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Research on Aerofoil Shape to Increase the Effectiveness of Aeroplanes

Parekh Abhishek J[1], Patel Mann B[2]
[1, 2]Student, Mechanical Department, SSASIT, Surat

Abstract: In the modern era where emphasis on air travels is increasing day by day. There is no near alternative of jet fuel. In such situation where fossil fuel use becomes bounded than, we should try to increase efficiency from available resources so as to push world towards sustainable development. Efficiency of aeroplanes greatly depends on couple of major factors like load carried, type of fuel used, power of engine installed, etc. But if we take similar aircrafts with similar loads than one criterion plays pivotal role in efficiency of aircrafts and that is shape of aerofoil wings. Angle of attack also depends on this. Optimum shape of aerofoil has always been topic of research for engineers. In present paper, an aerofoil shape with bottom surface backlash is analysed in ABAQUS software. Different modes of failure help in better designing as well as maximum bearable load by aerofoil shape.
Keyword: 1. Aeronautical engineering, 2. Fluid Mechanics, 3. Analysis on ABAQUS, 4. Computational fluid dynamics.

I. INTRODUCTION

Dream of humans to fly has not been seen advent of WRIGHT brothers; rather it has been since ancient age. Wall paintings, scriptures, etc evidences have humans with wings inscribed on them, showing the lure of humans to fly in sky. In present era, now it has not been a dream anymore. But we are facing new challenges offered by this technology of flying. From making civilian planes to bombers and then fighters and now drones. Technology has greatly advanced but one thing has remained unchanged and unsolved. Very low efficiency of planes. Present paper tries to address this issue. There has been immense research on this topic but still, we have a very little progress. Research on unique aerofoil shapes is continuously going on without any major breakthrough.

II. METHODOLOGY USED

Methodology used here is computational fluid dynamics. Computational fluid dynamics is sub branch of fluid dynamics where fluid flows are studied under the light of data structure, simulations and numerical analysis. Free flow is simulated through software's and interaction of fluid with surface is shown by boundary condition. An aerofoil shape was modelled in ABAQUS and than load was simulated on it.

