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Effects of Waste Plastic on Cement Stabilized Soil

Prof. Rashmi Pantawane[1], Aayushi Agrawal[2], Girish Hatwar[3], Vikesh Khobragade[4], Vivek Chopade[5], Pragat Sahare[6]
[1] *Assistant Professor, Department of Civil Engineering, J D College of Engineering & Management, Nagpur, Maharashtra.*
[2, 3, 4, 5, 6] *UG Student, Department of Civil Engineering, J D College of Engineering & Management, Nagpur, Maharashtra.*

Abstract: ***Soil adjustment is the procedure that improves soil physical properties, such as shear quality, bearing limit that should be possible through the use of controlled compaction or expansion of suitable admixtures such as cement, lime, sand, fly ash or geo-textiles, geo-synthetics, etc.***
Expansive soils such as black cotton soil are always causing problems with swelling, shrinking and unequal foundation settlement. Black Cotton soils with high swelling and contracting potential are one of India's major soil deposits as a result of changes in moisture content.
The foundation is essential for any structure and it must be sufficiently able to help the whole structure. To establish the foundation, the soil around it plays a very important role in making plastic waste one of the world's biggest problems. . Utilization of plastic bottles and other plastic is exponentially expanding step by step because of these we are facing different ecological issues.
The new method of soil adjustment can be adequately used to address the difficulties of society, to reduce the amounts of waste, creating valuable material from non-helpful waste materials. A review paper is introduced here to focus on soil stabilization by utilizing waste plastic items. Tests such as liquid limit, plastic limit, standard proctor compaction test, California bear ratio (CBR) test and direct shear test were performed check improvement in the properties of black cotton soil. Different contents of plastic waste % by weight varying by 0.5% 1.0% and 1.5% The black cotton soil was added and the optimal percentage of plastic strips was determined by the California bearing test ratio. 2%, 4%, 6%, 8% and 10% cement is used as a stabilizer by weight of soil.
Keywords: Black cotton soil, Plastic waste, Cement, Soil Stabilization, California Bearing Ratio, Direct Shear test.

