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Weight Reduction and Strengthening Of RC Beam Using CFRP and GFRP Layers by ANSYS 15.0

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Abstract: ***The current paper focuses on the study of RC beam with FRP as external layers. CFRP and GFRP as FRP materials are considered during the current work to study their behaviour on the deformation, strain and weight by means of ANSYS 15.0. Different geometries of concrete beam are drawn having numbers of laminates of FRP, considering all the geometries have outer dimensions. Effect of number of layers is also correlated with control beam having no FRP layers. The outcomes specify that total deformation decreases after giving FRP layers within the reinforced concrete. Total of maximum strain developed into the beam is also appeared to be decreases with accumulation of FRP layers and beam having three FRP layers shows minimum maximum strain. Among the Two FRP materials (CFRP and GFRP) considered CFRP shows better results correlated to the GFRP. Results also reveal that with increment in the load applied, beam through CFRP as external layer shows better performance correlated to all other cases.***
Keywords: CFRP, GFRP, Deformation, Strain, Weight, Reinforced Beam, ANSYS 15.0.

I. INTRODUCTION

Maintenance of concrete members with covering FRP sheets grant an extra cost-effective and precisely superior substitute to the usual techniques in several situations as of its offers huge strength, less weight, corrosion resistance, fatigue resistance, simple and swift installation and slightest change in infrastructural geometry. In addition, FRP manufacturing offers an exclusive chance intended in favor of the improvement of shapes as well as forms that would be difficult or impractical by the usual materials. Even if the fibers used in FRP are quite costly correlated with conventional strengthening materials, labor and equipment costs to establish FRP methods are often lower. FRP methods could moreover be useful in areas with limited contact where usual techniques would be impossible. Retnam et. al. [2] they observe material properties of GFRP and CFRP material. Raj [3] studied examination for increase the flexural and shear ability of RC beam by GFRP and CFRP. Musmar et. al. [4] intends to revise the action of RC beams as subjected to oblique loading. More et. al. [5] paper informs us about the flexural performance of AFRP strengthen reinforced concrete. Antony et. al. [6] investigated the external work on the strength parameter of concrete beam by ANSYS. Rao et. al. [7] worked on the assessment of act of ordinary concrete and fibre reinforced regular. Vasudevan et. al. [8] worked on FE designing of RC beams by means of ANSYS 12.0. Sobuz et. al [9] investigational the flexural act of RC beams strengthened with CFRP laminates. Pannirselvam et. al [10] work objective be to assess the structural performance of RC beams with exteriorly bonded FRP strengthening. Correia et. al. [11] analyzed on structural presentation of GFRP hybrid beam. Subramani et. al. [12] worked on a systematic study to observe the act of concrete beams bonded through strengthened Glass Fiber-Reinforced Polymer (GFRP).

II. OBJECTIVE & METHODOLOGY

To do this FE software like ANSYS be utilized. Design and dimensions of the beam are taken from literature. After that appropriate boundary conditions like load acting on the beam and fixed support are applied. Then the consequences of FRP layers (GFRP and CFRP) are studied in the ANSYS software by giving added layers on concrete beam. Study of weight assessment is also conducted.

III. MATERIALS

All the properties are taken from literature I reviewed.

TABLE I CONCRETE PROPERTIES

Properties	Values found in laboratory
Density (kg/m^3)	2300

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Compressive strength (MPa)	36.0
Modulus of elasticity (GPa)	28.6
Ultimate/Splitting tensile strength (MPa)	2.95
Poisson ratio	0.18

TABLE II STEEL PROPERTIES

Reinforcement type	Yield strength (MPa)	Modulus of elasticity (GPa)
Tension, T10	482	195
Compression, T6	470	186
Shear, R6	215	200

TABLE IV CFRP & GFRP LAMINATES PROPERTIES

	Values	
Property	CFRP	GFRP
Sheet form	Uni-directional roving	Uni-directional roving
Yield strength (MPa)	1315	1400
Modulus of Elasticity (GPa)	165	45
Elongation at ultimate (%)	2.15	3.1
Design thickness (mm)	1.2	1.2
Tensile strength (MPa)	1685	1410
Density (Kg/m^3)	1600	2100
Poisson ratio	0.28	0.28

IV. MODELING

Figure 1 below displays the exaggerated look of the bottom side where the FRP as external layers has given. Figure 2 displays the Cross-sectional and 3D look of the control beam. Figure 3 displays the meshing in geometry of beam. Table 5 displays the dimensions of the all the four geometries.

