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Settlement Analysis of Dredged Material and Its Stabilization Using Surkhi/Brick Dust

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Abstract: ***Soil stabilization is the phenomenon by virtue of which the soils are altered to enhance their physical Properties. The process aims to increase the shear Strength of soil thus improving its load bearing capacity to support pavements and foundations. Diverse range of soil materials varying from Expansive clays to granular materials can be treated by a diverse set of Additives like silica, lime, fly-ash, cement and so on. In J&K, the most common types of soils are the alluvial soils which get deposited in river beds as a result of sedimentation. River Jhelum in J&K is one of the major hotspots for accumulated sediments with an estimate of about 36 lakh cubic meters of sediments in its river bed, leaving very little space in it to take excess water. Subsequently, it is severely threatened by the Phenomena of still higher levels of sedimentation and hence consequent Floods. Dredging practices are a challenge for the maintenance of rivers and their Spillways. In Geotechnical Engineering, the valorisation of dredging Sediments and their Use in public works is increasingly prospected by Researchers in recent Years. Moreover, Floods in Kashmir valley in September 2014 compelled the Govt. Of Jammu and Kashmir to take Necessary steps in order to avoid similar situation in near future. This project therefore intends to study the stabilization of dredged material procured from Sindh Nallah having a higher content of alluvial Soil using Surkhi/Brick dust as an additive. Soil stabilization by this means can be utilized on airport pavements, highway pavements, earthen dams and many other situations where sub-soils are not suitable for construction.***

Keywords: Sindh Nallah, Dredged material, Surkhi, OMC, MDD, CBR, Direct Shear test.

I. INTRODUCTION

Dredging operation generates a large amount of sediments which cannot be used for the construction activities because of its poor geophysical Properties such as high water content, presence of organic matter and salt. Moreover, the offshore or open dumping of the dredged soil cause environmental pollution due to the release of hydrocarbons and some heavy metal elements in the surroundings.

For the improvement of Mechanical and geophysical properties of dredged soil, stabilization technology Can be adopted. Several strategies have been employed by various scientists to alter the properties of dredged soil. For instance, modification of the properties of the dredged clay via fly ash addition to reduce its compressibility and increase its shear strength so that the soil could resist the compressive loading better.

On the basis of geotechnical investigations, treated dredged soil can be utilized as a source for various engineering applications and a stabilizer for improving behaviour of dredged soil. In this study, disturbed as well as undisturbed samples of dredged soil from Sindh Nallah were used for conducting various laboratory tests for determination of physical index and mechanical properties as per standard procedure.

II. OBJECTIVES

The present study is a step towards environment friendly and sustainable management of waste material. Keeping this notion into consideration, the two wastes viz. dredged material and surkhi are mixed to generate an eco-friendly resource to validate the following objectives:

A. To study the various geotechnical parameters of dredged material of Sindh Nallah.
B. To stabilise the dredged material of Sindh Nallah for improving its engineering properties by exploring the influence of Surkhi on tensile strength of the dredged material.
C. To explore the potential application of the so formed amalgam for different uses like filling, Embankment airport pavements, highway pavements and in road construction and in earthen dam foundations.

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III. MATERIAL USED

A. *Dredged soil*

The Soil samples both disturbed as well as undisturbed were taken from three different locations with GPS coordinates (34°.12'37"N,74°.46'20"E), (34°.32'78"N,74°.66'07"E) and (34°.34'89"N,74°.64'02"E) and undisturbed were mixed Thoroughly to have a sample of average properties. The tests were carried out as per relevant Indian Standards. The first phase of testing includes characterization of Basic Properties of Dredged Material and the second Phase includes determination of its Strength Parameters and their variation with different percentages of Surkhi.

Table-1 Basic properties of soil

S.No	Properties	Values
1	Liquid Limit (LL)	31.40%
2	Plastic Limit (PL)	22.28%
3	Plastic Index (Ip)	9.12%
4	Specific Gravity (Gs)	2.54%
5	Optimum Moisture Content (OMC)	19.5%
6	Maximum Dry Density (MDD)	1.54
7	California Bearing Ratio (CBR)	3.46
8	Cohesion of material (C)	63
9	Friction angle of material (ø)	19°
10	Unconfined Compression strength (UCS)	6.07 kg/cm^2

B. *Surkhi / Brick dust*

Brick dust with its component burnt brick powder is a waste powder generated from the burning of bricks with the soil covered by Surroundings. Due to burning of soil bricks it hardened and at the time of removal the set up we get the powder form of brick. It has Red colour and fine in nature. It has great ability to reduce the compressibility.