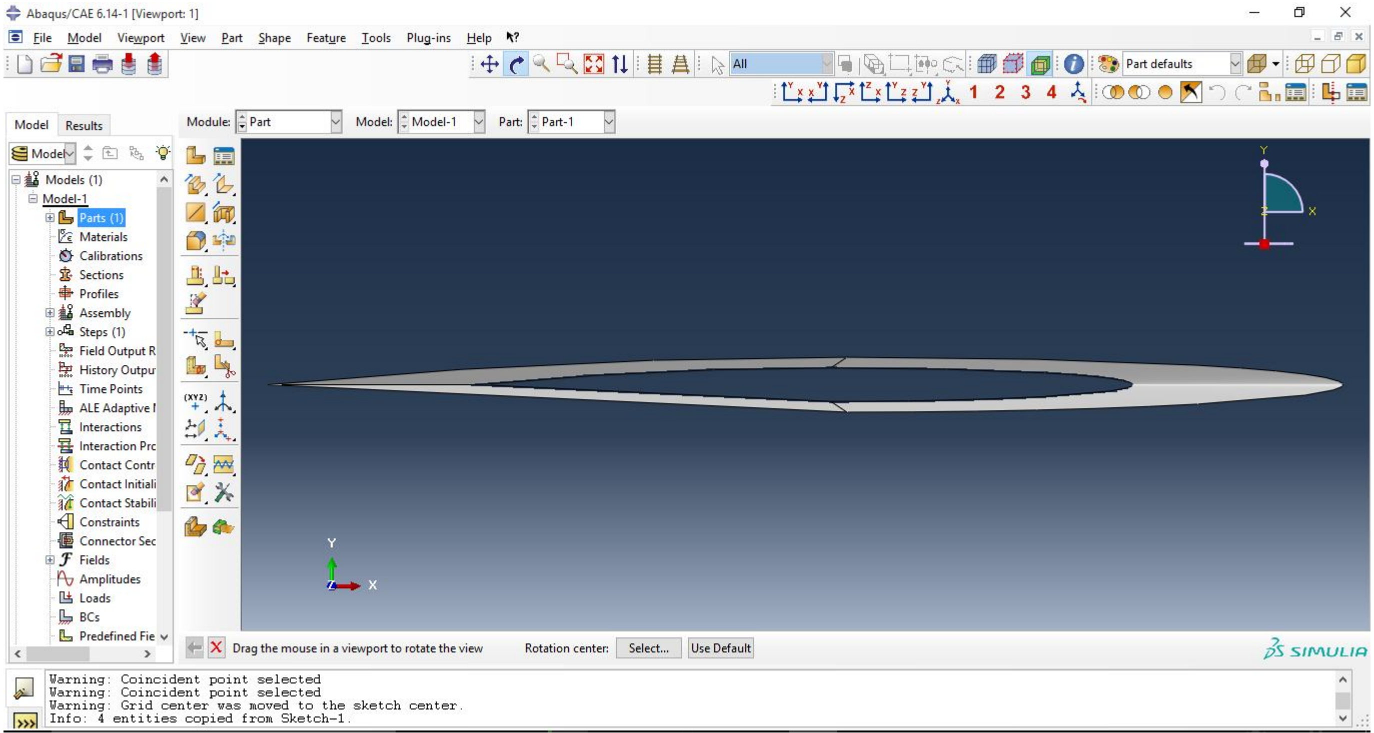
III. MODELLING THE AEROFOIL

A. Model Geometry

3D Deformable geometry of the Aerofoil specimen made of Al material considered in this analysis depth of extrusion was kept 200. All parts were modelled with elastic material models. The material properties used in these simulations are shown in Table 3.1 for PMMA. The XFEM analysis requires additional material information in the enriched area of the crack. The maximum principal stress criteria (Maxps Damage in Abaqus) was selected for the damage initiation criteria.The calculated true ultimate strength was used as the limiting maximum principal stress. Fracture energy was used for the damage evolution criteria.

Material Property	Value
Young's Modulus	2700
Poisson's Ratio	0.3
Ultimate Stress	46.2 MPa

Material properties Al.