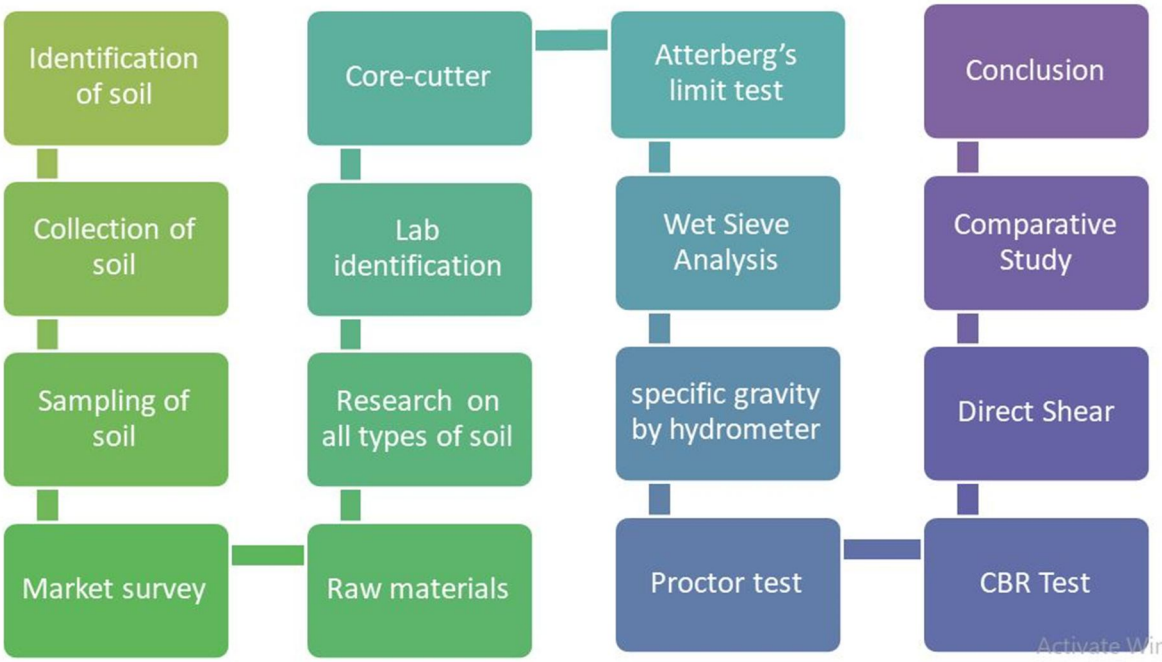
I. INTRODUCTION

Soil is the most essential part of our daily lives. Human and animals uses soil for various purposes such as irrigation, which is an utmost importance for human survival. A large part of this existing soil is clayey type of soil which creates disturbance in the properties of soil.
The process of enhancing the various properties of soil in order to make it, more compatible is called as Stabilization. For the purpose of stabilization of clayey soil, a study on mixing of cement into the soil has been carried out and the considerable amount of rise in its shear strength was observed. To attain the desired amount of strength, a specific material called plastic which has better elastic properties is mixed in this soil. In this project work we have focused on the addition of plastic fiber mixed with cement to enhance the properties of the soil.
The use of plastic fiber results in increasing the durability of the soil while also maintaining its elastic properties. The plastic material which we are using is banned plastic in India which also helps to reduce the harsh effects on environment by this project. Utilization of cement in this project helps strengthen the binding properties of the soil. If this method is adopted at site it will surely make the entire construction work economical.
The inclusion of plastic fiber will intersect the failure plane which will ultimately provide resistance to shear when the soil is subjected to any loading. The reinforced soil obtained by applying the concept derived through this project can be used as a subgrade material for the pavement as well as in case of foundation trenches.

II. METHODOLOGY

The aim of the project is to stabilize the soil for improving the various properties such as shear strength, bearing capacity by using different mixes of plastic strips and cement. Soil type was determined by examine of various soil parameters like OMD, MDD, Atterberg's limit and Wet sieve analysis.
Further, C.B.R and Direct shear Test parameters for soil were determined to see increase in its shear strength. The sample mix S100 indicates 100% soil. Cement 2%, 4%, 6%, 8%, & 10% is mixed with the plastic strips of 0.5%, 1%, and 1.5% in proportion with soil sample.

III. PROCESS PLAN



IV. MATERIALS

A. Soil

Expansive soils in India popularly known as black cotton soils are among the problem soils from the point of view of civil engineering. The basic mineralogical composition is very important of the different factors affecting the soil's swelling behaviors. Most of the expansive soil is rich in mineral, montmorillonite, and some in illite. The soil's most important characteristics are that it shrinks when dry and is hard and has very high bearing capacity. Large cracks form in the soil, but expand when the soil is moist and loses capacity

B. Cement

Cement is a binding material used for construction. Various grades of cement are available in the market as we studied such as OPC 43 & 53 grade etc. Cement has hydrating properties which results in even setting and hardening under water. Here, we are using OPC 53 grade of cement for this project.

Properties of OPC 53 Grade Cement

Sr.No.	Properties	Typical range	Result	IS Code
I.	Consistency (%)	26-33%	27.5	IS 4031- 4
II.	Setting time Initial (minutes) Final (minutes)	30 – 600 min	 125 250	IS 4031- 5
III.	Soundness (mm) (by Le-Chat Expansion)	--	1.0	IS 4031- 3
IV.	Comp. Strength (kg/sq.cm) 7 days 28 days	--	 45 58	IS 4031-6

C. Plastic Strips

Plastic is hazardous material for the environment as well as human life. Plastic strips obtained from polythene bags, bottles etc. As we know, plastic has some useful properties such as elastic property and toughness, resistance to chemical. Now days, plastics under 50 microns has been banned in the market. So here, we are using banned plastic strips with the soil and cement for further study and experimental purpose.