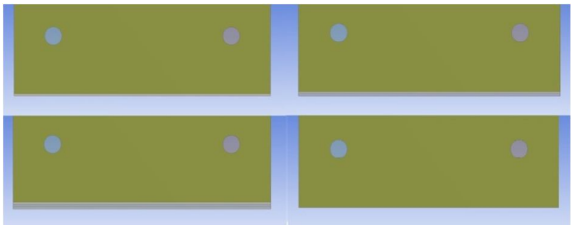

Fig. 1 Exaggerated view of the control beam and beam with FRP layers

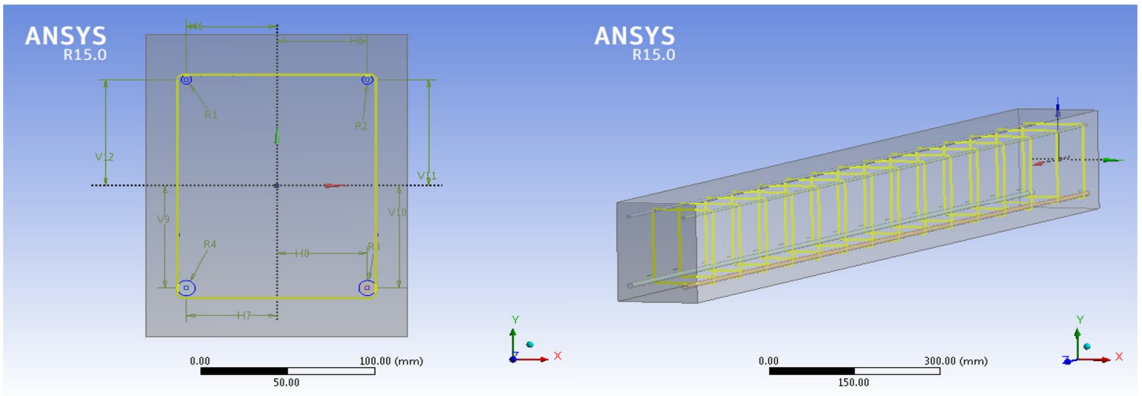

Fig. 2 Cross-sectional and 3D look of the control beam

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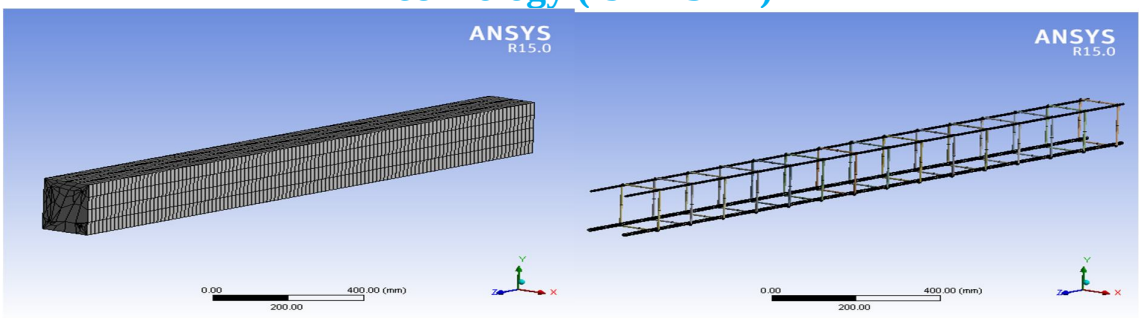