IV. EXPERIMENTAL WORK

A. *Preparation of Sample*

The soil sample was oven dried at approximately 105°C and then sieved using sieves having different pore sizes to separate the particles of varying sizes. The calculated amount of surkhi was added with the air-dried soil sample in small increments by hand to yield different percentages of the mix viz 0%, 7 %, 15% and 20%.All these constituents were mixed thoroughly so as to get a fairly homogenous mixture followed by the addition of required volume of water to form a wet specimen.

B. *Standard Proctor Test*

The standard proctor test was performed as per IS 2720 (Part VII) 1980. The compaction tests were done on soil and surkhi blends and the optimum moisture content(OMC) and maximum dry density(MDD) were determined at different percentages of surkhi. The required volume of water was added to the mix and the wet specimen was compacted in mould in three layers utilizing standard proctor rammer of 2.6kg to yield MDD and OMC for various samples.

C. *California Bearing Ratio(CBR) Test*

The CBR tests were executed as per IS 2720 (part-16) 1987.The test was conducted on four samples.

1) *Sample 1:* pure dredged material
2) *Sample 2:* 93% soil + 7%
3) *Sample 3:* 85% soil + 15%
4) *Sample 4:* 80% soil + 20%

The samples were prepared in a cylindrical mould of 151mm diameter and 174mm height. The Samples were experimented for each variable proportion and the samples were soaked in water for 96 hours before test was conducted. All the experiments were executed at a penetration rate of 1.25mm/min and continued until a penetration of 10mm was obtained. CBR values were calculated and the Load-Penetration curve was plotted for all the specimens.

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D. Direct Shear Test

The test was executed as per IS 2720 (part 15) 1986. The test was executed to four samples with different percentages of surkhi (0%, 7%, 15% and 20%). The soil samples were prepared in a mould having dimensions of 6×6 and the readings were taken at a following load of 0.5kg/cm^2, 1kg/cm^2 and 1.5kg/cm^2. The cohesion of material (C) and friction angle of the material (ø) was determined.

V. RESULTS AND DISCUSSIONS

According to experimental program, numerous tests were carried out on soil with various percentages of surkhi. The effects of surkhi inclusion on OMC-MDD relationship, cohesion, friction angle and CBR values were calculated.

A. Standard Proctor Test

It is observed in Table-2 and Figure(a) that with the inclusion of surkhi, the MDD increased progresively with surkhi addition. The maximum Value of MDD was obtained for a soil sample containing 20% surkhi by dry weight of the soil sample.

Table-2: OMC and MDD for soil samples containing varying quantity of surkhi

S.No	Soil %+ Surkhi%	M.D.D (g/cc)	O.M.C (%)
1	100% + 0%	1.54	19.50
2	93% + 7%	1.55	22.35
3	85% + 15%	1.58	19.92
4	80% + 20%	1.61	21.36