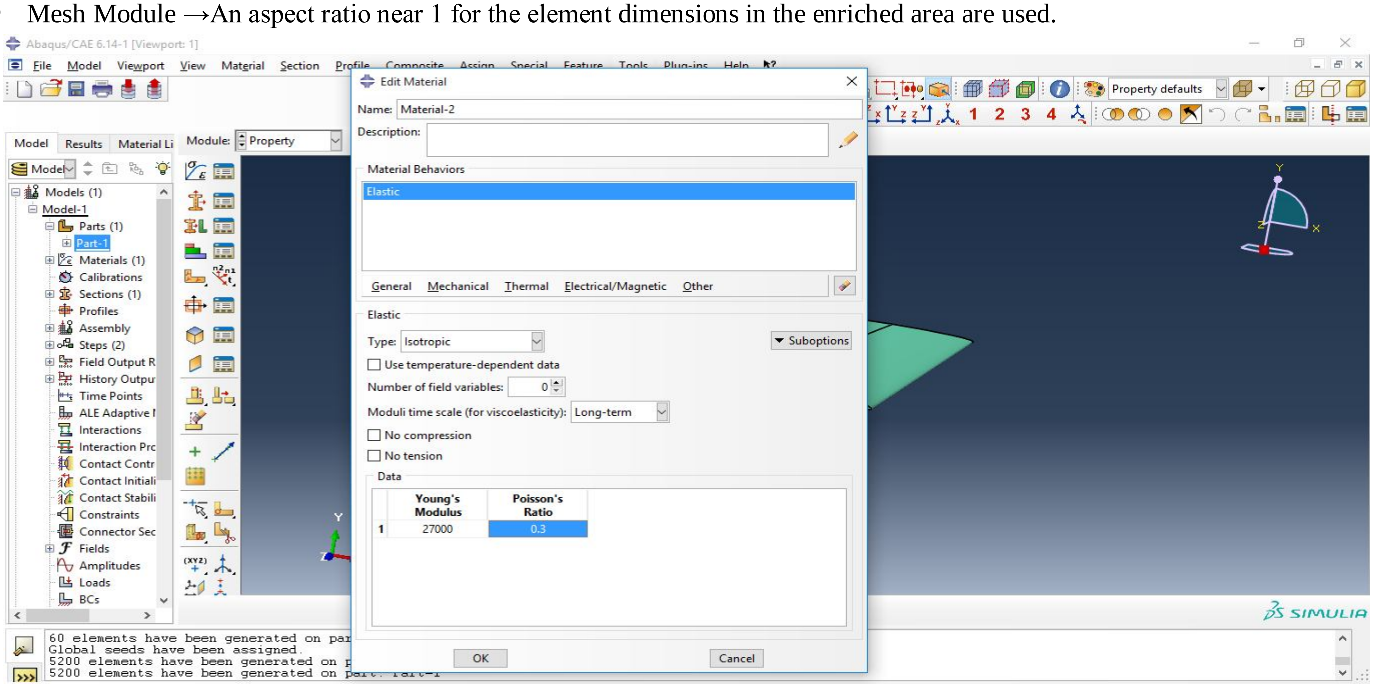


1.) Modelling of part in Sketch module.

B. Specifying XFEM in ABAQUS

Model containing a top and bottom surfaces so the following steps are to be done:

1) Part Module →Create a 3D deformable solid for aerofoil shape.
2) Select material from property Module →young's modulus = 2700 and possion's ratio=0.3.
3) Interaction Module→ Special→ManagerCreate→Select sections of all location →Select Planar Shell part. Specify contact property →okay
4) Mesh Module →An aspect ratio near 1 for the element dimensions in the enriched area are used.



2.) Assigning properties to materials.

