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Fault Diagnosis of Horizontal Axis Turbine with Different Twist Angle to Reduce Stress under Failure Thrust Force

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Abstract: Five types of configurations of tidal turbine blade including validation model have been considered with different profile tidal turbine blade with twist angle of 9, 10, 10.5, 11, 11.5 and 12 degrees. An optimized model of tidal turbine blades is developed. The simulation of the optimized model i.e. 12 degree twist angle gives minimum value of stress and deformation at different loads i.e. 441, 271, 272 and 610N which has optimized and converged result compared to respected models of tidal turbine blade, it has also been observed that stress and deformation was reduced at static load of 610N in 12 degree twist angle tidal turbine blade with the Zylon, Kevlar and CFRP material, thus the observed fault is diagnosed in this present research work. The configuration of optimized model gives maximum convergence on all parameters amongst all the configurations used.
Keywords: Tidal turbine blade, Twist Angle, Stress, Deformation, Thrust Force.

I. INTRODUCTION

A. Tidal Energy

Tidal electricity is a form of hydropower that converts power acquired from tides into useful forms of strength, which includes electricity. Tides are created by way of the gravitational effect of the moon and the sun on this planet inflicting cyclical motion of the seas. One of the strengths of harnessing strength from tidal tiers and tidal streams over different types of renewable power is that the manner is totally predictable.

Tidal variety technologies make use of the vertical difference in top among high tide and low tide. Projects take the form of tidal barrages or lagoons that use turbines in the barrier or lagoon to generate electricity as the tide floods right into a reservoir. When the tide outdoor the barrier recedes the water retained can then be released via generators, which generates power.

II. TYPES OF TIDAL TURBINE

A. Horizontal Axis Turbine

Horizontal axis generators extract strength from shifting water in tons the same manner as wind generators extract electricity from shifting air. The tidal circulate causes the rotors to rotate across the horizontal axis and generate energy.

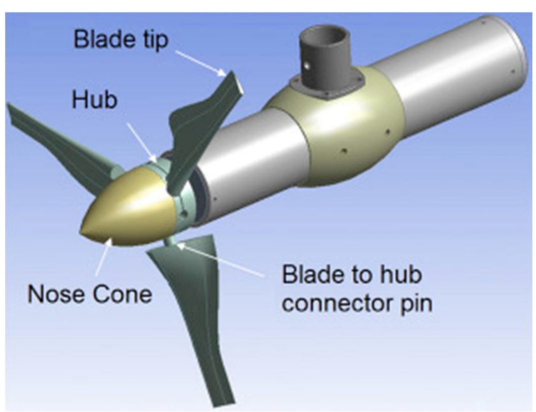

Figure – 1: Horizontal axis turbine

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B. Vertical Axis Turbine

Vertical axis mills extract electricity from the tides in a comparable manner to that above, but the turbine is installed on a vertical axis. The tidal flow causes the rotors to rotate across the vertical axis and generate electricity.

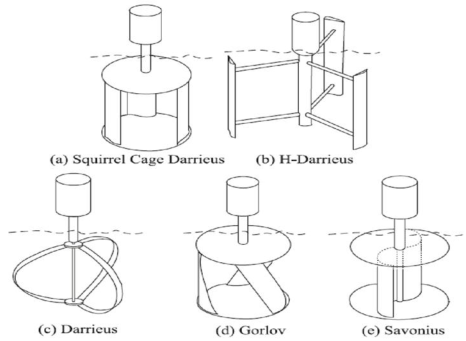

Figure – 2: Vertical axis turbine

C. Oscillating Hydrofoil

A hydrofoil is attached to an oscillating arm. The tidal present day flowing both side of a wing consequences in carry. This movement then drives fluid in a hydraulic machine to be transformed into electricity.