Properties Of Plastic Strips

Properties	Range
Diameter / Width	2 mm
Length	15 mm
Tensile Strength	32 N/mm^2
Flexural Strength	41 N/mm^2
Elongation	40-100 N/mm^2

V. TESTS TO BE PERFORMED ON NORMAL SOIL

A. Mix Proportion

Weighing batching is adopted and mixing combinations (total 7 nos) in the proposed work were planned

Mix Proportions

Material	Combinations				
Soil	98%	96%	94%	92%	90%
Cement	2%	4%	6%	8%	10%

Mix Proportions For Optimum Cement-Soil And Plastic Fibre

Material	Values in percentage contribution of sample		
Soil	90%	90%	90%
Cement	10%	10%	10%
Plastic	0.5%	1%	1.5%

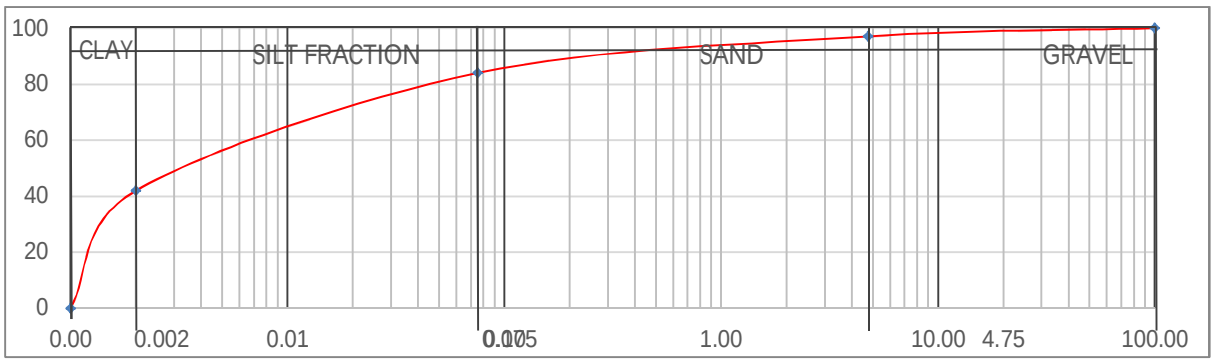
B. Wet sieve analysis

Wet sieve Analysis is a procedure that is generally used to assess the distribution or gradation of particle size of a granular material. It is also used to prepare a granular material for analysis of particle size by removing fines that may impede the process of separation.

Wet Sieve Analysis			
Sieve	Empty sieve	With sieve after oven dried	Final Reading
10 mm	67 gm	0 gm	0 gm
4.75 mm	360 gm	420 gm	60 gm
2.36 mm	300 gm	340 gm	90 gm
1.18 mm	310 gm	440 gm	130 gm
600 µ	320 gm	330 gm	10 gm
2.13mm	300 gm	320 gm	20 gm
75µ	270 gm	270 gm	10gm
Pan	280 gm	290 gm	-

Result**:** Gravel= 3% Sand = 15% Silt & Clay= 82%

C. Graph



D. Core Cutter Test

This method is used to determine the dry density of soil. It is need to determine the stability analysis of slopes, bearing capacity of soil and the design of underground structures. It is very quality control test, compaction is required.

Results: Field density of core cutter = 1.95 gm/cc

V. RESULTS AND DISCUSSIONS

A. Test And Results On Soil

Properties of Black Cotton Soil

Sr. No.	Properties	Typical range	Observed	IS code
I.	Silt & clay content (%)	40-60	82%	IS (2720-4)
II.	Liquid limit (%)	50-60	63.41	IS (2720-4)
III.	Plastic limit (%)	25-40	27.12	IS (2720-6)
IV.	Shrinkage limit	9-18	10.77	IS (2720-6)
V.	Specific gravity	2.6- 2.8	2.63	IS (2720-4)
VI.	Standard Proctor Test			
	Maximum Dry Density (g/cc)	1.4-1.8	1.749	IS (2720-7)
	Optimum Moisture Content (%)	15-30	16.4	IS (2720-7)
VII.	California Bearing Ratio (%)	2 – 6 %	2.341	IS (2720-16)

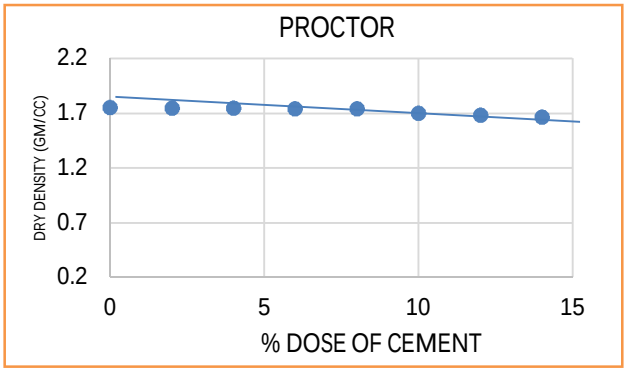
B. Test And Results On Cement Stabilized Soil