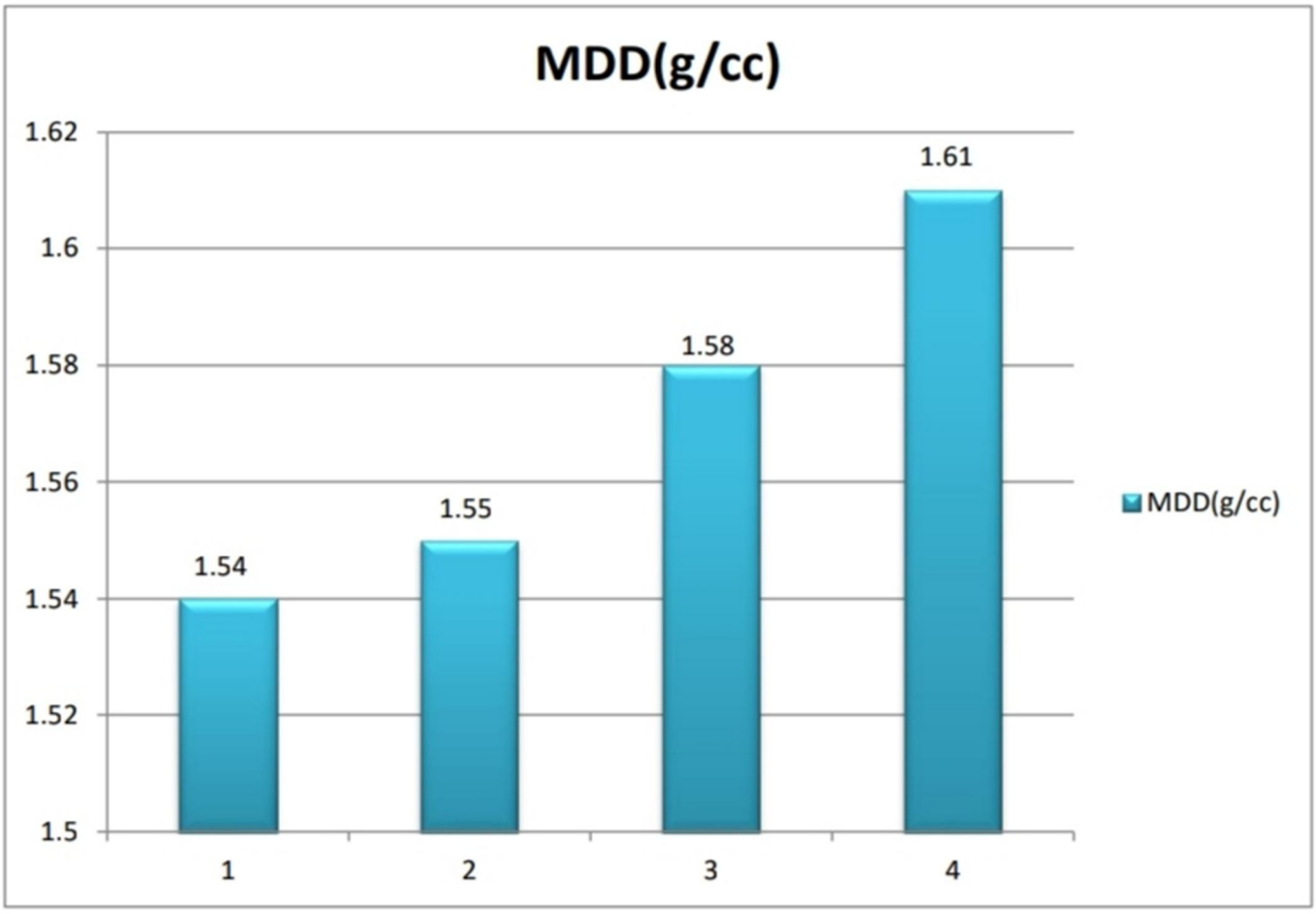

Figure (a) : MDD for soil samples containing variable percentage of Surkhi

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B. California Bearing Ration Test

The outcomes of soaked CBR test from Table 3 and Figure(b) indicated that the CBR value increased upon inclusion of surkhi. The maximum value of CBR was obtained for a soil sample Containing 80% soil+20% surkhi.

Table-3: C.B.R value for soil samples containing varying percentages of surkhi.

S.No	Soil % + Surkhi %	CBR Value
1	100% + 0%	3.46
2	97% + 7%	4.74
3	85% + 15%	7.63
4	800% +20%	8.11