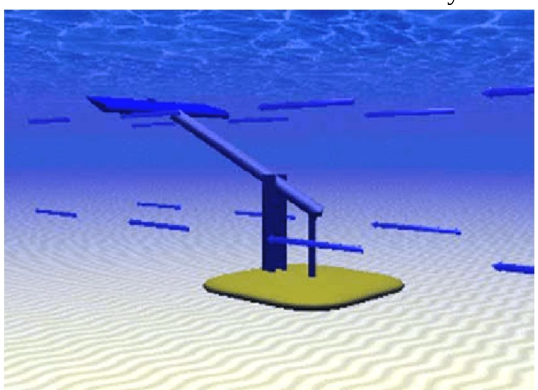

Figure – 3: Oscillating hydrofoil

D. Enclosed Tips (Venturi)

Venturi Effect devices residence the device in a duct which concentrates the tidal flow passing through the turbine. The funnel-like collecting tool sits submerged inside the tidal modern-day. The float of water can power a turbine without delay or the precipitated stress differential within the system can pressure an air-turbine.

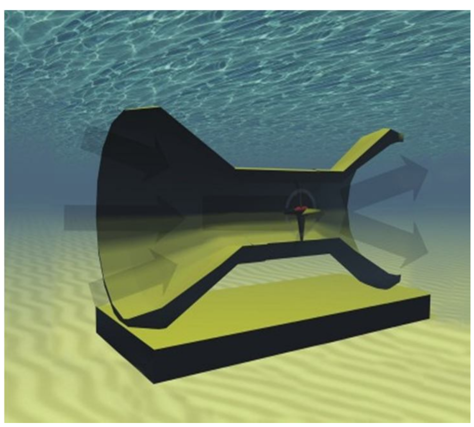

Figure – 4: Enclosed tips (Venturi)

E. Archimedes Screw

The Archimedes Screw is a helical corkscrew-fashioned tool (a helical surface surrounding a vital cylindrical shaft). The tool attracts energy from the tidal flow because the water actions up/via the spiral turning the generators.

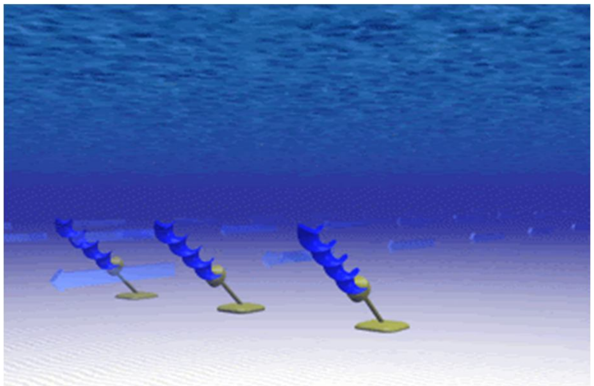

Figure – 5: Archimedes screw

F. Tidal Kite

A tidal kite is tethered to the sea mattress and includes a turbine beneath the wing. The kite 'flies' in the tidal move, swooping in a figure-of-8 form to boom the rate of the water flowing through the turbine.

Figure – 6: Tidal kite

III. RESEARCH METHODOLOGY

Table 1 - Dimensions of Tidal Turbine Blade (mm)

Radius	1000
Chord	1300
Twist angle (degrees)	9, 10, 10.5, 11, 11.5, 12

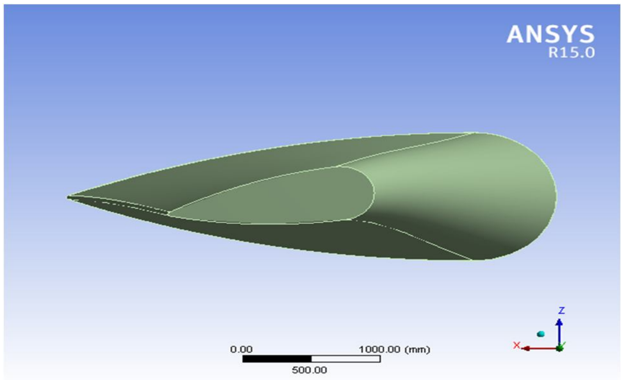

Figure 7 :3D Model of Tidal turbine blade (Base Model).