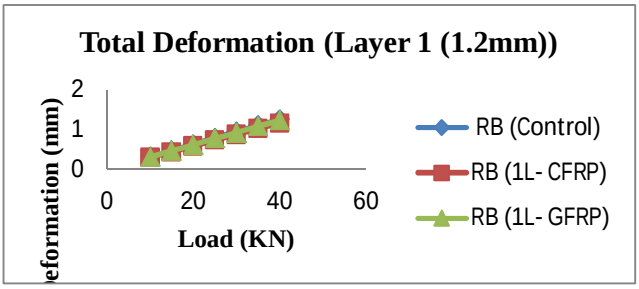
Fig. 3 Meshing in geometry of beam

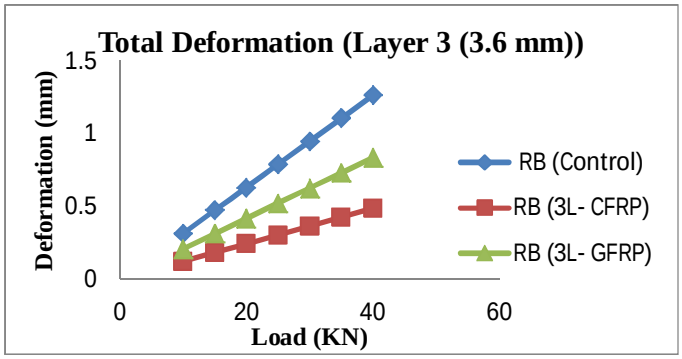
TABLE V DIMENSIONS OF GEOMETRIES DRAWN

Dimensions	RB (control)	1L- FRP	2L-FRP	3L-FRP
Length	1900	1900	1900	1900
Height	200	198.8+1.2	197.6+1.2+1.2	196.4+1.2+1.2+1.2
Width	150	150	150	150

V. TEST RESULTS AND DISCUSSION

Figure 4 represents the assessment of the amount of total deformation generated among the different beams considered in the current work. Load is varied from 10kN to 40kN by a difference of 5. It could be detected from the figures that there is not much deviation amid the total deformation generated for 1L-FRP beams correlated to control beam, but for 2L-FRP and 3L-FRP beams distinction among the deformations generated could be easily observed. It can also be monitored as of the figures that CFRP reinforced beam shows less deformation generation as considered to GFRP reinforced beam. It can also be detected that with increment in the load applied total deformation generated in the CFRP reinforced beam is less correlated to GFRP reinforced beam. 3L-CFRP shows slightest amount of total deformation generated contemplated to all the cases considered in the current work.





