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Enhancement of Expensive Soil by Addition of Stone Dust and LDPE Fibre

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Abstract: Three different percentages of S.D will be incorporated in the proportions of 4%, 8% & 12%. After finding the MDD (in KN/m^3) and UCS (in KN/m^2), the Optimal Percentage of Stone Dust will be used to make a blend with the three varying percentages of LDPE (i.e. 1%, 2% and 3%) and furthermore the properties engineering properties will be checked. The length of the fibers is 6 mm respectively. In the previous years, the research on fiber reinforced soils revealed that this material is to be cost effective technique for reinforcement of sub grade soils in flexible pavements as compared to systematically reinforced soil. LDPE is an economical material that offers good physical, chemical, mechanical, thermal and electrical properties, not found in any other synthetic plastic. Keeping in view such gaps in the literature, experimental research were undertaken to study the experience of highly compressible soil- stone-dust &fiber mix for road construction.

I. INTRODUCTION

Stabilization of compressible soil is the main focus of this analysis study. This study punctuates the impact of LDPE fiber on strength characteristics of soil, shrink-swell properties of expansive soil etc. This study explores importance of Low density polyethylene fiber to bolster the strength characteristics, shrink-swell properties and tensile cracking strength of expensive soil etc. Another objective of this study is to check efficacy of Stone dust (collected from sanauli stone crusher Plant) on change in properties of soil such as, California bearing ratio, unconfined compressive strength etc.

A. Stone Dust

Stone dust has been successfully used in many engineering projects to enhance the strength characteristics of soil. Reason behind stone-dust is used in soil stabilization applications is to enhance the compressive and uni-axial strength of soil. Increase in strength of soil due to presence of high quantity of silicon oxide and alumina in stone-dust. Utilizing S.Din geotechnical engneering for reformation of soil has been wide instructed from environmental purpose. Due to rising of urban & industrial growth, reduction of industrial waste is important issue to tackle these days and going to be worse in coming year.

Table – 1.1: Index Properties of Stone Dust

Properties	Value
Natural moisture content (%)	9.11
Particle size distribution Sand (%) Silt (%)	 97.1 2.9
Specific gravity	2.76
Liquid limit (%) Plastic limit (%) Plasticity index (%)	NP NP NP
OMC (%) MDD (g/cm^3)	11.5 1.97
Angle of internal friction (degree)	35
Cohesion (kN/m^2)	0.07
CBR soaked (%) CBR unsoaked (%)	11.5 26.28

B. Low Density Polyethylene

Low density polyethylene is the second-most produced synthetic plastic after polyethylene in the world, Low density polyethylene fiber in soil shows significant changes in the shear and ultimate strength along with enhancement of other engineering properties. According to the latest statement of the market analyses company hope that the requirement of Low density polyethylene synthetic plastic is to be grown up by an average of 3% annually unto 2024. Due to increased demand of this waste material is also produced on large scale. This fiber waste can be utilized for various engineering applications such as concrete, soil stabilization etc. Introducing Low density polyethylene fiber in soil shows significant changes in the shear and uni-axial strength along with advancement of other engineering properties e.g. compaction, porosity, improve tensile cracking strength of soil, capillary absorption, resistance to weathering, filtration capacity, durability etc.

Table 1.2: Characteristics of the Low density polyethylene Fibers

S. No.	Property	Value
1.	Specific gravity	0.91
2.	Unit Wt.	0.91g /cm3
3.	Nature	Inert
4.	Breaking tensile strength	350 M pa
5.	Water absorption	Nil

Table 1.3: Physical Properties of LDPE

Properties	Values
Tensile strength	0.20 – 0.40 N/mm^2
Notched impact strength	No break
Thermal co-efficient of expansion	100 – 220 *10^{-6}
Max. Continued use temperature	65^{o}C
Melting point	110^{o}C
Glass transition temperature	-125^{o}C
Density	0.910– 0.940 g/cm^3

II. RESEARCH GAP

Under mentioned observations pulled out from the detailed scrutiny of the literature presented in the chapter

A. Comprehensive search work is reported on use of systematically & randomly distributed fiber reinforcements, this brought out the reformation of geotechnical experience of soils. However little work reports on the practice of waste LDPE mixed with S.D material and other chemical stabilizer like as lime, GGBS etc.
B. The majority of works carried out in the area of sub-base or base correction of the various types of pavements using fiber to overcome erosion & loading effect and S.D to increase strength & index properties of soil. Less work has been done, utilizing LDPE fiber and Stone dust for progress of the engineering properties of soils. Consequently, a capacitance of systematical investigation study in this area is required.
C. Research on to HDPE has been done in abundance. But a lesser amount of research has been done on LDPE that too has not been done in combination with Stone Dust. Although this material is present in plenty.