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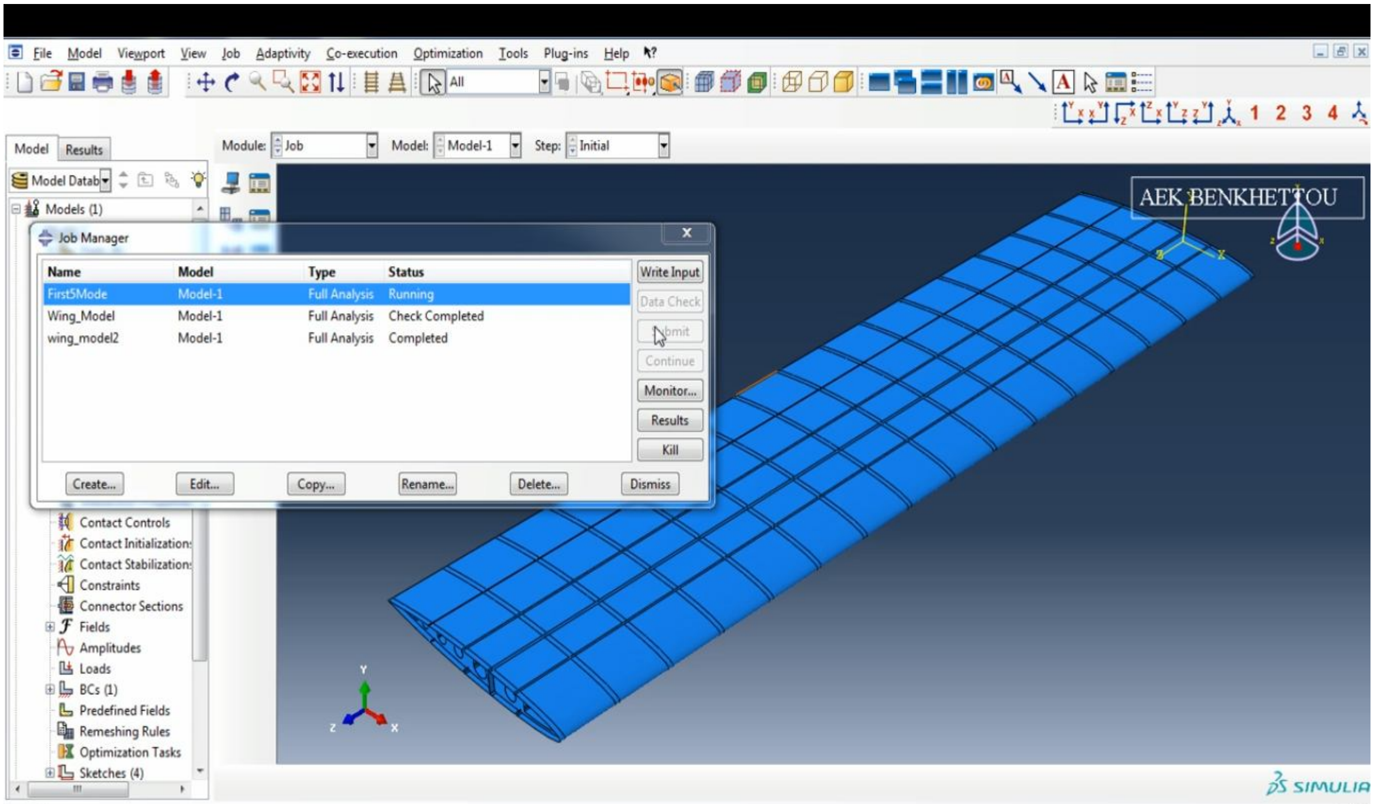
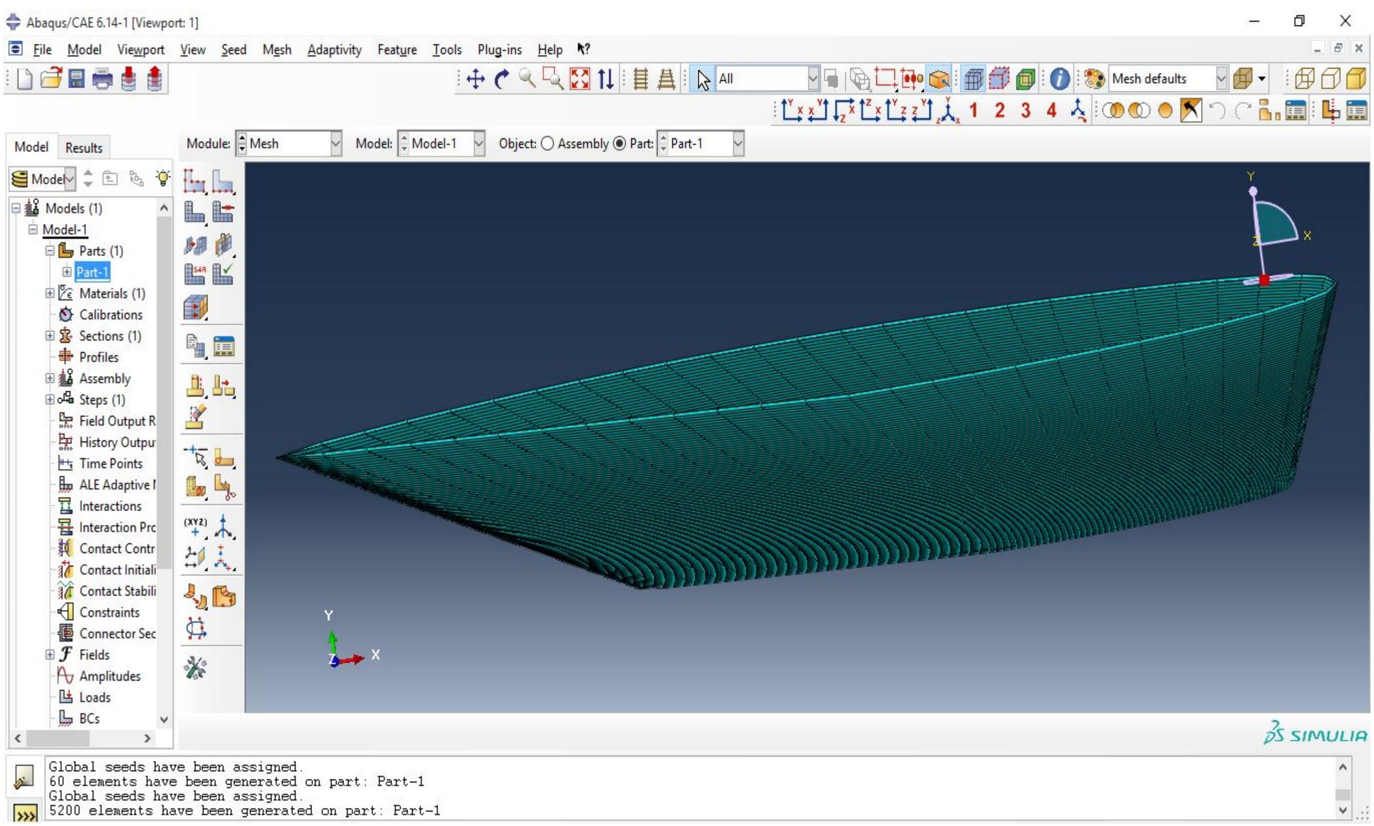


3.) Creating Job module.



