iJRASET
International Journal For Research in Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 12 **Issue:** I **Month of publication:** January 2024

DOI: https://doi.org/10.22214/ijraset.2024.58115

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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 12 Issue I Jan 2024- Available at www.ijraset.com

Stabilization of Clay Soil Using Lime and Polypropylene Fibre

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Abstract: ***Soil is the basic foundation for any civil engineering structures. It is required to bear the loads without failure. In some places, soil may be weak which cannot resist the oncoming loads. In such cases, soil stabilization is needed. Numerous methods are available in literature for soil stabilization. But sometimes, some of the methods like chemical stabilization etc. adversely affect the chemical composition of the soil.***
The following material were used for preparing the samples;
Clay soil
Lime
Polypropylene fibre (12mm length)
Clay soil used for these experiments was brought from site, near EB Office, Kadayanallur. The physical properties of soil were determined as per IS specifications.
This project aims to conduct a study to check the improvements in properties of clayey soil by adding lime (constant 3% weight of the clay soil) and various percentage of Polypropylene fibre (0%,0.25%, 0.50%, 0.75%, and 1.0% weight of the clay soil). These mixtures were investigated by conducting standard proctor compaction test, unconfined compression test and CBR test. The test were performed as per Indian standard specifications. Finally the maximum strength is obtained at 0.50% PPF and by maintaining 3% lime.

I. INTRODUCTION

For any land-based structure the foundation is very important and has to be strong to support the entire structure. In order for the foundation to be strong the soil around its plays a very important role. So to work with soils need to have proper knowledge about their properties and factors which affect their behaviour. In order to satisfy the soil properties the soil stabilization is very important so that the addition of lime and polypropylene fibre makes soil stabilization by arresting the cracks so that it improves strength. The addition of lime and polypropylene fibre decreases the optimum water content, and increases strength and maximum dry density and reduced the swelling potential, liquid limit, plasticity index.
But further addition can increases swelling in soils with high sulphate contents, decrease in plasticity of soils and excessive lime treatment contribute to brittle failure characteristics of soils that lead to rapid and great loss in strength when failure occurs. Here in this project soil stabilization has been done with the help of lime and randomly distributed polypropylene fires, obtained from waste materials.
Soil properties vary a great deal and construction of structures depends a lot on the bearing capacity of the soil, hence, we need to stabilize the soil to improve the load bearing capacity. The gradation of the soil is also a very important property to keep in mind while working with soils. The soils may be well-graded which is desirable as it has less number of voids or uniformly graded which though sounds stable but has more voids.

A. Objectives Of The Project Work

1) To evaluate the index properties of clay soil.
2) To identify the increasing in strength of soil by replacing fire at various percentages.
3) Study the soil strength by adding lime (constant 3% weight of the clay soil) and polypropylene fibre in varies percentages (0%, 0.25%, 0.50%, 0.75%, and 1% weight of the clay soil).
4) To identify the optimum % of poly propylene fibre by conducting various strength test on various percentages of fibre.

