of compressive strength of different concrete mix proportions

Aggregate Type	Mix No.	Slump (mm)	compressive strength (Mpa)		split tensile strength (Mpa)		flexural strength (Mpa)		Permeability of various mix at 28th day (mm/sec)
			7 days	28 days	7 days	28 days	7 days	28 days	
flaky	MFl	91	7.29	10.12	1.23	1.44	2.08	2.31	19.23
	M F2	97	6.88	9.12	.97	1.19	1.80	2.01	23
	M F3	93	8.29	10.98	1.14	1.38	2.02	2.25	18.57
pebble	M P4	131	8.75	11.81	1.42	1.76	2.53	2.73	17.5
	M P5	167	7.14	9.42	1.03	1.27	2.11	2.32	21
	M P6	150	9.35	12.85	1.10	1.36	2.30	2.57	15.28
Normal (angular)	M 7	125	9.08	12.27	1.72	2.29	3.13	3.31	16.32
	M 8	147	8.27	11	1.40	1.67	2.81	2.97	20
	M 9	139	11.55	14.49	1.52	1.86	2.92	2.15	13.98

V. CONCLUSIONS

1) In this studies of pervious concrete flaky agg. Give better permeability , pebbles give better placing or workable and angular give better strength.
2) Pervious concrete made with pebbles as coarse aggregate results increasing permeability property due to its round shape nature.
3) Pervious concrete made with OPC as binder and pebbles as a coarse aggregate satisfies the pervious concrete requirements with adequate properties and it can be used for sustainable pavement construction.
4) with using 0.35 w/c ratio and combination of $Mix_1$and Mix_2 (50%) aggregate gives better result for pervious concrete.
5) Porous concrete is unsuitable for heavy duty roads. because of there compressive strength not full fill our required.

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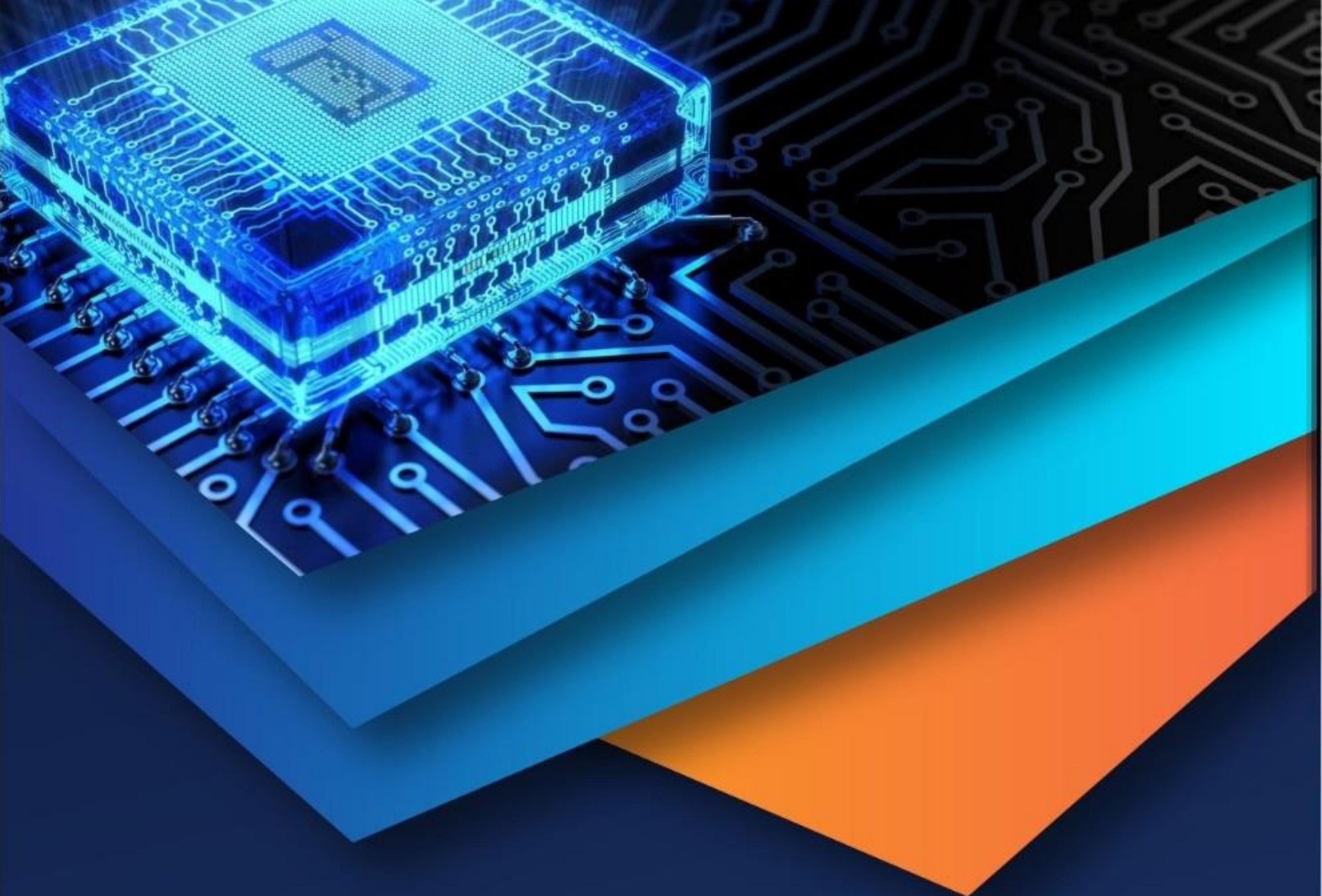

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