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# Design and Development of a Numerical Model and Study on Kinematic Analysis of a Circular Diamond Saw Blade for Ceramics

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***Abstract:** Diamond tools are currently being used by an increasing number of architects, miners and construction engineers because they are faster and easier to use than older, more traditional instruments like sledge hammers and pneumatic and hydraulic jacks. Bridge and highway surfaces are cut with diamond asphalt and concrete cutting machines to provide for quick, clean, and easy section removal and replacement. The entire cost is reduced since diamond tools take less time and manpower*

***The experiment is carried out to validate the performance of diamond saw blades by taking into consideration characteristics such as normal force, tangential force, cutting speed, cut depth, and peripheral velocity. In present exploration work we are introductory phase of plan conclusion of a jewel device cutting edge with various segmental like 8,12,16,20 corn meal by utilizing Solid works programming we are planning the apparatus cutting edge after that we are imported in Ansys Software for Analysis reason. Computing the necessary qualities for examination and estimations of earthenware tiles likewise are some other stone molecule.***

***Another power model of cutting is presented and inferred numerical demonstrating for chip thickness. Identical chip thickness to coarseness space proportion is gotten from the new power model another outspread opening like profile is presented. Fragmented sort jewel saw sharp edge with the measurement of 400 mm and different portion, for example, 8, 12, 16 and 20 are planned in Solid works effectively. An examination study between existing roundabout outspread space and cone like opening is done to decide deformity, stress dispersion, vibration and temperature conveyance.***

## I. INTRODUCTION

Cutting is a critical cycle in the creation of rock sections. It impacts not just the expense adequacy of the current methodology yet in addition on the proficiency and nature of the ensuing techniques underway. A present sawing stone with jewel devices is the most famous technique, which devours the greater part of manufactured modern jewel [1]. Comparative with early methods for rock machining, cutting with jewel roundabout saw-edges reforms the entire area both in lessening the expense and in working on the proficiency. Not with standing, the progressive implications appear to epitomize in the handling of the marbles [2]. The greatest cutting profundity for stones, particularly for hard rocks, is significantly less than that for marbles. Cutting profundities more profound than 25 mm is difficult to be acknowledged due to warm and mechanical over-burden of the saw-sharp edge. With developing utilization of regular rock as constructional and decorative materials, there is an expanding request to diminish creation cost and increment usefulness [3,4].

Very rough jewel sawing can be named a half and half machining process. For it is a mix of the regular processing or wood sawing processes and the crushing system. This is valid on the grounds that it utilizes little to genuinely enormous estimated sharp edges to eliminate material from a work piece. The measure of material eliminated during one cutting pass might be moderately enormous or little, as found in crushing and material wrapping up. With round sawing, the sharp edge turns a steady way at high fringe speeds, normally more than 25 m/s. This prompts the advancement of a tail of framework behind every individual jewel molecule which goes about as a help during cutting[5]. Schematic representation of the cutting zone, normal for round sawing, is introduced in give adequate room to chip evacuation, boundaries portraying the sawing activity must be considered related to the organization of the slicing edge so not to thicken the slurry unnecessarily, subsequently staying away from cruel wear conditions for the lattice. The bearing of sawing, regardless of whether vertical or descending may likewise influence the apparatus conduct and legitimize a change to the saw cutting edge determination.

## II. LITERATURE REVIEW

*A.* Carosio and Paspaliaris [1] inside the last century, stone sawing advances have changed considerably. In that sense observed that presenting engineered jewels give quicker and beneficial sawing processes just as utilizing mathematical control frameworks permits exact sawing of stone with basically no limitations. Alongside the previously mentioned, a few improvements meant to raise the effectiveness of stone machining were delivered in the course of recent years. Notwithstanding this multitude of mechanical improvements, the primary issues related with the current regular stone creation chain incorporate extremely low proficiency, the colossal all out squander began and huge changes in quality and execution during use of the end results.