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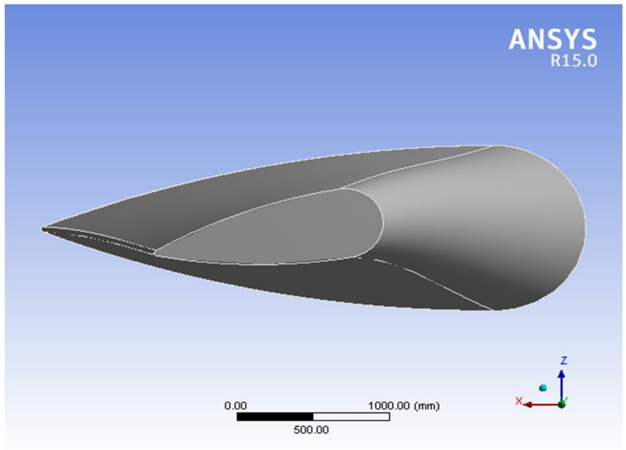

Figure 8 :3D Model of tidal turbine blade (Tidal turbine blade with 10 degree twist angle).

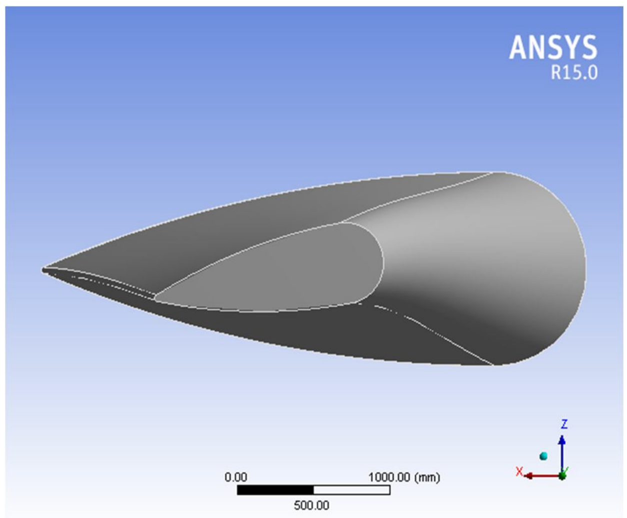

Figure 9 :3D Model of tidal turbine blade (Tidal turbine blade with 10.5 degree twist angle).

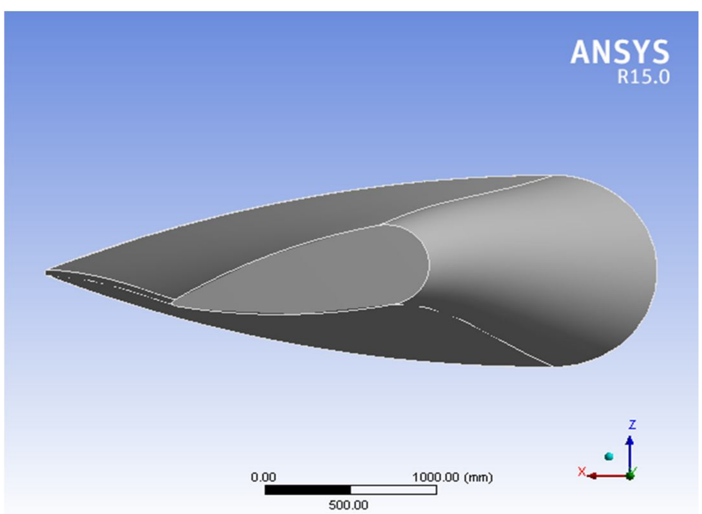

Figure 10 :3D Model of tidal turbine blade (Tidal turbine blade with 11 degree twist angle).