III. OBJECTIVES

A. To study the effect of stone dust and LDPE on index and geotechnical properties of the soil.
B. To study application of waste material.
C. To study the compaction characteristic of clayey soil and soil mixed with stone dust, LDPE (for different properties).

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IV. METHODOLOGY

Table 1.4: Properties of Soil

S.No.	Properties	Value
1	Color	Light Brown
2	Liquid Limit (%)	35
3	Plastic Limit (%)	16
4	Specific Gravity	2.6
5	Gravel Size (>4.75mm)	0
6	Sand Size (0.075-4.75mm)	61%
7	Silt Size (0.002-0.075mm)	31%
8	Clay Size (<0.002mm)	8%
9	Maximum Dry Density (gm/cc)	18.9
10	O.M.C. (%)	9.17
11	U.C.S Value (kg/cm^2)	1.73
12	C.B.R Value (%) unsoaked	10.56
13	C.B.R Value (%) soaked	5.59

A. *Optimum Moisture Content and Maximum Dry Density along with Unconfined Compressive Strength (UCS) Variations*

Table – 1.5: Determination of OMC (in percentage) and MDD (KN/m^3) for Virgin soil

S No	Moisture Content (in Percentage)	Dry Density (in KN/m^3)
1	8	17.8
2	10	17.9
3	12	17.2
4	14	17

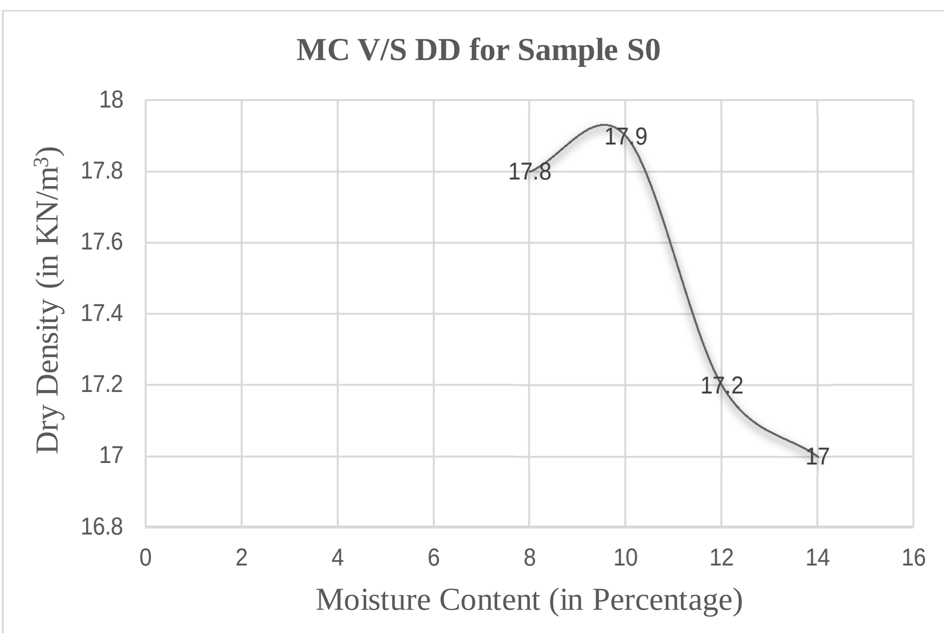

Fig. 1.1: MDD for S0 Sample

Table 1.6: Test result for OMC and MDD (Using Stone Dust)