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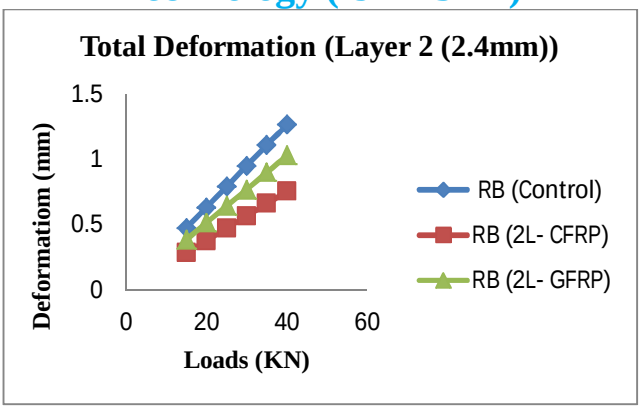
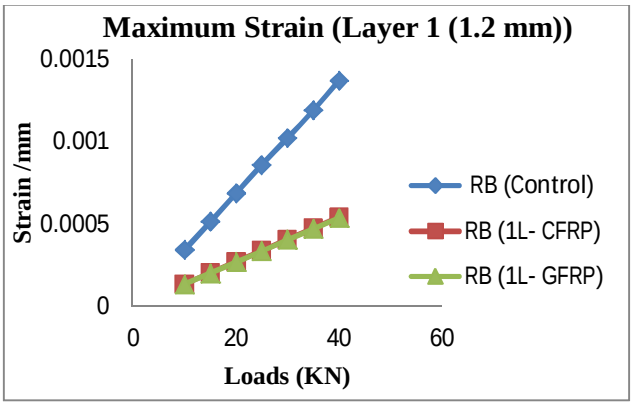
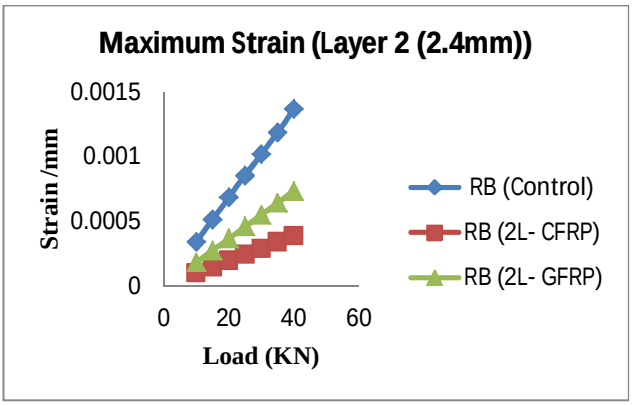


Fig. 4 Effect on total deformation

Figure 5 represents the assessment of the amount of maximum strain generated. Load is varied from 10kN to 40kN with a difference of 5. It can be detected from the figures that for 1L-FRP beams quantity of strain generated is reduced correlated to strain generated in the control beam, and not much divergence among the maximum strain for CFRP and GFRP beam is observed. It could also be detected from the figures that CFRP reinforced beam shows less maximum strain generation correlated to GFRP reinforced beam. It could moreover be observed that with increment in the load applied maximum strain generated in the CFRP reinforced beam is less compared to GFRP reinforced beam. 3L-CFRP shows slightest amount of maximum strain generated compared to all the cases considered in the current work.





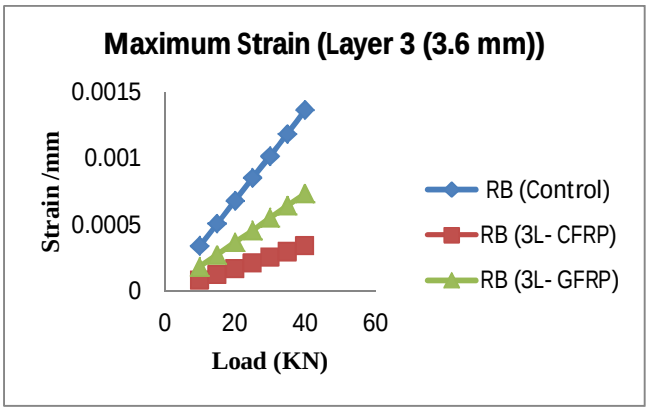


Fig. 5 Effect on maximum strain

Figure 6 shows the weight evaluation of the all the cases studied in the current work. It can be detected from the figure that by giving the FRP layers total weight of the beam is decreasing. It can also be examined that CFRP reinforced beam shows least weight correlated to the GFRP reinforced beam. 3L-CFRP shows slightest amount of weight for the similar outer dimensions of

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the beam correlated to all cases considered.