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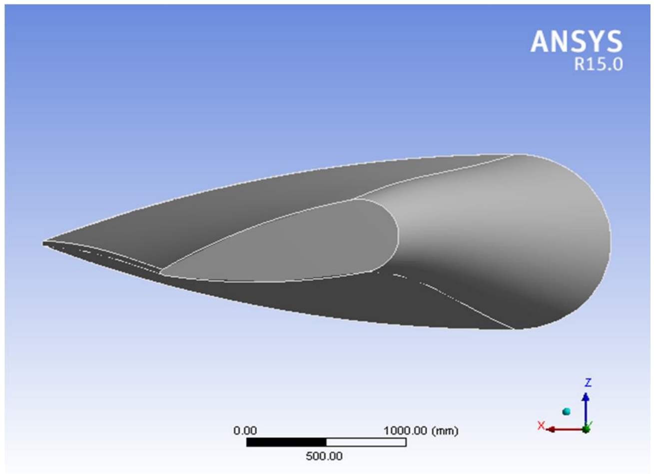

Figure 11:3D Model of tidal turbine blade (Tidal turbine blade with 11.5 degree twist angle).

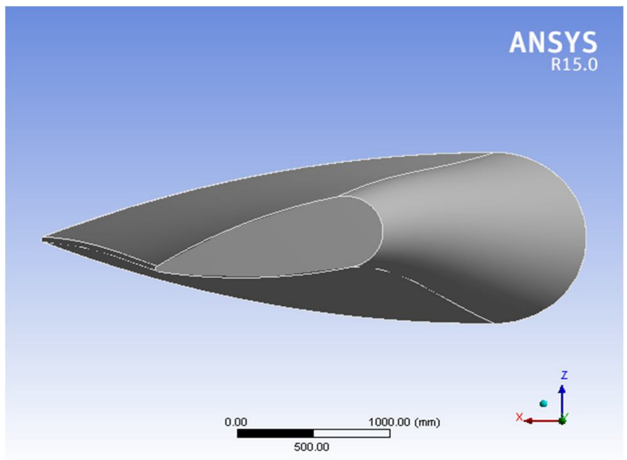

Figure 12:3D Model of tidal turbine blade (Tidal turbine blade with 12 degree twist angle).

IV. RESULTS & ANALYSIS

A. Validation of the Existing Simulation Results for Different Configurations of tidal turbine blade models with base paper data of stress and deformation.

The Existing simulation results are obtained for stress and deformation w.r.t. twist angles and material with different optimized model of tidal turbine blade, twist angle ranging from 9mm to 12mm also thrust force ranging from 271 to 610 N. The results are in graphs show less than 10% deviations between existing simulation results. But the deviations are not so large, and thus the existing simulation results of different configurations of different tidal turbine blade models in the research work can be regarded as reasonable.

Table 2: Stress and deformation values with respect to thrust force.

Validation (for twist angle 9 degrees)		
Thurst Force (KN)	Stress (Mpa)	Deformation (mm)
441	72.368	2.6
271	52.883	1.3
272	58.255	1.8
610	108.658	10.6

B. Overall comparison of Different tidal turbine blade twist angles with respect to thrust force.

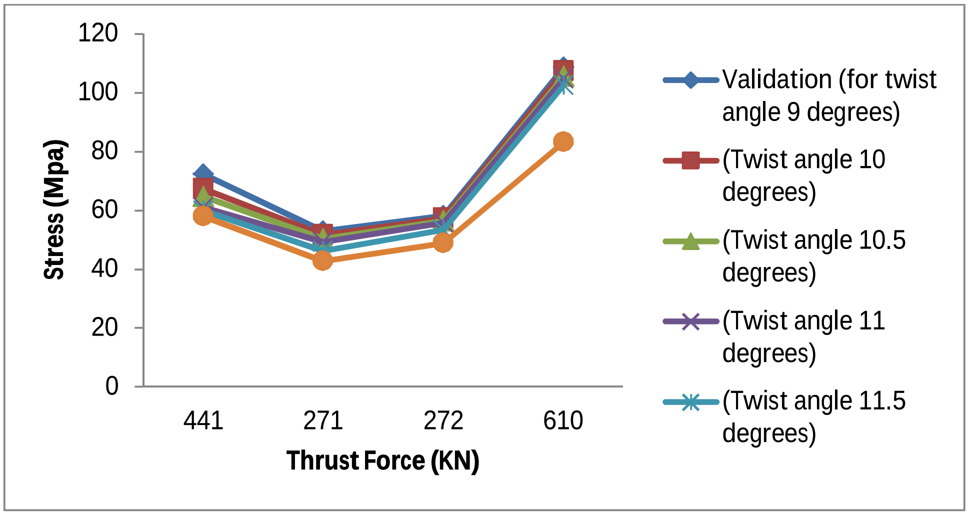

Figure 13: overall comparison of stresses in (MPa) with respect to thrust force in different twist angle of tidal turbine blade.