S. No.	Stone dust + LDPE (%)	OMC (%)	MDD (KN/m^3)
S0	0+0	10.5	17.4
S1	4+0	10.1	17.8
S2	8+0	9.8	18
S3	12+0	9.6	18

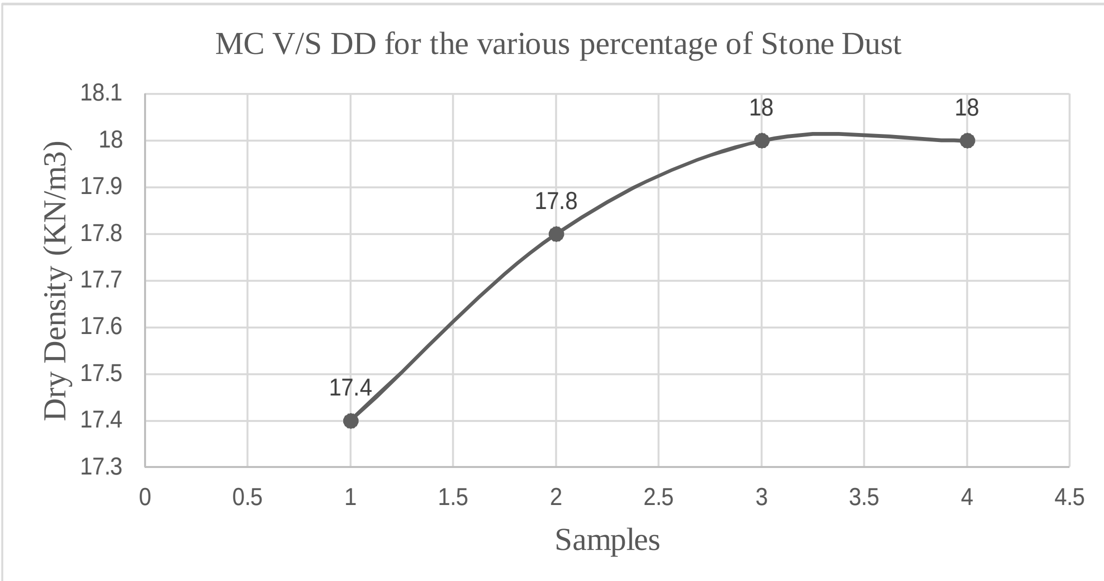

Fig – 1.2: Determination of optimum moisture content

B. *Unconfined Compressive Strength (UCS) Variations Using Stone Dust*

Table 1.7: Variation in UCS using stone dust in different percentages

S. No.	Stone dust + LDPE (%)	UCS (KN/m^2)
S0	0+0	173
S1	4+0	300
S2	8+0	351
S3	12+0	349

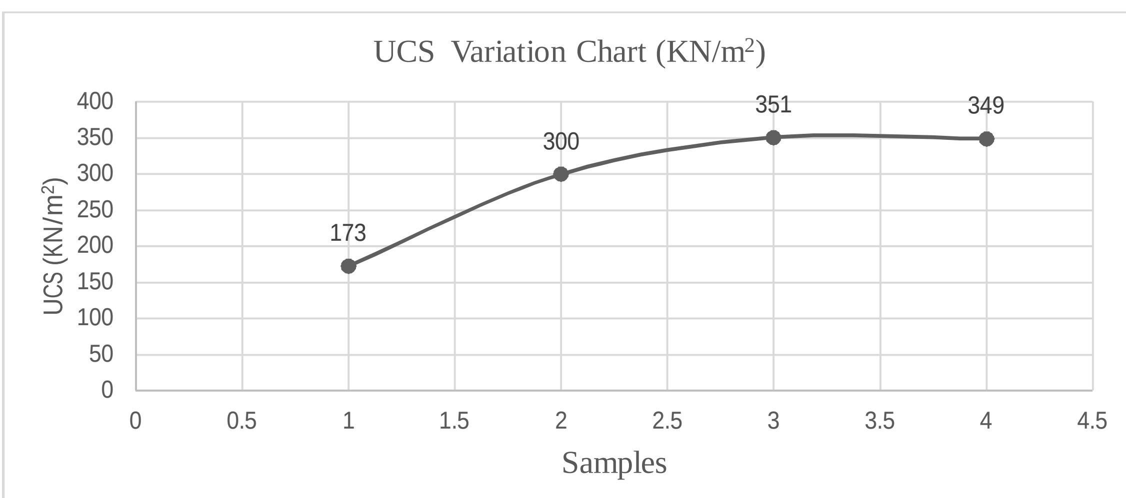

Fig 1.3**:** Variation of UCS with respect to SD

C. Determination of OMC (%) and MDD (KN/m^3) Using Optimal Stone Dust and LDPE

Table 1.8: Test result for OMC and MDD (Using Stone Dust)