II. METHODOLOGY

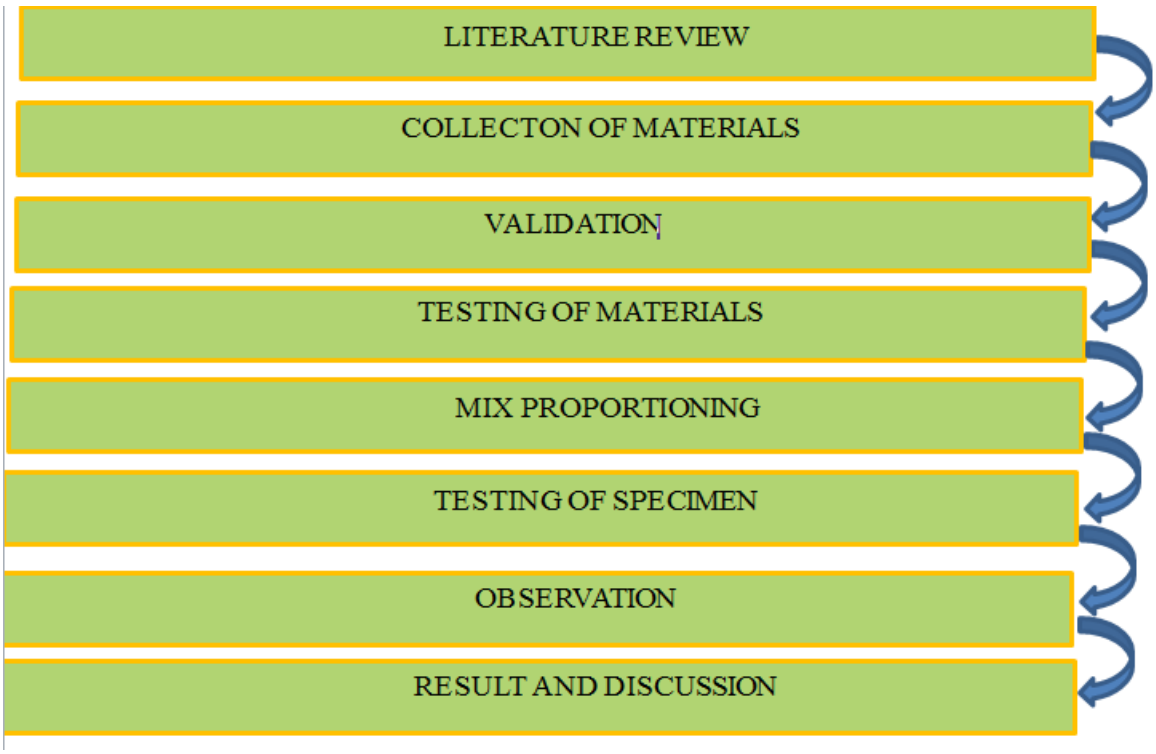

FIG 1. Flowchart

III. RESULTS AND DISCUSSION

1) Specific Gravity Of Clay Soil:

TABLE.1. Observation of specific gravity of soil

S.No	Description	Trail 1	Trail 2	Trail 3
1	Mass of Pycnometer (M1)	0.569	0.569	0.569
2	Mass of (Pycnometer + Soil) (M2)	0.937	0.935	0.932
3	Mass of (Pycnometer + Soil + water) (M3)	1.825	1.823	1.820
4	Mass of (Pycnometer +water) (M3)	1.593	1.590	1.590
5	Specific gravity	2.705	2.750	2.725
6	Average Specific gravity	2.725		

2) Grain size distribution by sieve analysis:

TABLE.2. Observation of sieve analysis

S.No	Is sieve	Size of opening (mm)	Mass of soil retained(g)	Cumulative mass of soil Retained (g)	Cumulative % retained	% finer
1	4.75	4.75	0	0	0	0
2	2.36	2.36	0.1	0.01	0.01	99.99
3	1.18	1.18	0.4	0.04	0.05	99.95
4	600 micron	0.600	0.6	0.06	0.11	99.89
5	425 micron	0.425	0.6	0.06	0.17	99.83
6	300 micron	0.300	0.2	0.02	0.19	99.81
7	150 micron	0.150	42.6	4.26	4.45	99.55
8	75 micron	0.075	82.2	8.22	12.67	87.33
9	Pan	<0.075	4.9	0.49	13.16	86.84

3) Free swell test of clay soil:

TABLE.3. Observation of free swell index of clay soil

Additive content	Expansive soil		
Reading on the Glass Jar	S1	S2	S3
V_w = volume of soil specimen read from the graduated cylinder containing distilled water	13.5	14	14.5
V_k = volume of soil specimen read from the graduated cylinder containing kerosene	10	10	10
Free swell index = $(V_w - V_k)/V_k$ x 100%	35%	40%	45%
Average free swell index	40%		

4) Compaction properties by standard proctor compaction test:

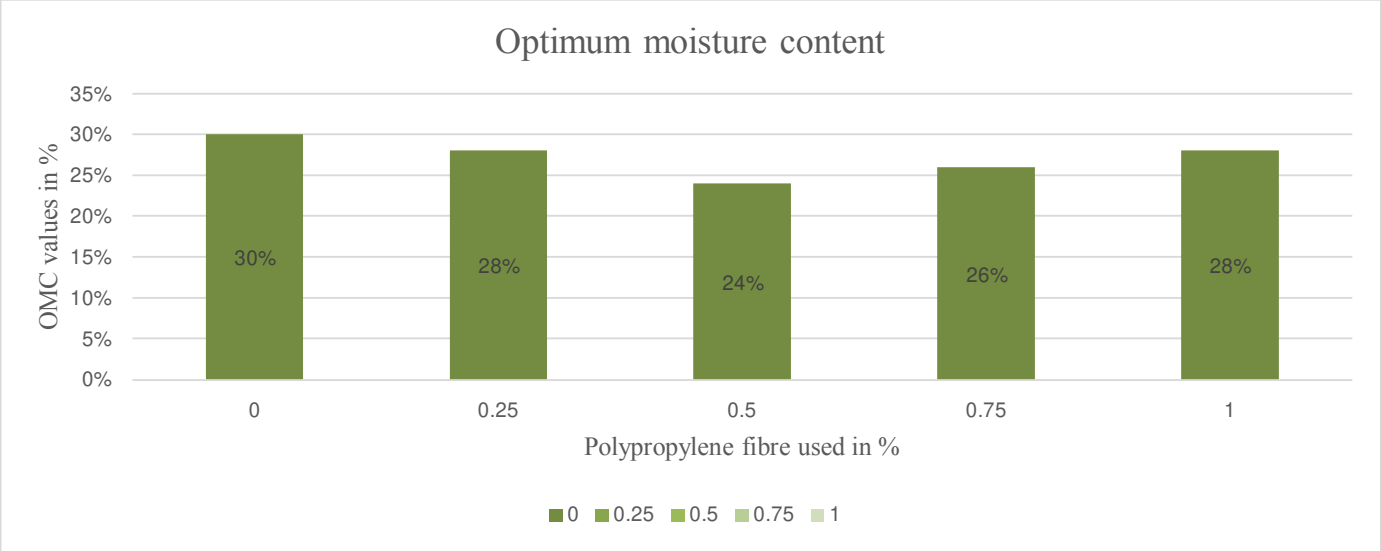

Fig 2. Optimum moisture content

5) California Bearing Ratio test:

TABLE.4. Soaked and Unsoaked CBR values

S.No	Mix Properties	CBR values in % Unsoaked Sample (%)	CBR values in % Soaked Sample (%)
1	Clay soil	5.5	2.75
2	Clay soil(96.75%)+Lime(3%)+PPF(0.25%)	11.11	5.5
3	Clay soil(96.5%)+Lime(3%)+PPF(0.5%)	18.1	15.4
4	Clay soil(96.25%)+Lime(3%)+PPF(0.75%)	15.92	7.88
5	Clay soil(96%)+Lime(3%)+PPF(1%)	15.18	7.5

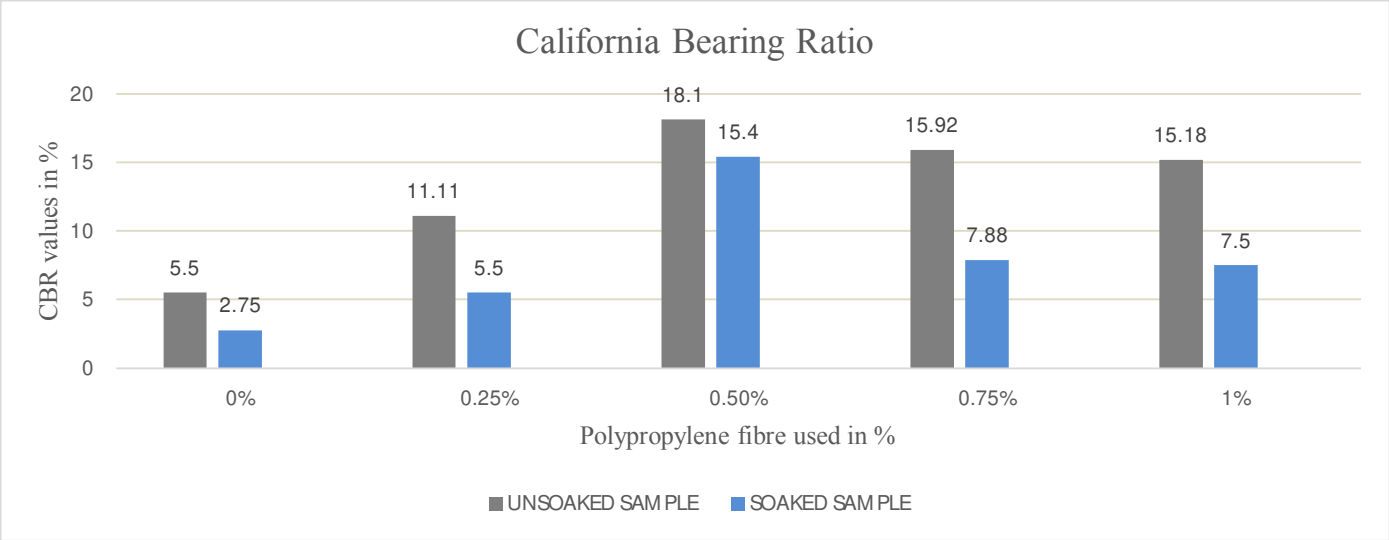

Fig 3. Soaked and Unsoaked CBR values

6) unconfined compressive strength of soil:

TABLE.5. UCS observation for soil:

S.No	% Polypropylene fibre	Shear strength (kg/cm^2)
1	0	0.295
2	0.25	0.985
3	0.50	1.45
4	0.75	1.28
5	1	1.14

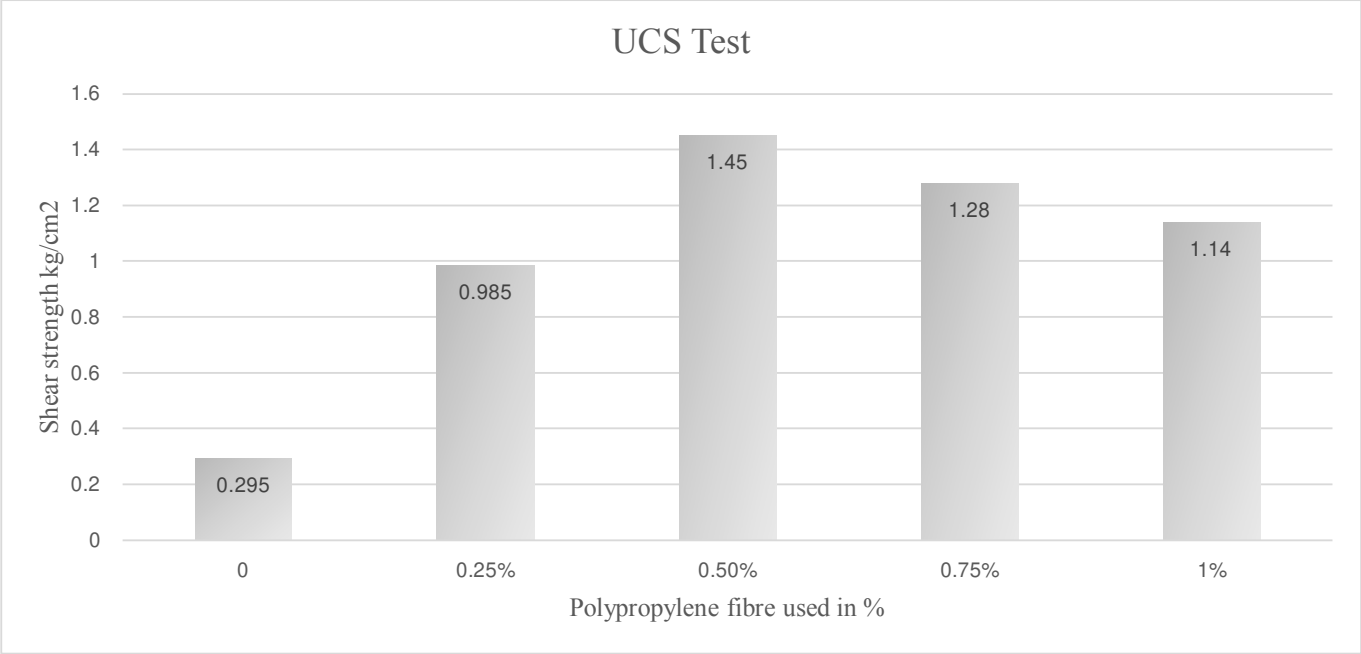

Fig 4. UCS test values

IV. CONCLUSIONS

The following conclusions are made based on the laboratory experiments carried out in this investigation,

1) From proctor compaction test, with increase in the percentage of polypropylene fibre and constant lime (3%) the MDD increases from 1.407g/cc to 1.709g/cc at 0.50% of polypropylene fibre and the OMC has decreased from 30% to 24% at same 0.50% of polypropylene fibre. The relationship between optimum moisture content and maximum dry density of clay soil significantly affected by above 0.50% addition of polypropylene fibre. During the study, MDD increases with decreasing OMC. This is due to the fact that the dry unit weight of fibre is more than that of the clay soil.

2) CBR values of unsoaked sample increases from 5.5% to 18.1% on addition of 0.50% of polypropylene fibre and lime (constant 3%), then decreases to 15.18% with the addition of 1% of polypropylene fibre to the clay soil. CBR values of soaked sample increases from 2.75% to 15.4% on addition of 0.50% of polypropylene fibre, the CBR value decreases to 7.5% with the addition of 1% of polypropylene fibre in the clay soil. The optimum CBR values of soaked and unsoaked samples found to be 15.4% and 18.1% respectively.