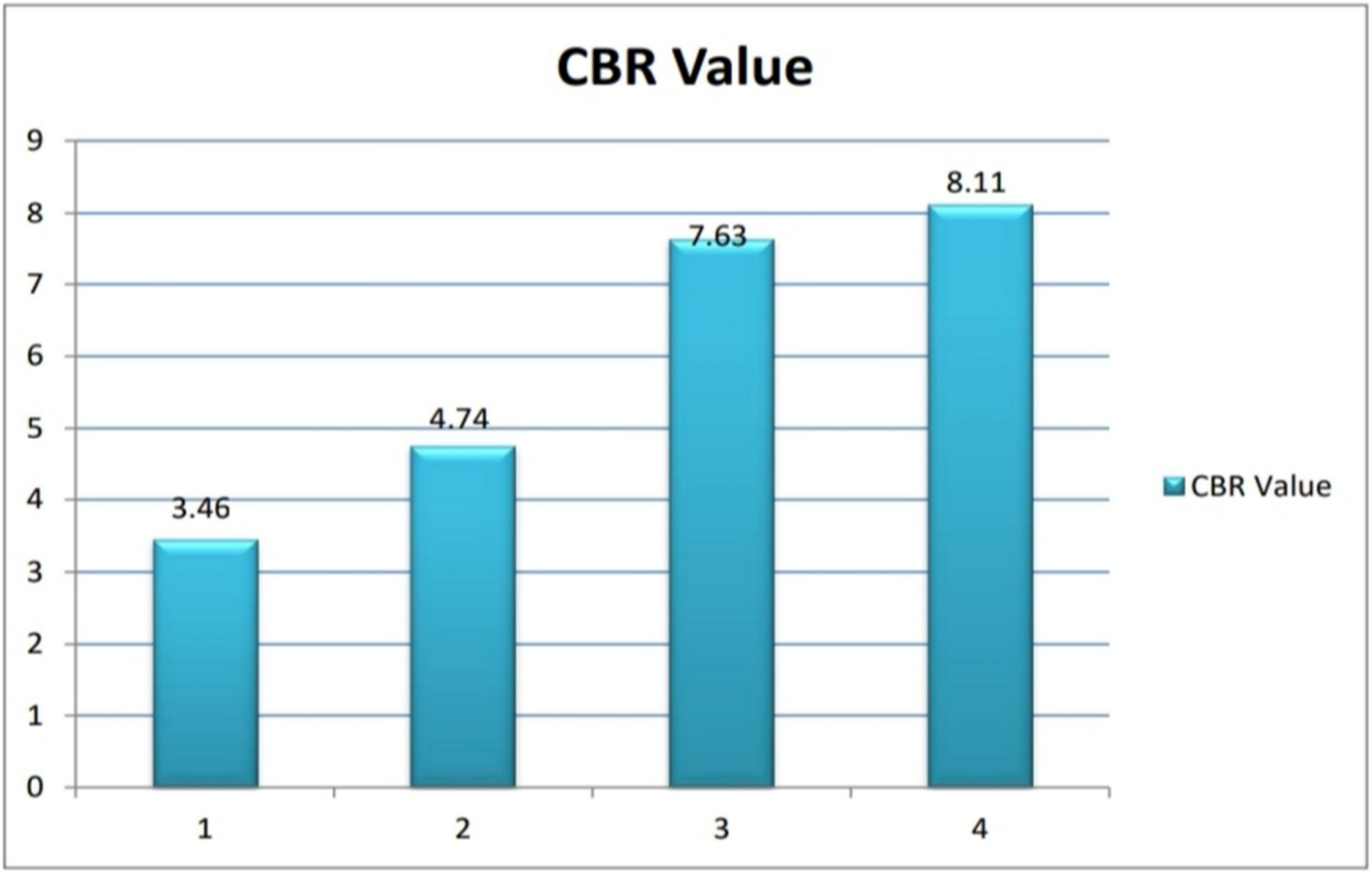

Figure (b): CBR value for soil samples with varying percentage of Surkhi

C. Direct Shear Test

It is observed in Table-4 and Figure(c) that with the inclusion of surkhi, the cohesion of soil sample and friction angle of soil sample increased.

Table-3: DST value for soil samples containing varying percentage of surkhi.

S.No	Soil% + Surkhi%	Cohesion (c)	Friction angle (ø)
1	100% + %	63	19°
2	93% + 7%	69	25°
3	85% + 15%	75	31°
4	80% + 20%	81	40°

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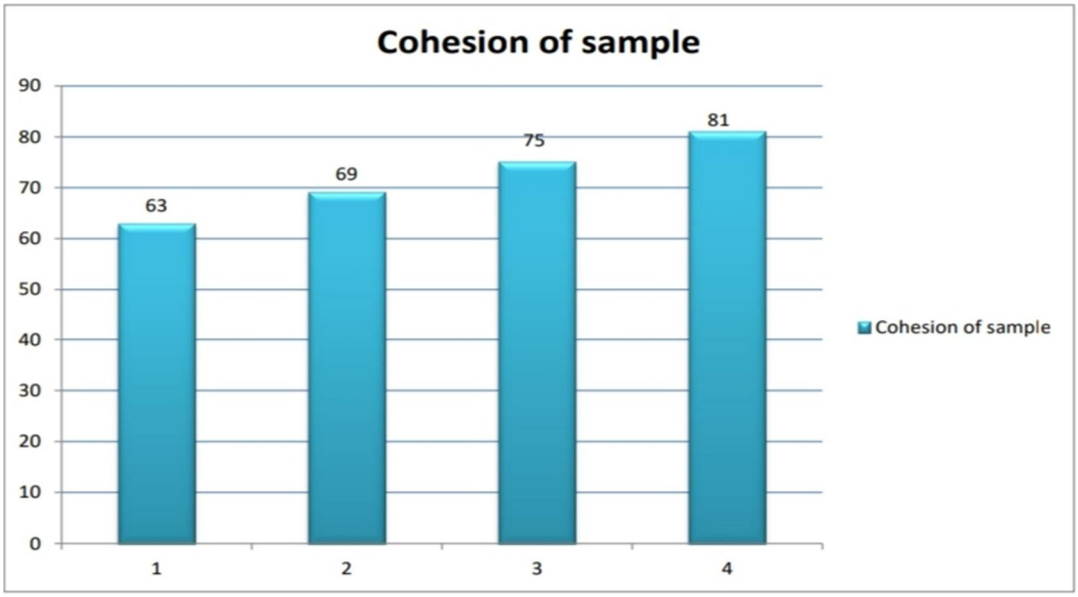