4.) Providing meshing to job.

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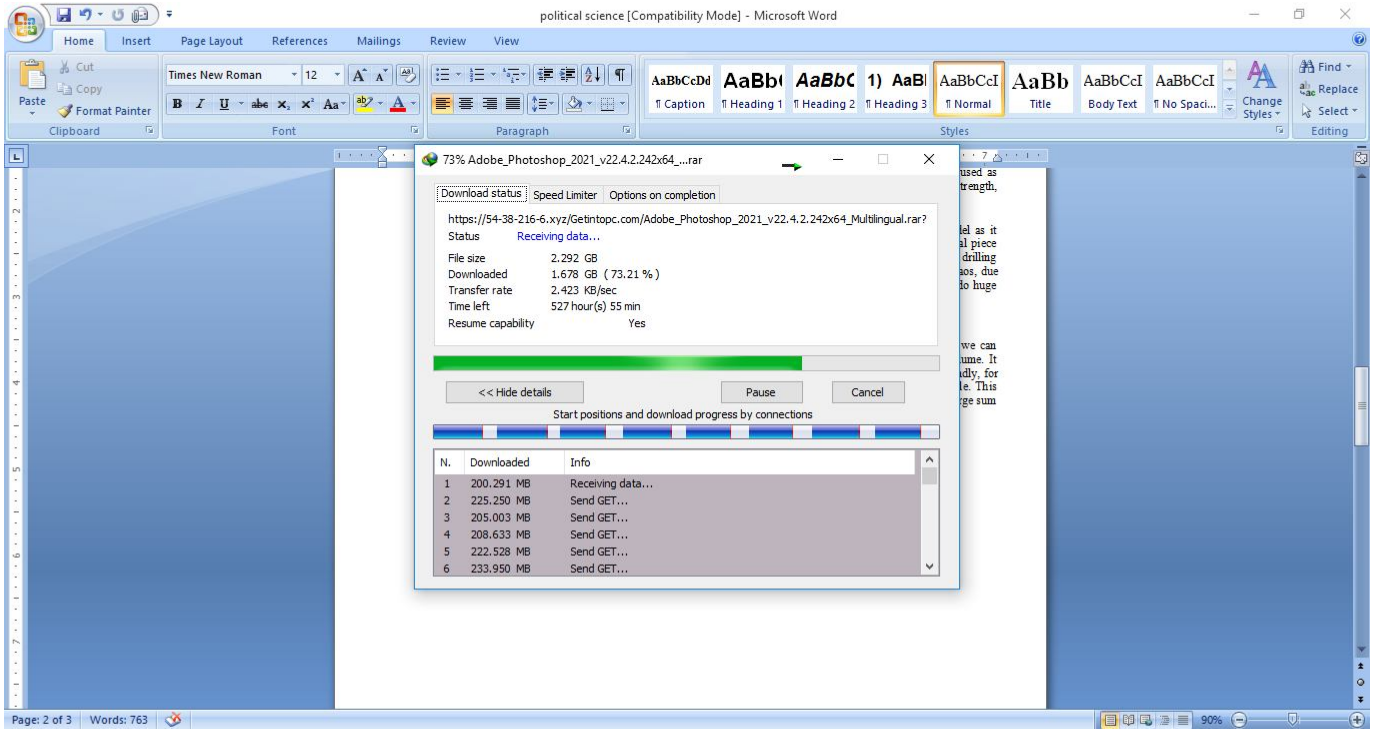
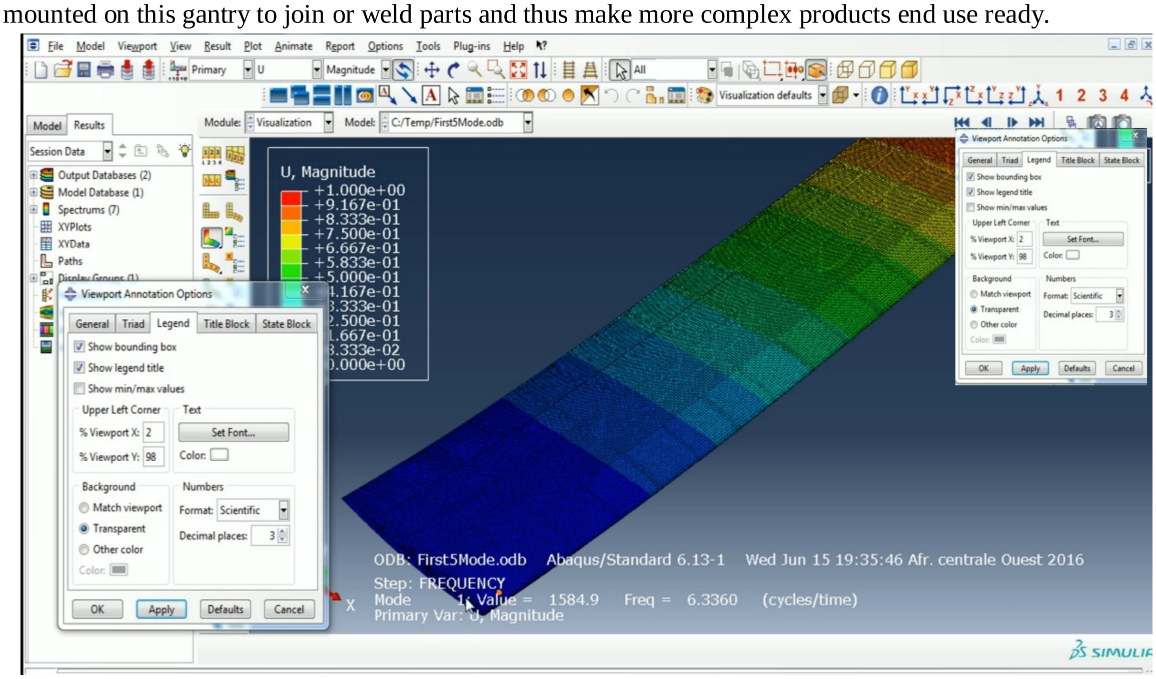