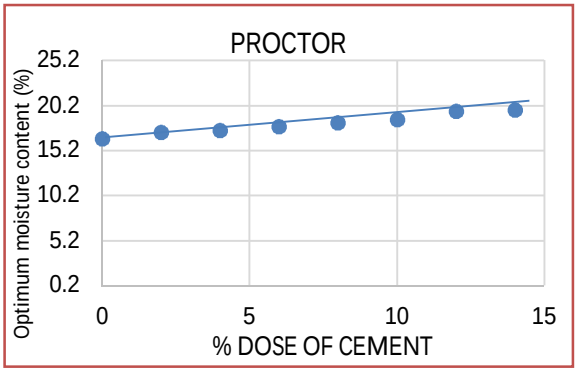
Various doses of cement are added into black cotton soil and all the tests were performed to analyses the strength of black cotton soil.

Tests On Black Cotton Soil Using Cement

Virgin Soil		Cement addition by weight				
		2%	4%	6%	8%	10%
Liquid limit	65.25	65.01	63.92	60.02	59.01	55.92
Plastic Limit	28.15	30.88	37.89	38.01	38.21	37.11
Maximum dry density	1.749 g/cc	17.22	17.41	17.86	18.22	18.60
Optimum moisture content	16.4%	1.745	1.743	1.741	1.738	1.701
IP	37.1	34.13	26.03	22.01	20.8	18.81