*B.* There are a few investigations zeroed in on the jewel portioned roundabout saw blades for normal stone sawing processes. The investigation of Konstanty [2] depicted the sawing component and underlying properties of those devices and surveyed the elements that should impact the sawing system. In view of this review, different creators concentrated on the choice and use of the jewel sectioned round saw blades. In that sense, a few viewpoints that influence how saw blades work are work piece properties, working conditions, refrigeration, upkeep of the machine, metal centre plan, etc.

*C.* While Luo and Liao [3] examined how the calculation and morphology of the jewel sway on it, Luo investigated about conduct of worn surfaces of the precious stone sections in a round saw; to be sure, worn particles occurring at the fragment surface make a sawing activity less proficient. Buyuksagis6 likewise observed a connection between the wear level and the power utilization. One more significant finding in this field was introduced in crafted by Kitkiewicz and S' wierzy[14]. Their exploration brought about a definition which relates the impact of the measure of tin in the metal network creation of a sintered roundabout saw blade. This substance assists with expanding hardness yet the connection varies a ton for a distinction of 1% in the measure of the lattice arrangement rate.

## III. DESIGN, ANALYSIS AND OPTIMIZATION OF SUPER ABRASIVE DIAMOND CIRCULAR SAW BLADE

In terms of execution, life, and cost, a suitable design for fragmented type gem roundabout saw cutting edge is critical. Mathematical shape, which includes centre breadth, portion width, fragment tallness, thickness, Radial opening size, and annular space size, are the primary plan boundaries. Although there is annular gap on a big amount of the wood saw cutting edge, the saw edge is aesthetic [5]. Pressure circulation, vibration, and whistling commotion are all affected by the expansion of every boundary in a saw cutting edge. The inexpensive earthenware roundabout sharp edge has a few drawbacks, including clamour, vibration, a lack of heat movement, and a lack of warm extension. By introducing another spiral and annular aperture and adjusting the fragment's sizes, the previously noted issue can be mitigated [6].

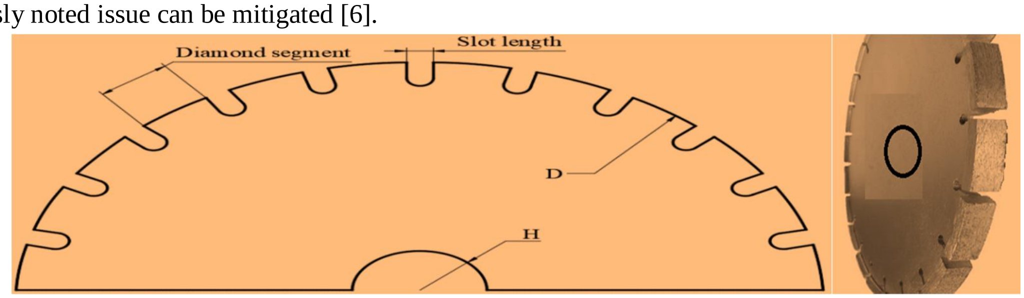


Fig 1: Nomenclature of saw Blade

Circular diamond saw blades of various diameters are available on the market. The diameter of the blade in this study is 400mm, and the number of segments is 8, 12, 16, and 50, with varying segment widths. A novel radial slot model has been developed, with a specific curve annular slot to handle vibration, noise, and thermal expansion.