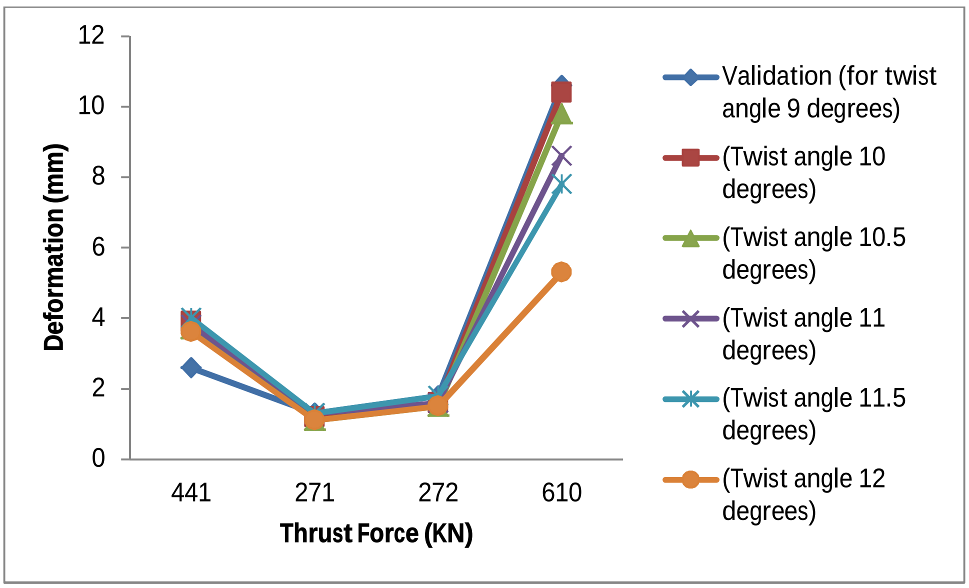

Figure 14: overall comparison of deformation in (mm) with respect to thrust force in different twist angle of tidal turbine blade.

C. Observation of Tidal turbine blade with deformation and stress with zylon and Kevlar material.

Table 3: Stress and Deformation of tidal turbine blade with different material and optimized angle.

(Twist angle 12 degrees)			
(Thrust Force 610 KN)			
	Zylon	Kevlar	CFRP
Stress	71.583	74.045	83.077
Deformation	3.1	1.1	5.3