5.) Running analysis with 5 Eigen values.

IV. OUTCOME

On contrary to this, lead screw holder can 3D printed with PLA. Due to additive manufacturing approach, we can have negligible amount of material wastage. Moreover, it is light in weight. We can control its infill volume. It eliminates labour work as it is automatic process. Once file is inserted and run, printer will do its work. Secondly, for drilling, instead of going to drill machine, we can insert drill head/ module in place 3D printer head/module. This reduces transportation time thus reducing Lead time. Even small saving of Lead time in factory is worth of large sum of money. Further more research and development is required as we can have a turret mechanism holding multirole including 3D printer head with other fabricating tools. Moreover, actuators and robotics arms can also be mounted on this gantry to join or weld parts and thus make more complex products end use ready.



6.) In results, we can see immense amount of stress developed on extreme edge away from plane.

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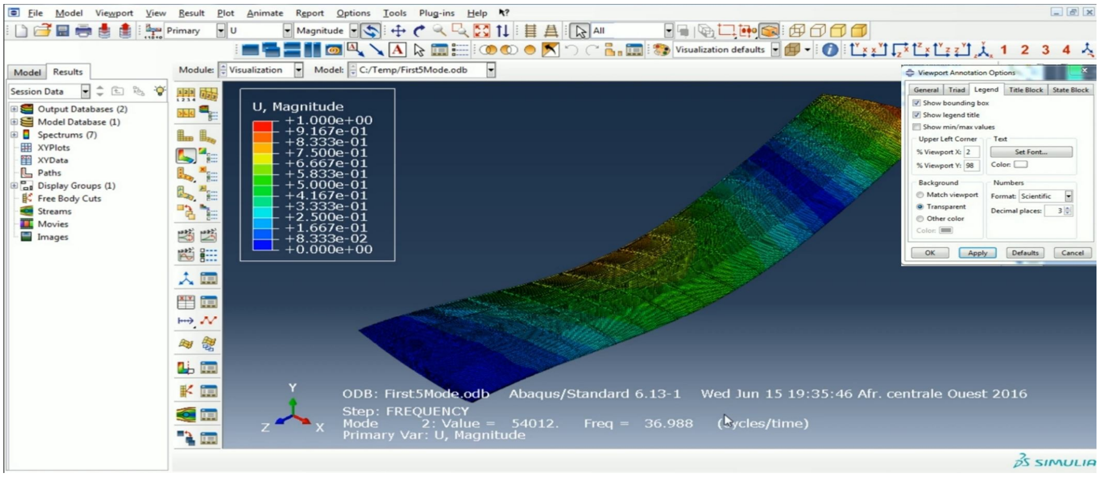

7.) Second type of failure on loading conditions being changed.