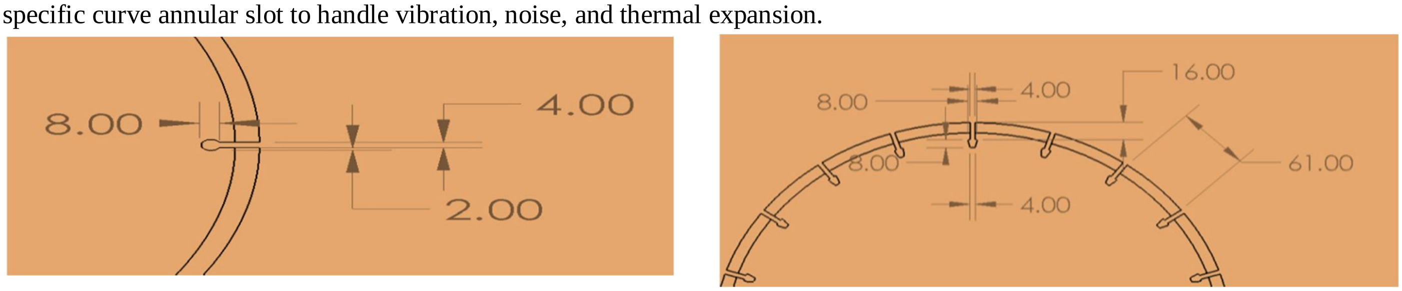


Fig 2: Dimension of Circular slot and Dimension of Conical slot

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| | Segment | Blade Core |
|---|---|---|
| Young's Modulus( GPa) | 120 | 210 |
| Poisson's Ratio | 0.25 | 0.29 |
| Density Kg/m3 | 8500 | 7600 |

Table 1: Properties of diamond tool blade

Mechanical qualities of the disc: Table 1 lists the mechanical properties of the disc's body and diamond segments. The body is mostly comprised of high-strength steel, with powder metallurgy processes used to create composite diamond parts. Diamond particles have been added to those segments to aid in the sawing operation.Modelling with Finite Element Analysis (FEA): In the analysis, ANSYS 5.4, a commercial finite element programme, is employed. As previously said, the model is divided into two parts: the body and the segments. Meshes are created with the help of eight nodded isoperimetric finite elements. With 14004 elements and 43146 nodes, shell elements are employed in the study. It is assumed that the problem is two-dimensional. Smaller pieces are also used in the tooth root regions to get a more precise outcome.

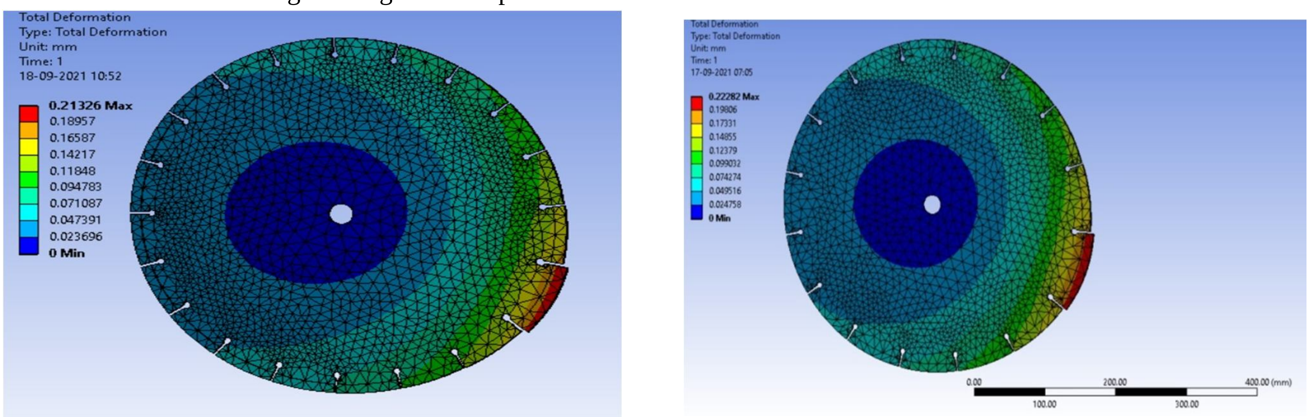



Fig 3. Stress distribution on 20 &16 Segment saw blade

| Segments | 8 | | 12 | | 16 | | 20 | |
|---|---|---|---|---|---|---|---|---|
| Radial slot | CR | CON | CR | CON | CR | CON | CR | CON |
| Deformation | 0.322 | 0.287 | 0.2746 | 0.244 | 0.229 | 0.222 | 0.213 | 0.208 |
| Von misses stress | 251.1 | 326.88 | 190.16 | 262.16 | 121.31 | 177.92 | 130.92 | 185 |

*CR-Circular Slot, CON-Conical slot*

Table 2: Coupled thermal-structural analysis (FEA) results of Diamond circular Saw Blade