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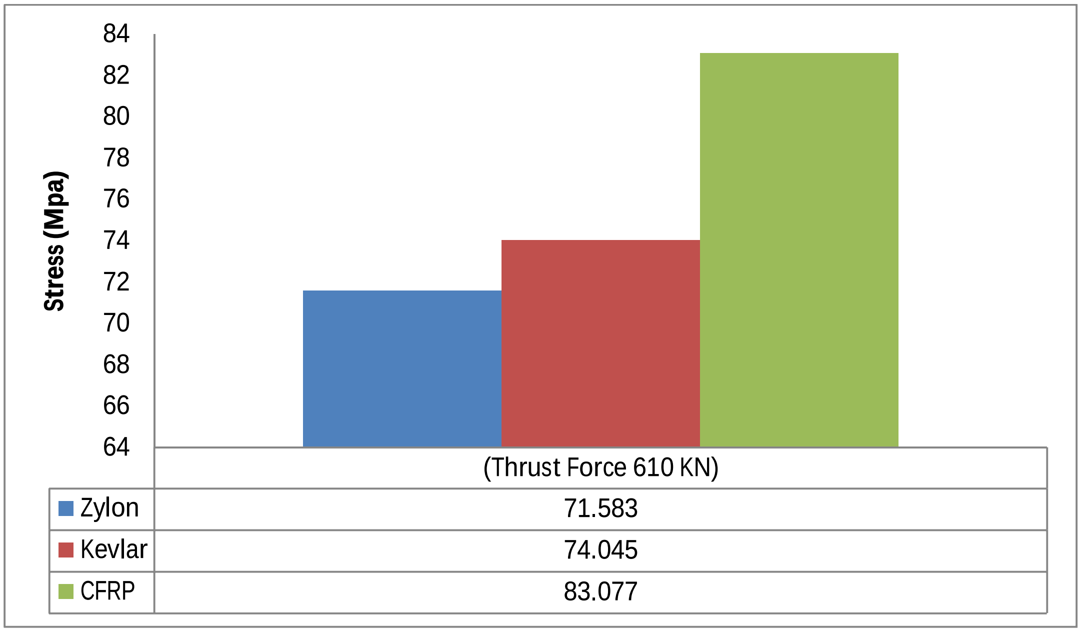

Figure 14: Comparison of stress in (MPa) between validation and 12 degree twist angle for different material.

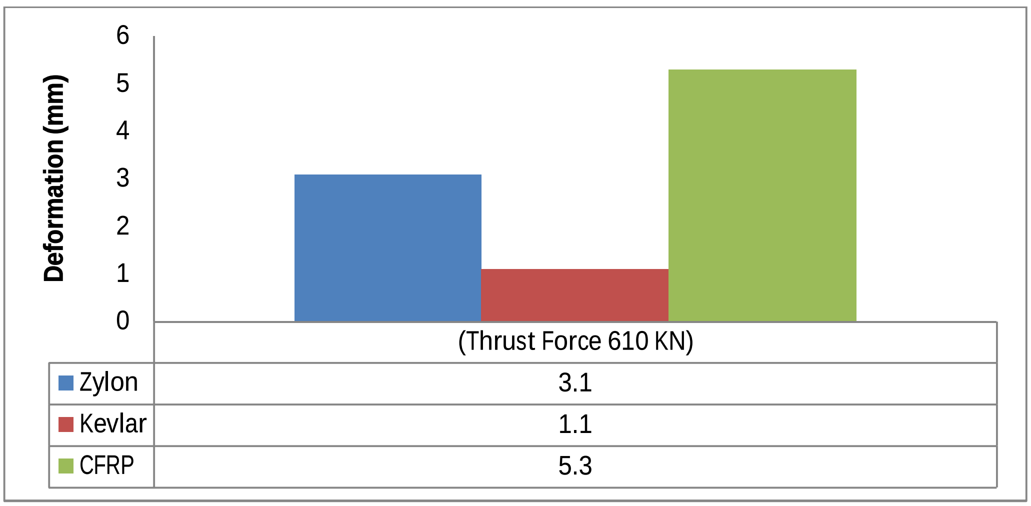

Figure 15: Comparison of deformation in (mm) between validation and 12 degree twist angle for different material.

V. CONCLUSION

In this research, detailed analysis of the influences of stress distribution, deformation effect of tidal turbine blade with different profiles has been conducted by simulations using the ANSYS software on static structural domain 15.0. Work bench. The following conclusions are withdrawn:

A. The different tidal turbine blade model was developed on CREO 5.0 and analysis was done using the ANSYS software (Static Structural domain) 15.0.

B. The stress distribution is the fundamental parameter in the performance of different tidal turbine blade profiles. The thrust force is constant i.e. 441, 271, 272 and 610N.

C. In the study tidal turbine blade with twist angle 9, 10, 10.5, 11, 11.5 and 12 degree are the key geometric parameter on the performance of tidal turbine blade under different thrust force with an implementation of tidal turbine blade with twist angle of 12 degree with CFRP, Zylon and Kevlar material, the developed stresses and deformation effect is improved.