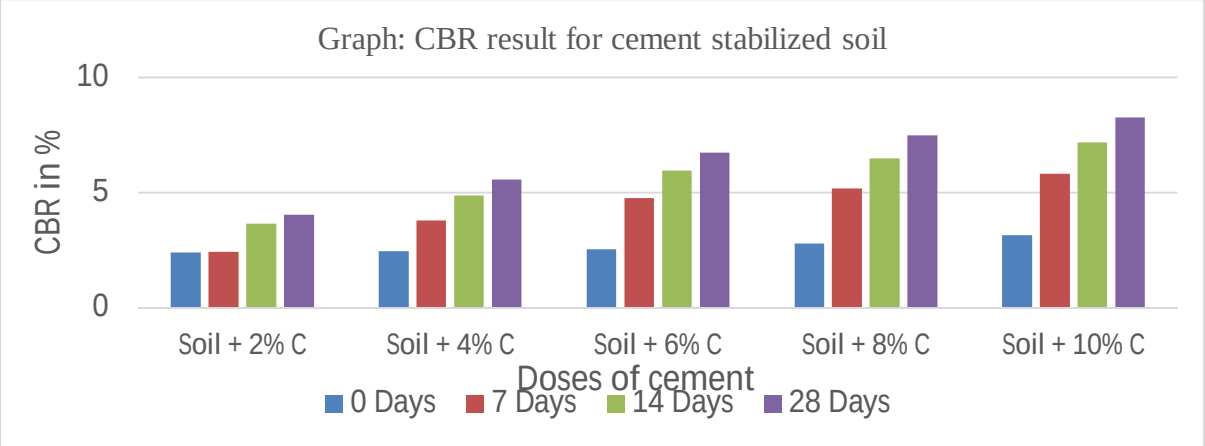
OMC & MDD





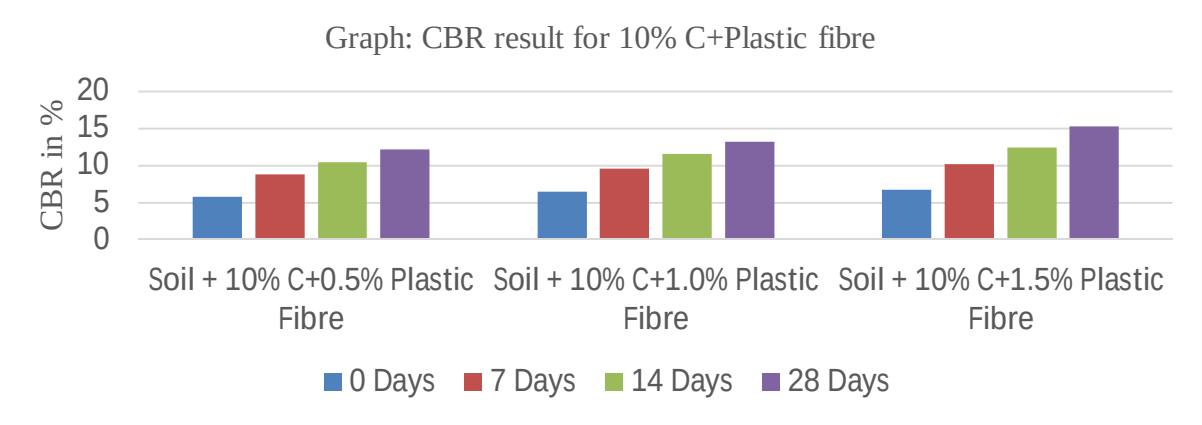
C. CBR Results For Different Doses Of Self - Contained Cement

Sr. No	Sample	0 days	7 days	14 days	28 days
I.	Soil	2.341	-	-	-
II.	Soil+ 2% c	2.383	2.431	3.652	4.028
III.	Soil+ 4% c	2.461	3.784	4.881	5.573
IV.	Soil+ 6% c	2.535	4.743	5.941	6.742
V.	Soil+ 8% c	2.787	5.179	6.476	7.474
VI.	Soil+ 10% c	3.142	5.817	7.162	8.264



CBR results for various doses of cement with soil and 0.5%,1.0%,1.5% plastic fibre

CBR result 10% with plastic fibre



Sr No.	Optimum limit	Nomenclature	0 Days (%)	7 Days (%)	14 Days (%)	28 Days (%)
I	soil +10% cement	s0+10%c+0.5%plastic fibre	5.762	8.763	10.481	12.174
		s0+10%c+1.0%plastic fibre	6.441	9.574	11.523	13.183
		s0+10%c+1.5%plastic fibre	6.763	10.217	12.446	15.286

Results Of Normal Soil With Cement

Sr.no	Nomenclature	Liquid Limit	Plastic Limit	Plasticity Index
I.	S0	65.12	28.15	36.97
II.	S0+ 2%C	65.01	30.88	34.13
III.	S0+4%C	63.92	37.89	26.03
IV.	S0+6%C	60.02	38.01	22.01
V.	S0+8%C	59.01	38.21	20.8
VI.	S0+10%C	55.92	37.11	18.81

D. Direct Shear Test

Direct shear is defined as a test which is performed to get the shear strength value of soil .Mostly test has been performed by drained and un-drained soil.

The purpose of the soil's direct shear test is to obtain its ultimate shear resistance, inner friction angle, cohesion, and deformation characteristics of shear stress.

E. Result of Direct Shear Test

Direct shear result for soil + 10% Cement & 0.5%, 1.0 % & 1.5 % Plastic waste.

Sr No.	Specimen	Load in Kg	Shear stress(kg/cm^2)
I.	Normal soil	1	0.5
		2	0.69
		3	1.21
II.	Soil + 10 % cement +0.5% Plastic waste	1	0.63
		2	0.82
		3	1.38
III.	Soil + 10 % cement +1.5% Plastic waste	1	0.68
		2	0.91
		3	1.57

Least count

Vertical gauge = 0.01mm Horizontal gauge =0.01mm

Proving gauge =0.002-5mm Calibration factor =0.262 (constant)

Dry density of soil =1.95 gm/cc Volume of mould =6*6*2.5=90cm^3

Weight of soil =1.95*90=175.5 gm

VII. RESULTS AND DISCUSSIONS

We have studied all the various tests conducted on this project. Now, here we are going to do a comparative study on plastic waste and cement mixed with the soil. Firstly, we performing tests on normal soil and another tests with plastic fiber mixed soil. We compare both the values in tests and observe the change in their properties. We noticed and came to the results that the soil which is mixed with plastics is having better strength and having good elastic properties as compared to the normal soil without any admixture.

VIII. CONCLUSION

A. Shear strength is one of the most important parameter of the soil which ultimately reflects the quality of soil.

B. When the soil was reinforced with cement and plastic fibre a rise in its shear strength was observed at a considerable rate.

