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DESIGN AND ANALYSIS OF A GAS TURBINE BLADE BY USING NACA POINTS

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ABSTRACT

The project's primary goal is to investigate the NACA series blade using various profiles using thermal analysis, static analysis, static analysis, vibrational analysis, and harmonic analysis to calculate the thermal flux, stress, strain, deformations, natural frequencies, and harmonic responses using finite element analysis (FEA).CATIA software is used to create the NACA series blades. Despite the fact that various research has shown that heat dissipation is high and blades in many models have raised abnormal issues when using different materials. Stress and distortion are both rising as a result of the overheating problem.

Ti alloy, Ni alloy 942, and composite materials like Al 6061+ 2% SIC and carbon – carbon composite are the materials chosen for analysis in this paper. When compared to the other materials for the various models of NACA series turbine blades, the composite material Al 6061 + 2% SiC has been shown to be the best material for the aircraft NACA series blades because it has the least stress, better static and thermal characteristics, less deformations at different frequencies, and better harmonic results.

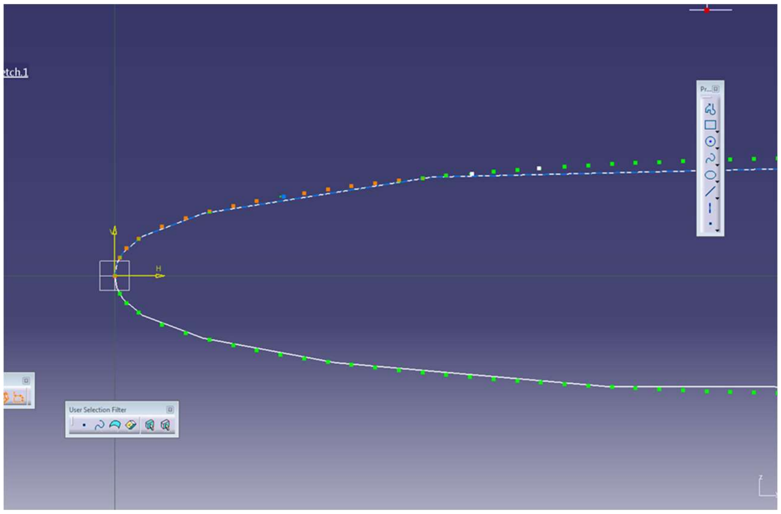
KEYWORDS: CATIA, ANSYS Workbench 14, NACA 0010 AIRFOIL, Structural Analysis, Thermal Analysis, Vibrational Analysis, Harmonic Analysis.

1.Introduction

A gas turbine or steam turbine's turbine section is made up of separate parts called turbine blades. The high temperature, high pressure gas that the combustor produces must be converted into energy by the blades. The gas turbine's rotor blades are frequently its limiting element. Turbine blades frequently make use of exotic materials like super alloys, numerous cooling techniques that can be divided into internal and external cooling, and thermal barrier coating to live in this harsh environment. In steam turbines and gas turbines, blade wear is a significant cause of failure. Stress brought on by vibration and resonance within a machine's working range is what leads to fatigue. Friction dampers are used to shield blades from these blades from these high dynamic pressures are used. The operating conditions for water and wind turbine blades are different, usually involving lower temperatures and rotational speeds.

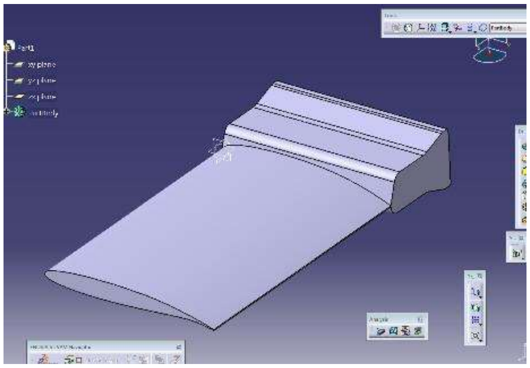
LITERATURE REVIEW

The study on the construction and stresses analysis of a jet engine turbine blade was conducted by Theju V, Uday P S, PLV Gopinath Reddy, and C.J.Manjunath. it is necessary to conduct research into the use of novel materials. In the current study, two distinct materials, Inconel 718 and Titanium T-6, were used to design the turbine blades. The impact of temperature and generated stresses on the turbine blade has been attempted to be studied. To determine the direction of the temperature flow that is developing as a result of the thermal loading, a thermal study has been done.in order to examine the stresses, shear stresses, and displacements of the turbine blade that have developed as a result of the coupling effect of thermal and centrifugal loads. By contrasting the results obtained for two different materials, an effort is also made to propose the best material for a turbine blade (Inconel 718 and titanium T6). According to the plots and findings, Inconel 718 can be regarded as the best material because it is affordable and has better material properties at greater temperatures than Titanium T6.