S.No.	S.D + LDPE (%)	OMC (%)	MDD (KN/m^3)
S4	9+1.0	9.7	17.9
S5	9+2.0	9.8	18.3
S6	9+3.0	10.0	18.1

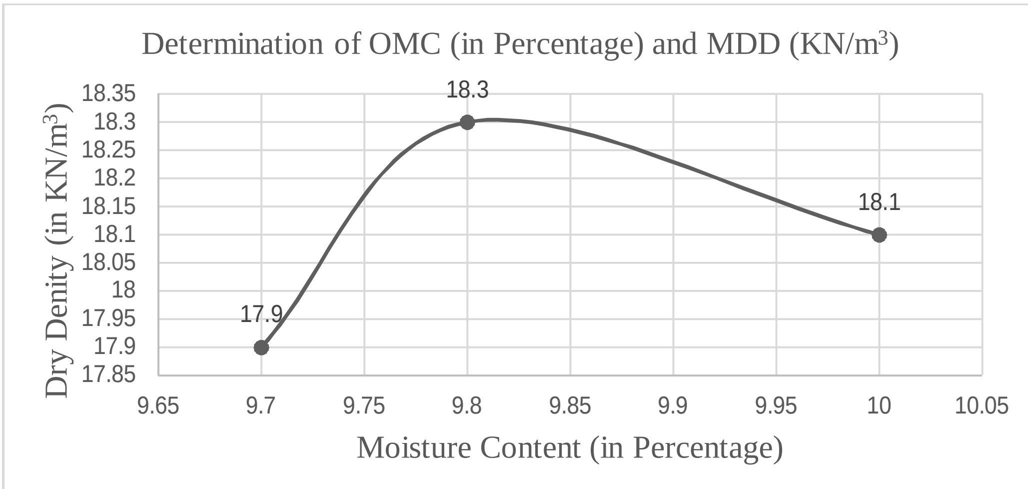

Fig 1.4**:** Variation of OMC (%) and MDD (KN/m^3) w.r.t. Optimal SD and Varying Percentage of LDPE

D. Unconfined Compressive Strength (UCS) Variations Using Optimal Stone Dust and Varying Percentages of LDPE

Table 1.9: Variation in UCS using optimal stone dust and Varying Percentage of LDPE

S. No.	S.D + LDPE (%)	UCS (KN/m^2)
S4	9+1.0	421
S5	9+2.0	461
S6	9+3.0	460

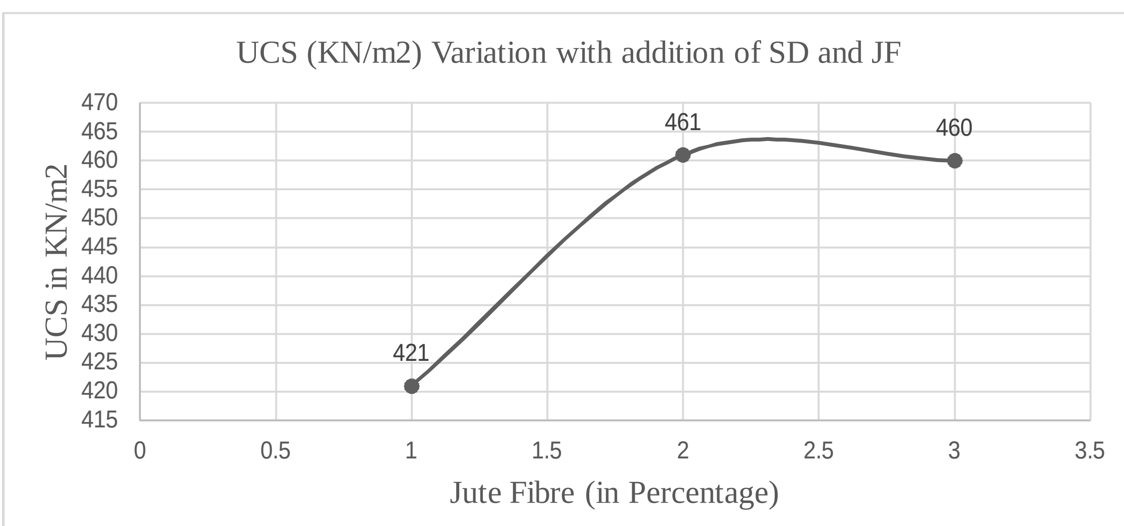

Fig 1.5**:** Variation of UCS w.r.t. Optimal SD and Varying Percentage of LDPE

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E. CBR Test Result For Soil Treated with S.D +LDPE Mix

IS 2716-16 (1987) has been followed for the test, the results are tabulated below;

Table 1.10: Test results of Un-soaked and soaked CBR

S.No.	S.D + LDPE (%)	CBR (in Percentage)	
		Un-soaked	Soaked
S0	0+0	4.8	3.6
S3	9+0	7.1	5.6
S5	9+2.25	7.2	5.7