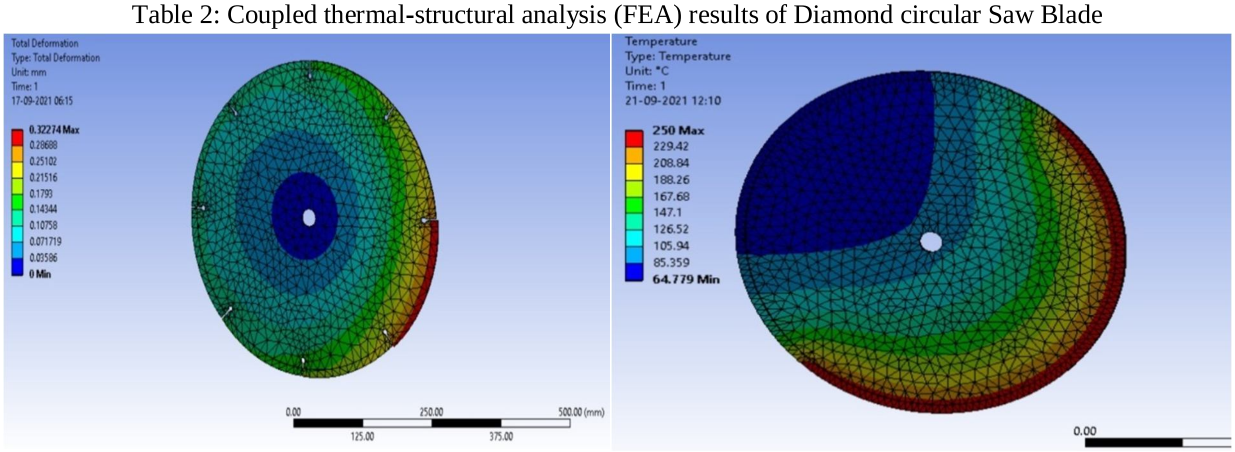
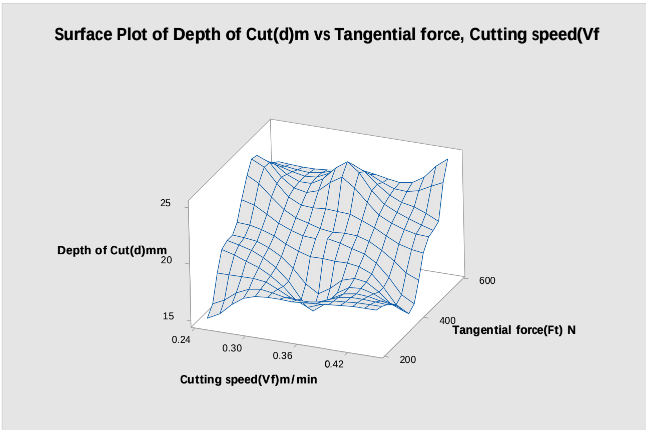



Fig 4. Stress distribution on with and without Segment saw blade

## IV. RESULTS & DISCUSSIONS

As the cutting speed and depth of cut increased, the Ft and Fn forces grew significantly. At high cutting speeds, these increases in cut depth are more noticeable. If the natural stone being cut has a hard and big particle structure, Fn forces will be significantly increased. The normal force is the force obtained at the saw's cut depth. The saw's tangential force is obtained in the cutting direction. The Ft force is less than the Fn force. The fact that natural stone comprises large particles affects the feeding of the cutting disc in the cutting direction, resulting in larger forces.