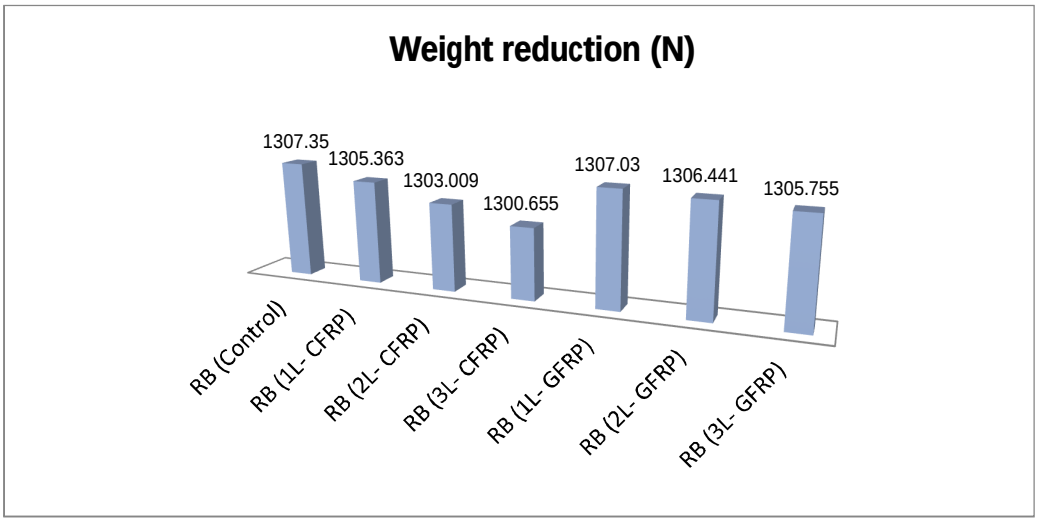

Fig. 6 Weight Comparison

Figure 7 displays the amount of total deformation generated for control beam (RB), 3L-CFRP and 3L-GFRP. One can notice the amount of total deformation generated in the beam. It can notice that 3L-CFRP beam has slightest amount of deformation generated in it, correlated to control beam and 3L-GFRP beam.