C. The main aim of this project was to make the clayey soil more stable in order to sustain the applied load from getting sheared.

D. Shear strength of soil increased when the percentage of additives was changed where the change was in terms of increasing the quantity of additives.

E. Till now the tests on reinforced soil with a decided proportion is conducted and there are some variations in proportions which are yet to be made.

F. The remaining variations are to be done very shortly.

G. So, after adding the additives, shear strength parameter of soil is enhanced.

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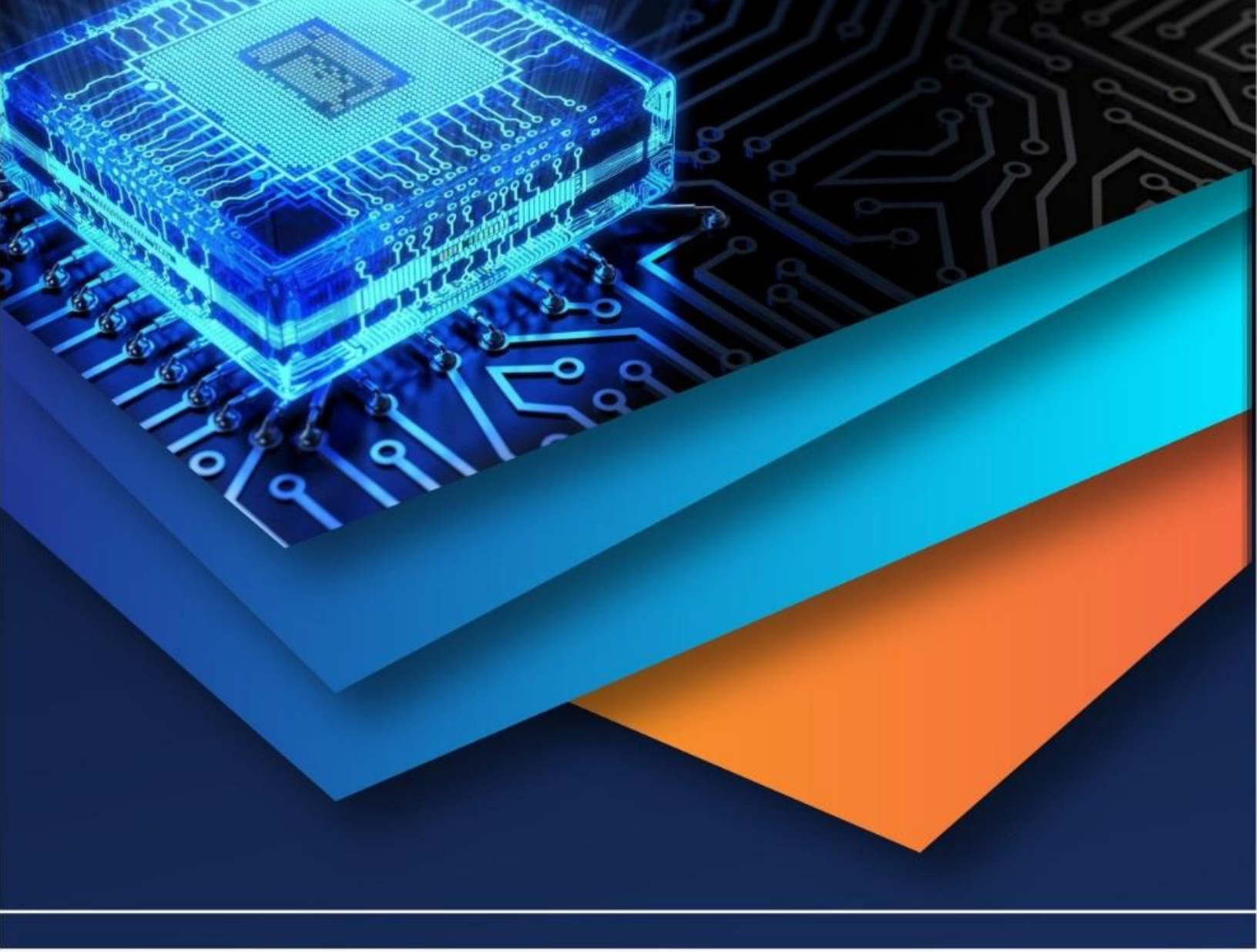

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