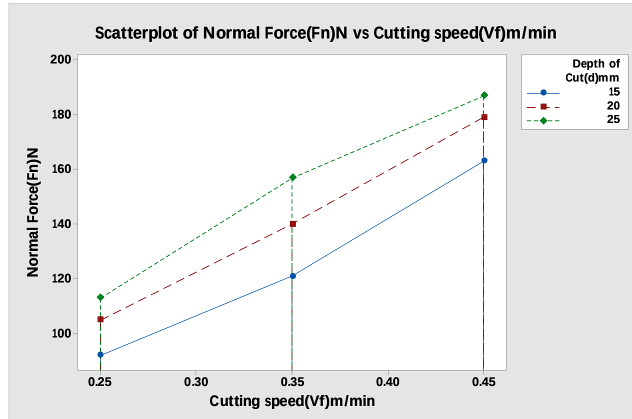




Fig shows 5: Cutting speed Vs. Normal force at speed of 25m/s and Surface Plot of tangential force

| Cutting speed(Vf)m/min | Depth of Cut(d)mm | Tangential force(Ft) N | Normal Force(Fn)N |
|---|---|---|---|
| 0.25 | 15 | 220 | 98 |
| 0.25 | 20 | 352 | 112 |
| 0.25 | 25 | 416 | 120 |
| 0.35 | 15 | 245 | 127 |
| 0.35 | 20 | 365 | 151 |
| 0.35 | 25 | 467 | 165 |
| 0.45 | 15 | 318 | 171 |
| 0.45 | 20 | 422 | 183 |
| 0.45 | 25 | 521 | 193 |

Table 3. Forces at Circumferential speed of 30m/s

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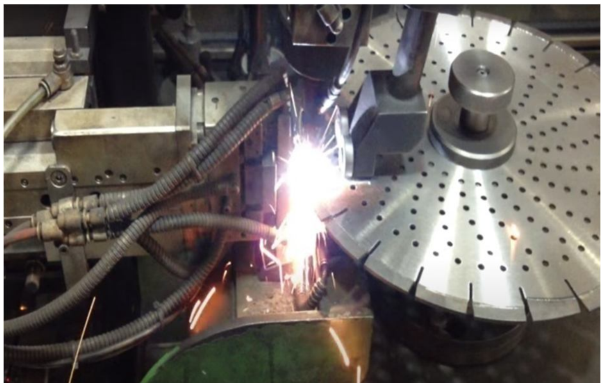

Fig 6 shows: Manufacturing of diamond tool blade

| The First ten order natural frequency of 12 segments conical slot | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Mode** | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| **Natural frequency (Hz)** | 42.306 | 62.26 | 65.49 | 70.19 | 109.74 | 168.65 | 226.98 | 302.43 | 378.51 | 387.11 |
| **The First ten order natural frequency of 20 segments Circular slot** | | | | | | | | | | |
| **Mode** | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| **Natural frequency (Hz)** | 43.89 | 63.85 | 65.96 | 68.89 | 108.34 | 161.39 | 219.41 | 283.78 | 359.2 | 396.36 |
| **The First ten order natural frequency of 20 segments Circular slot** | | | | | | | | | | |
| **Mode** | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| **Natural frequency (Hz)** | 42.31 | 62.26 | 65.49 | 70.19 | 109.74 | 168.65 | 226.98 | 302.43 | 378.51 | 387.11 |
| **The First ten order natural frequency of 20 segments Circular slot with annular slot** | | | | | | | | | | |
| **Mode** | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| **Natural frequency (Hz)** | 40.17 | 60.08 | 62.39 | 66.39 | 105.86 | 156.64 | 214.39 | 276.36 | 339.86 | 355.09 |

*Table 4. Results on vibration testing on different segments of tool blade.*

## V. CONCLUSIONS

Solid works successfully designed a segmented type diamond saw blade with a diameter of 400 mm and different segments such as 8, 12, 16, and 20. A novel cutting power model is presented, as well as mathematical modelling for chip thickness. As the circular velocity increases, the tangential force decreases slightly, but the decline in normal forces is greater. As the Fn force diminishes, the cutting process becomes easier. This cutting facility does not occur in the saw blade's feed direction, but machining becomes easier as the depth of cut increases. The volume to be sliced by a segment each rotation reduces as circular velocity increases, and as a result, lower forces become effective. When compared to segmented diamond saw blades, continuous diamond saw blades show more wear. The average tool wear is 1.168, although it is 0.732 in the segmented type. The same findings were found while using a weight loss technique. The average weight reduction of the segmented blade is 6.29g, which is less than the weight loss of the continuous blade, which is 10.93g.