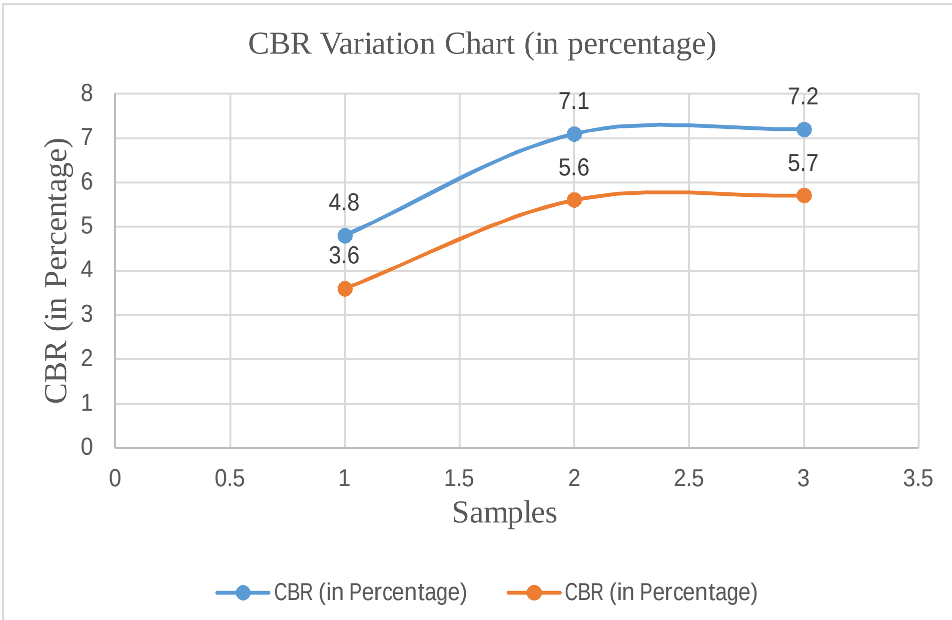

Fig. - 1.6: showing variation in soil properties when treated with S.D and LDPE

V. RESULTS AND DISCUSSION

From the present study, the following outcomes have been observed:

A. The Optimum value of MDD against the moisture content is achieved (MDD increased by 8.0 percentage higher compared to virgin soil), when soil is blended with 9% Stone Dust (Sample S3). In addition, combinations of optimum Stone Dust (i.e. 9 %) and LDPEs (i.e.2.25%) have shown further more increase of 9 percent as compared to virgin in MDD.

- Reason: the probable reason of the increase in Maximum Dry Density of the soil by addition stone dust and LDPE is due to proper rearrangement of soil particles and addition of non-plastic material, which improve the binding capacity.

B. The California Bering Ratio value for virgin soil was evaluated as 4.8 percent for un-soaked and 3.9 percent for soaked sample. The blend of 9 percent Stone Dust (Sample S3) has helped in achieving the Maximum Value of 7.1 percent (Nurture of 48 percent) for un-soaked and 5.6 percent (Nurture of 43.5 percent) for soaked sample. In addition, combinations of optimum Stone Dust (i.e. 9%) and optimal LDPEs (i.e.2.25%) have shown further more increase in CBR percentage of 7.2 percent (Nurture of almot 50 percent) for un-soaked and 5.7 percent (Nurture of almost 45 percent) for soaked sample.

- Reason: the probable reason of the increase in CBR value of the soil is by addition stone dust in comparison with the original Soil may be due to the increase in density of modified Soil mass having more strength.

C. The Unconfined Compression Strength results have shown the raise of curve with the adding percentage of SD and LDPE. With the addition of 9 percent stone dust, value of UCS increased to 352 KN/m^2 i.e. Raise of 110 percent compared to the virgin soil UCS value, Furthermore, addition of the blend of both Optimal stone Dust (9%) and LDPE (2.25%), UCS increased to 465 KN/m^2, results in raise of 170 percent with respect to virgin soil and 3.5 percent compared to the maximum value of LDPE blend.