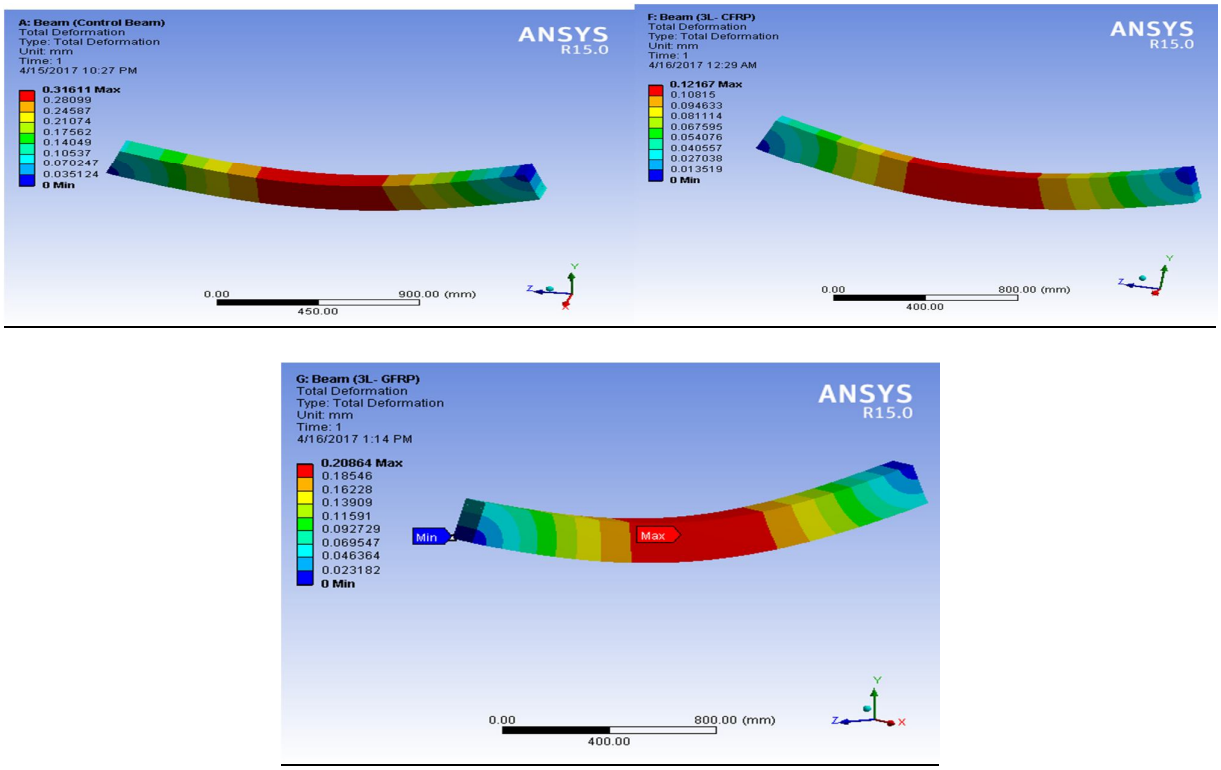

Fig. 7: Total deformation generated for control beam, 3L-CFRP and 3L-GFRP

Figure 8 displays the amount of Maximum strain generated for control beam (RB), 3L-CFRP and 3L-GFRP. One can notice the sum of Maximum strain generated in the beam. It can notice that 3L-CFRP beam has slightest amount of strain generated in it, compared to control beam and 3L-GFRP beam.

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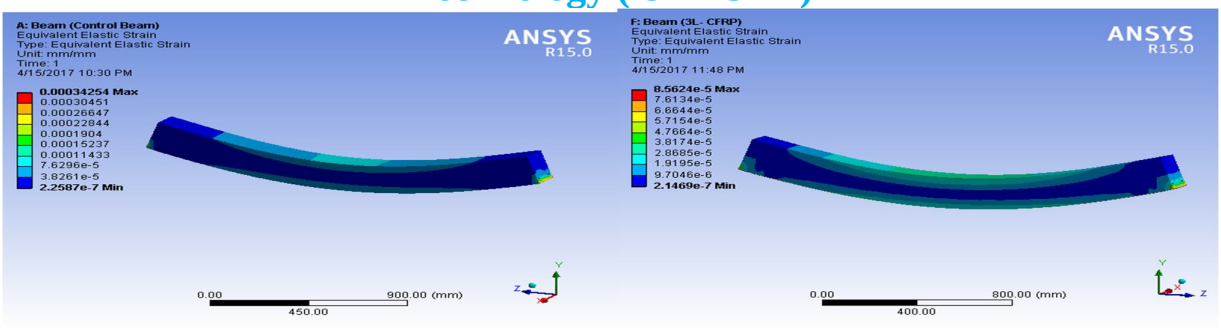

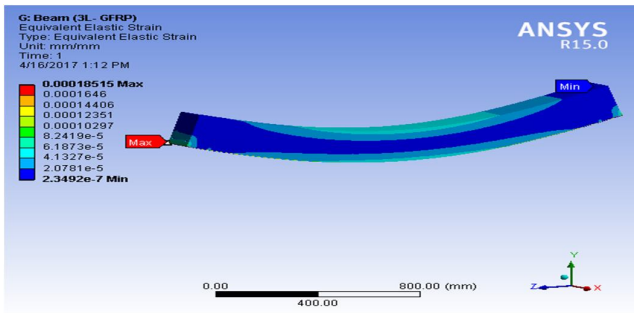

Fig. 8: Maximum strain for Control beam, 3L-CFRP and 3L-GFRP

VI. CONCLUSIONS

Based on the ANSYS 15.0 WORKBENCH test results, the subsequent conclusion can be made

A. CFRP laminates can be used effectively to strengthen the RC beams. Varying from width of FRP layer it reduced the deflection of beam between 8% - 62%.

B. CFRP layer it reduced the equivalent elastic strain between 61% -76%.

C. GFRP layers also reduced the deflection between 3% - 35%, but less as correlated to CFRP laminates.

D. 1L-GFRP results in the strain reduction of approximately 42%, but for 2L-GFRP it lessens to 42% because of low elastic modulus as compared to CFRP laminates.