3) Unconfined compressive strength test of clay soil with 0.50% of polypropylene fibre and constant lime (3%) increased when compared to normal clay soil increase from 0.295 kg/cm^2 to 1.45 kg/cm^2. At 1% of polypropylene fibre the unconfined compressive strength test value found to decrease.

4) At low percentage of polypropylene fibre and 3 percentage of lime the clay soil (liquid limit-52.6% and plastic limit-24.3%) found bearing capacity of soil increases and it ensure more economical in construction.
5) Finally, at the 0.50% of polypropylene fibre and 3 percentage of lime can potentially stabilize the clay soil have liquid limit-52.6% and plastic limit- 24.3%.

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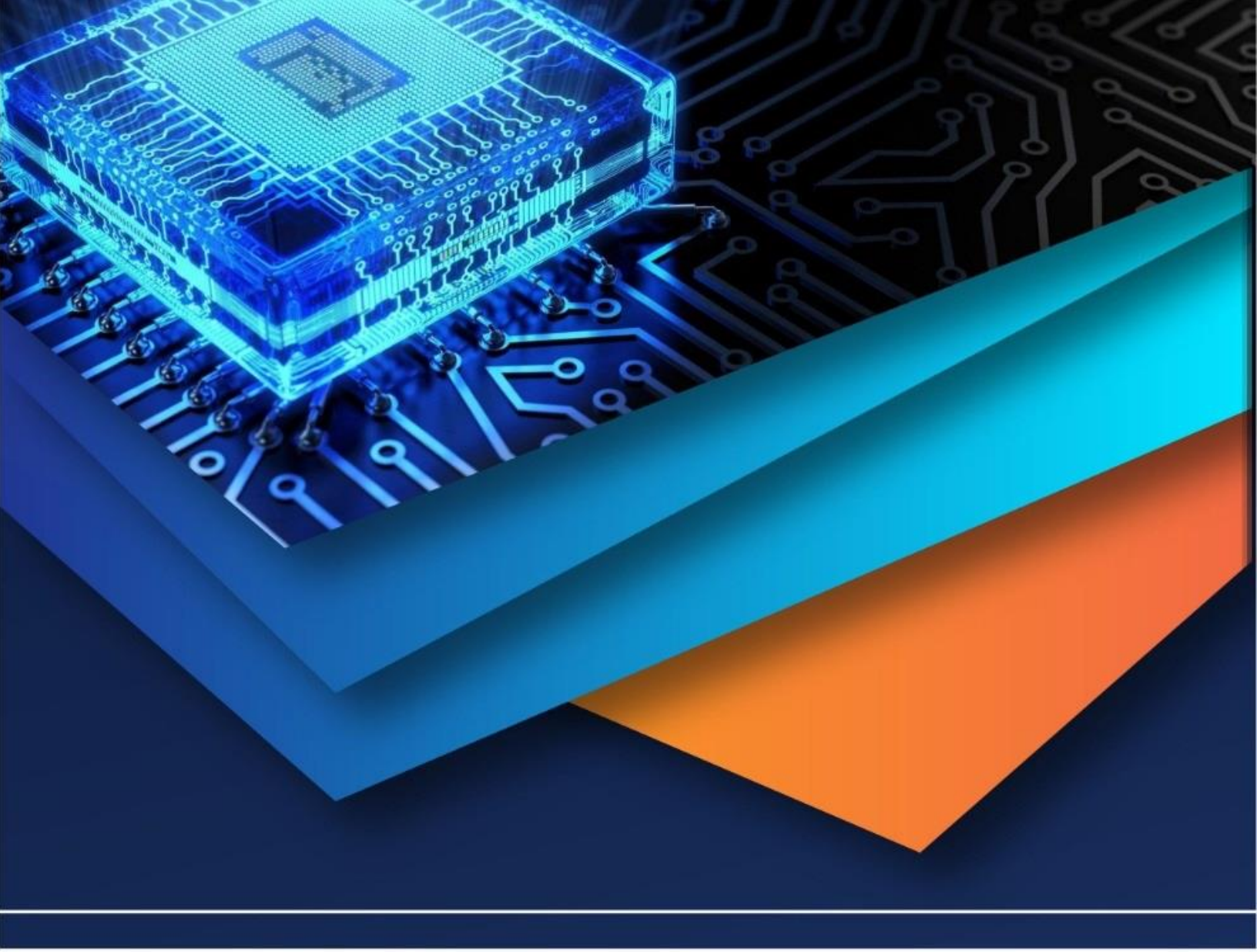

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