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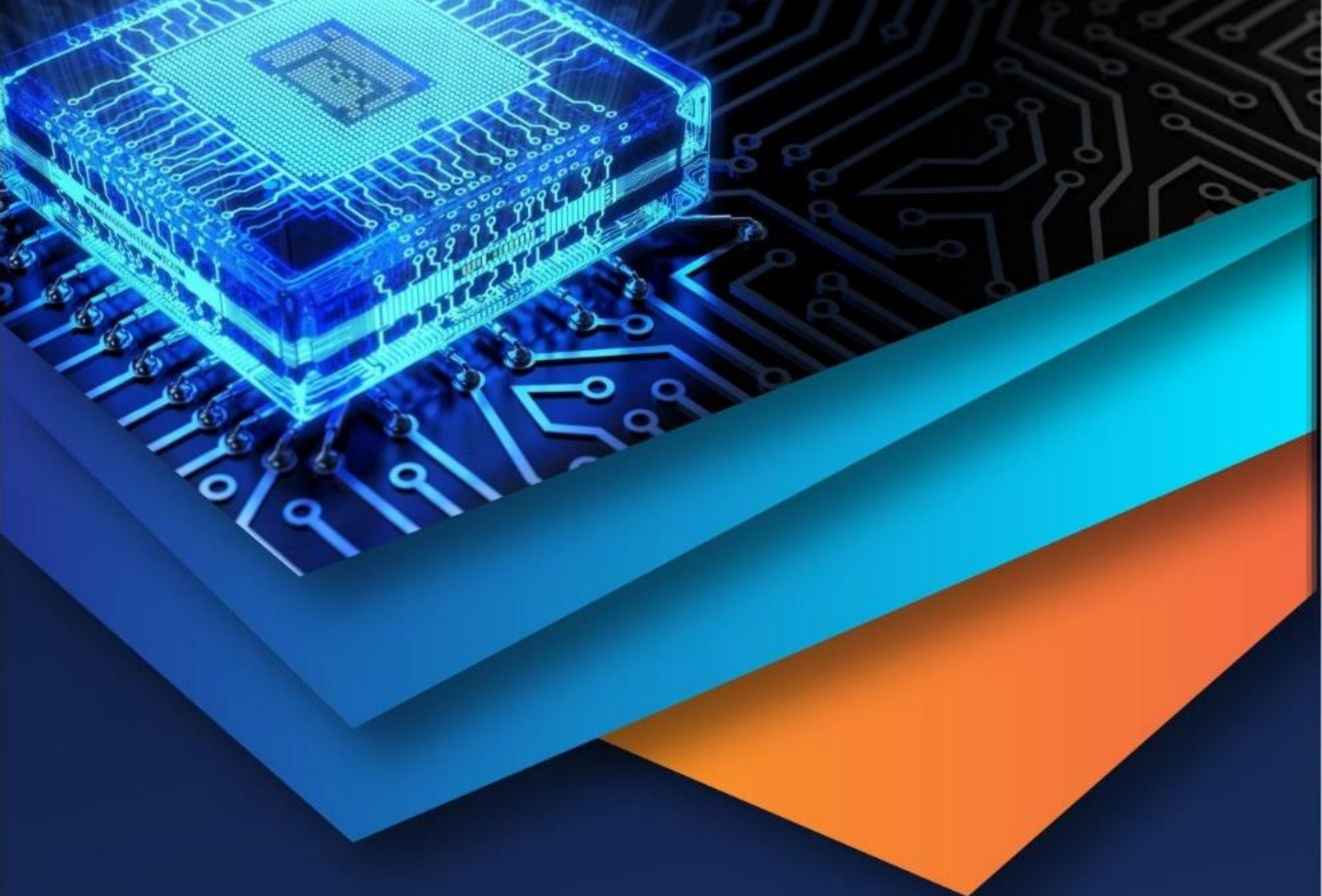


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