Figure (c): Cohesion value soil for samples with varying percentage of Surkhi

VI. CONCLUSION

From the above results, it is concluded that surkhi improves the engineering of Dredged material. Hence, it can be used in different construction projects like:

A. As a sub-grade material.
B. In construction of sub-base.
C. As a foundation material.
D. Construction of earthen dams and highway pavements.
E. For filling of low lying construction sites.

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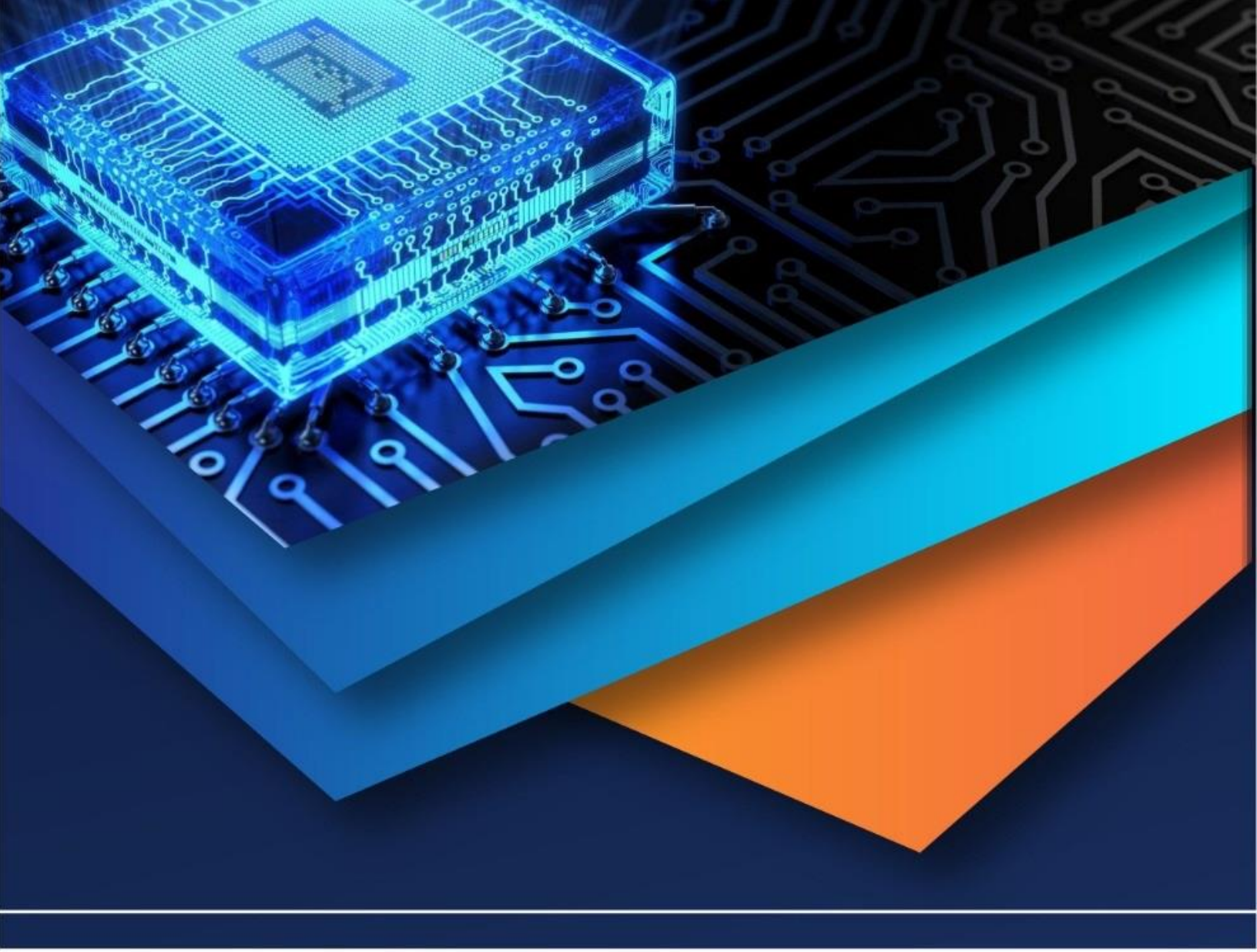

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