D. Results have least in tidal turbine blade of different configuration it concludes that at failure load of 610N, tidal turbine blade of 12 degree twist angle configuration having minimum stresses with minimum deformation.

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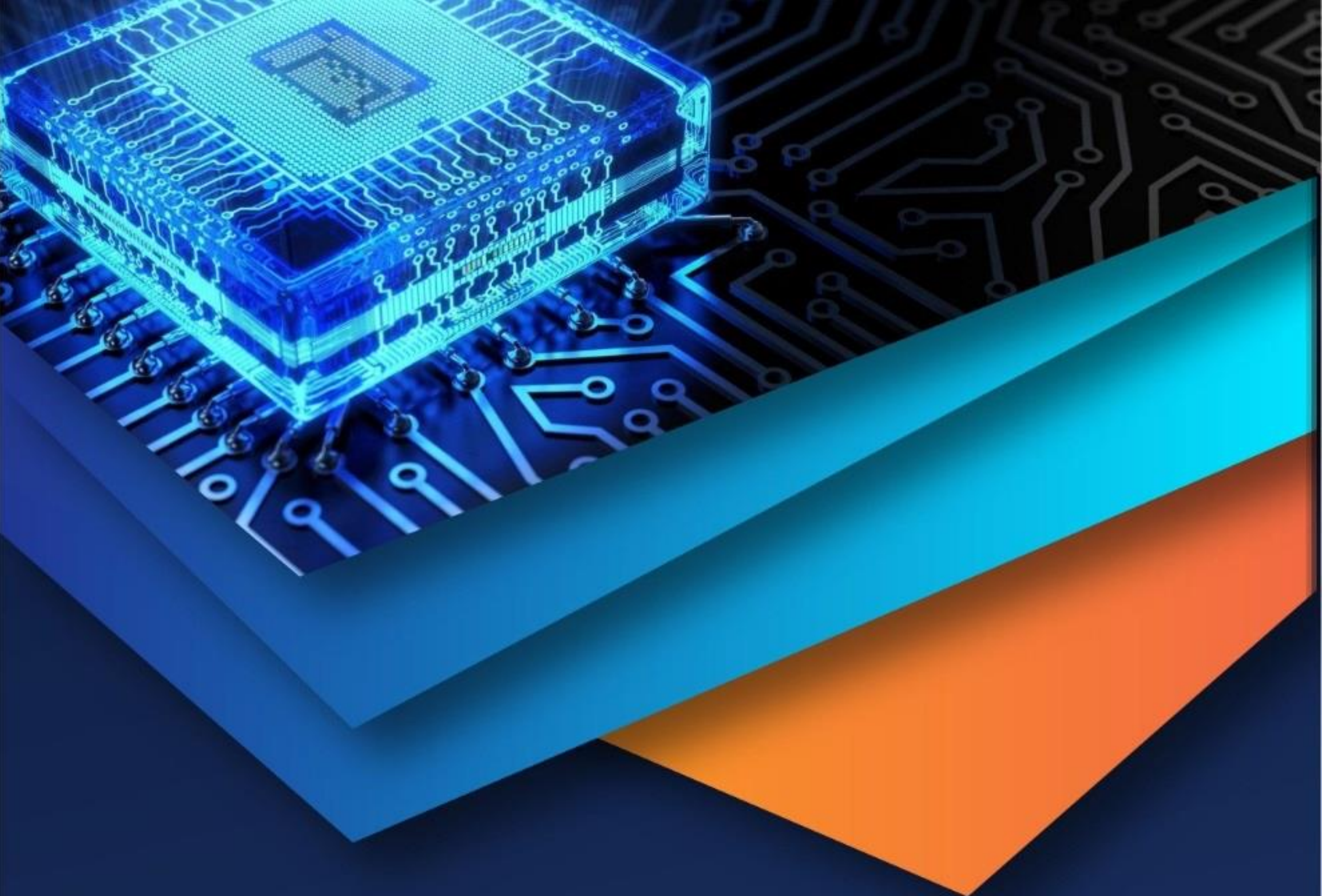

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