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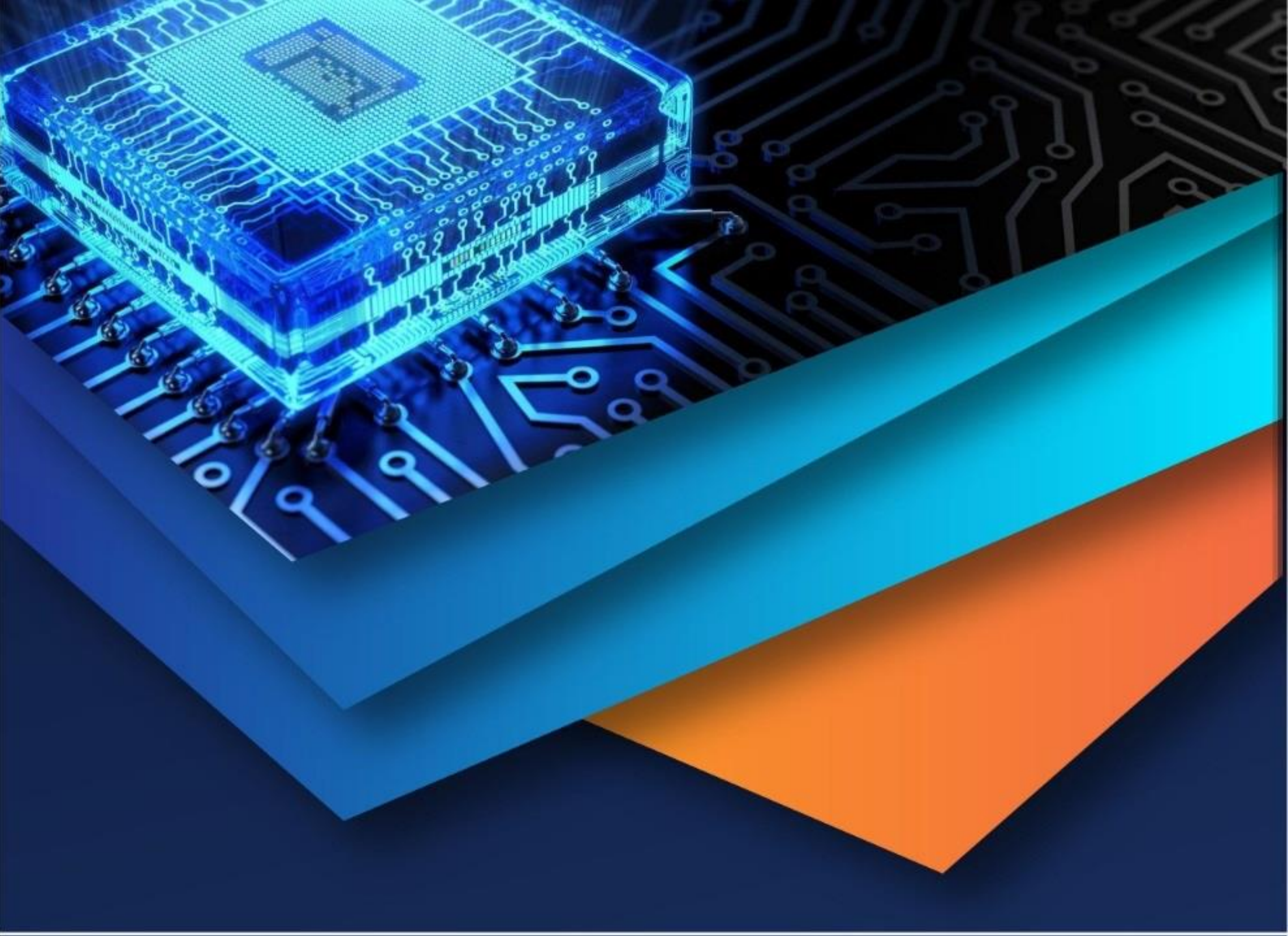

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