VI. CONCLUSION

Based on the studies carried out following are the conclusion drawn:

A. Stone dust a product from crusher unit consists of mainly sand size particles and is having good C.B.R. value. Thus, the stone dust itself can be considered as a good sub base material. Hence it can be used for construction of road embankment.
B. From the compaction studies out on stone dust, it is found that the maximum dry density and optimum moisture content relationship is fairly flat at peak values. Hence the variation in water content as compared to optimum moisture content leads to marginal change in maximum dry density.
C. The information based on the studies carried out will be useful for the design and construction of sub grade, embankment and structural fills for utilization of stone dust as a stabilizing agent.
D. Stone dust and LDPE has high specific gravity and the soaked CBR value for standard compaction is more. This indicates that stone dust can be used as an embankment material, backfill material for the lower layer of sub base. Also reuse of this waste material is economically advantages and does not bring any environmental hazards.
E. As the CBR value of stone dust and LDPE is more, the crust thickness of flexible pavement is less and it is economical in construction of road, highways.

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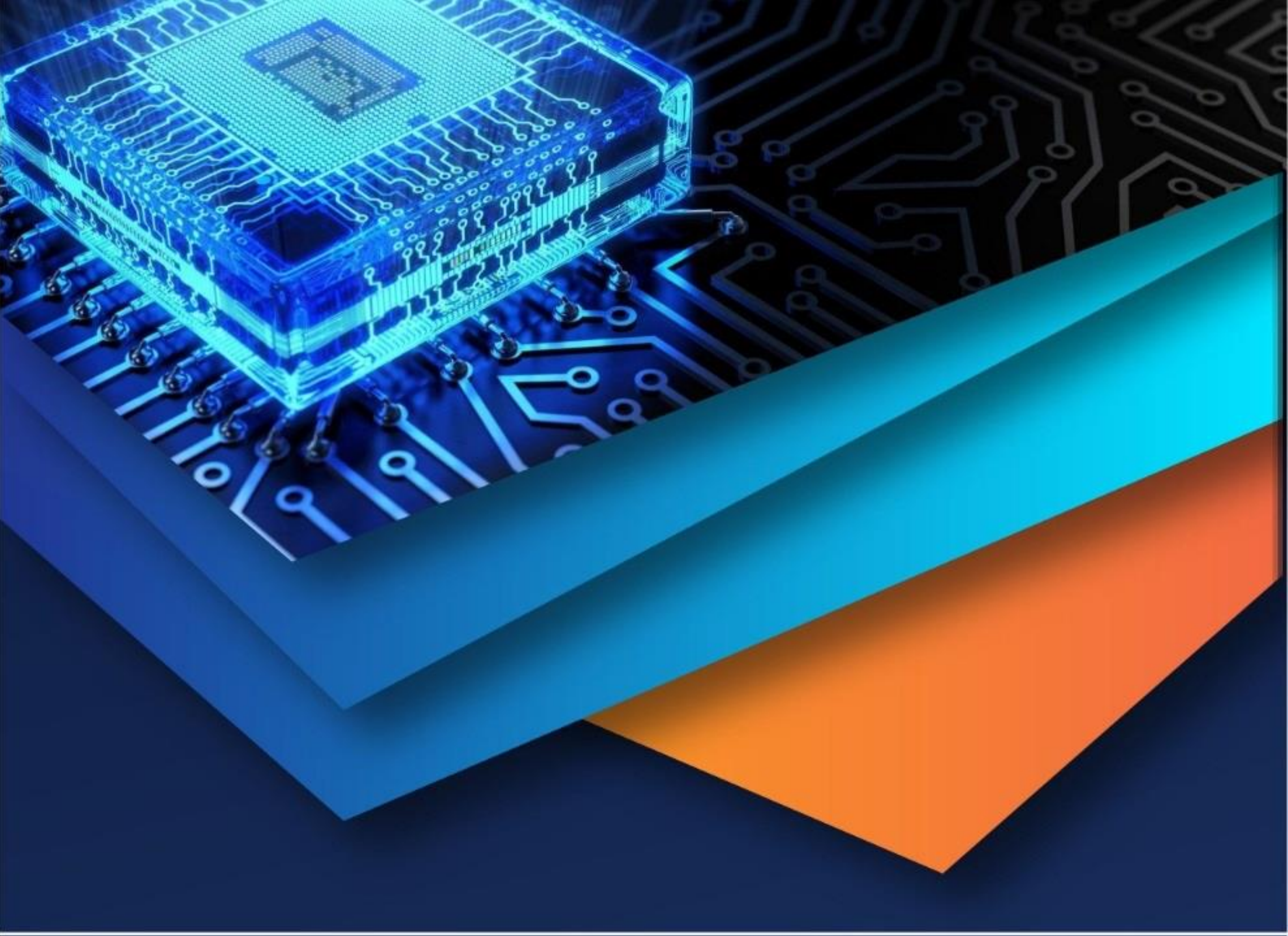

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