E. Replacement of concrete by CFRP and GFRP layer results in reduction of weight.

F. In common, CFRP layers are best as compared to GFRP laminates for the strengthening of RC member.

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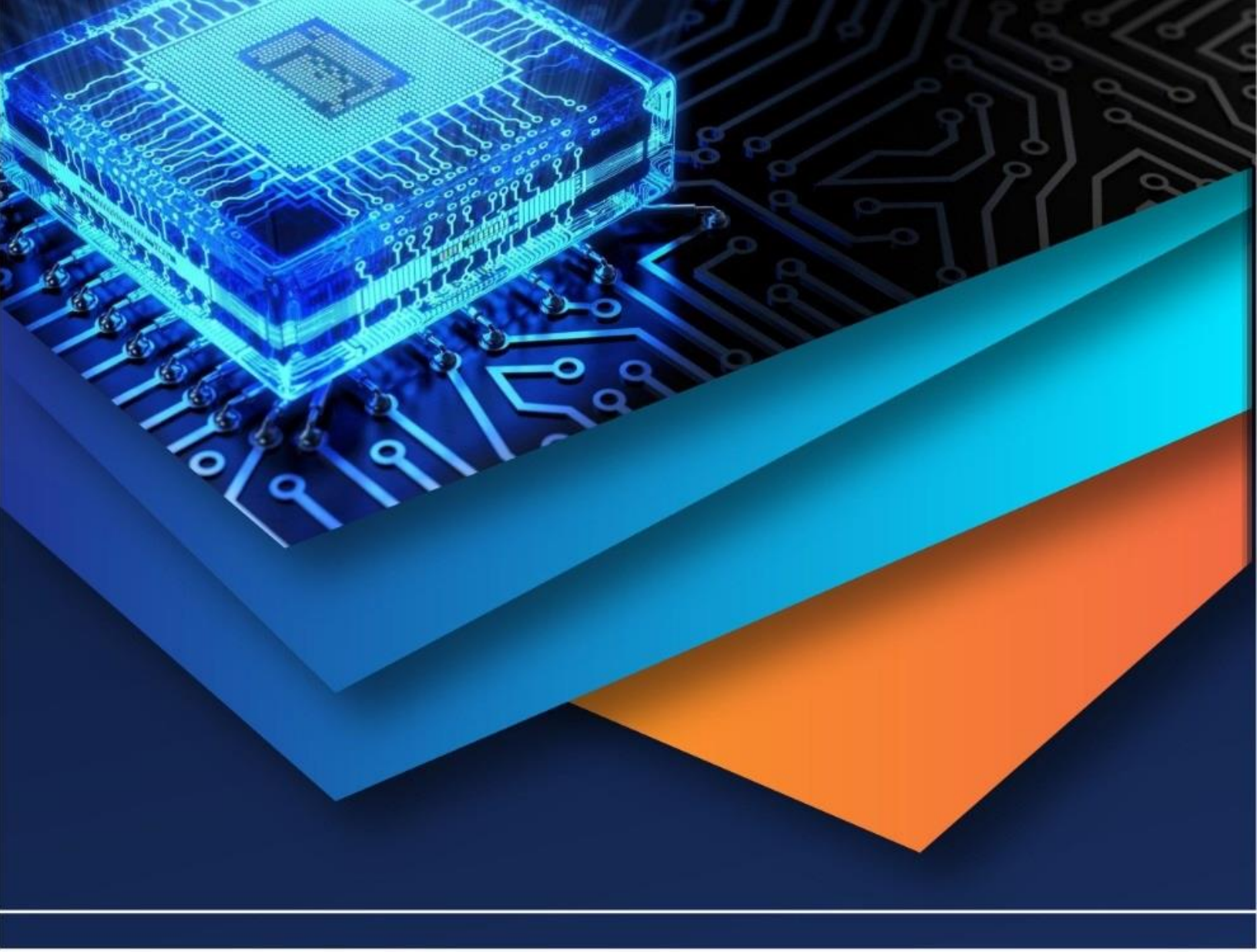

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