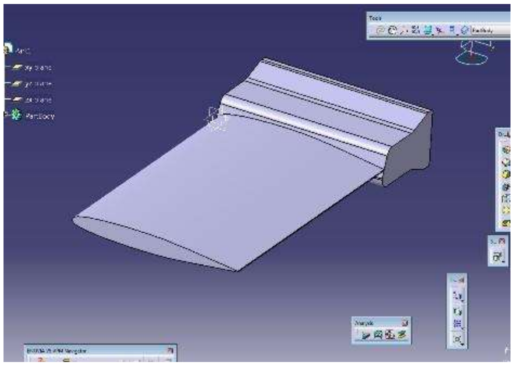


DESIGN OF ORIGINAL MODEL USING NACA POINTS

MODEL 1

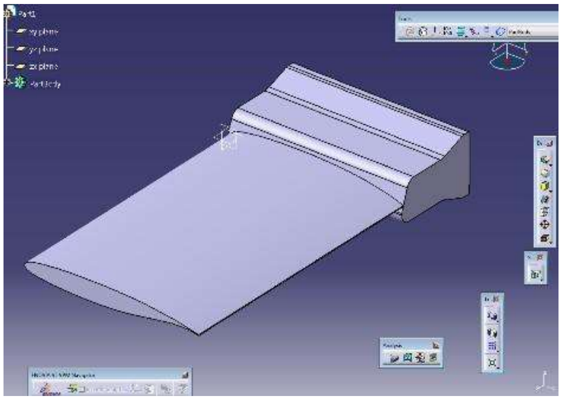


MODEL 2

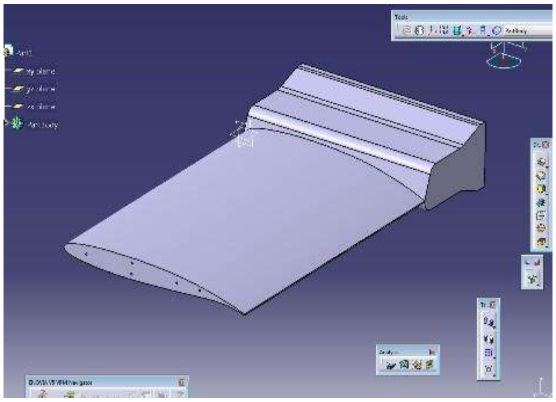


MODEL 3

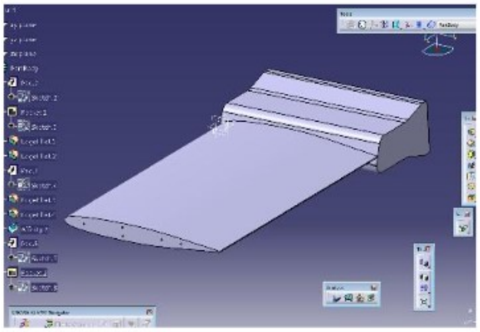
MODEL 4



MODEL 5



MODEL 6



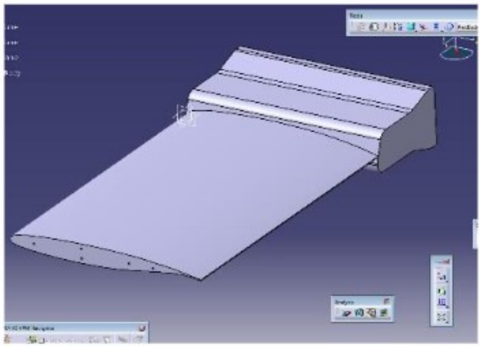
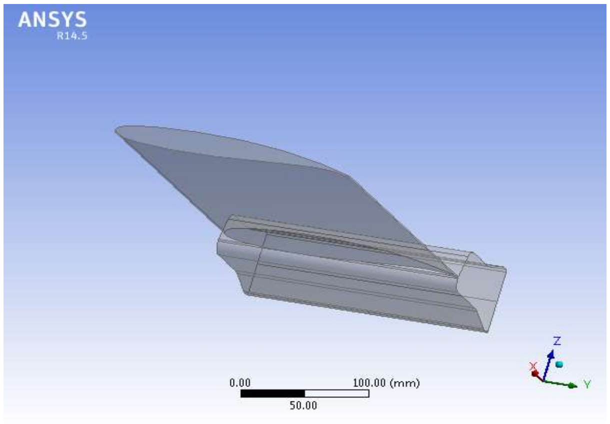


Figure: ANALYSIS OF 10%-0.2 MODEL 1 TURBINE BLADE USING Ti6 ALLOY



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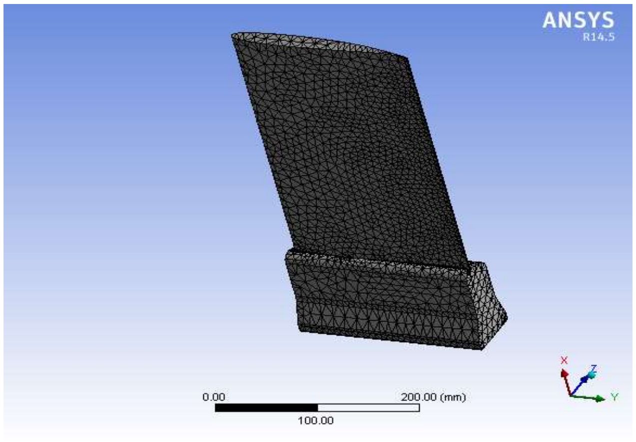
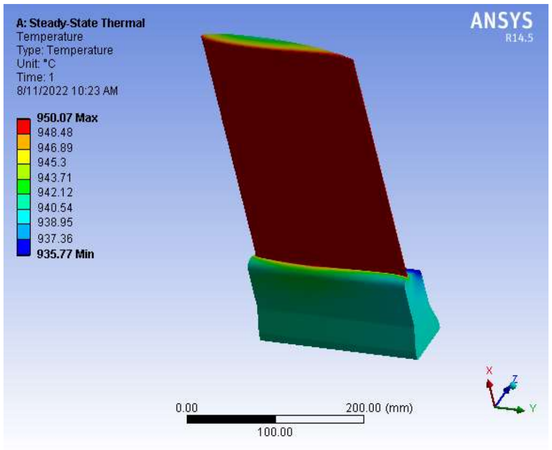
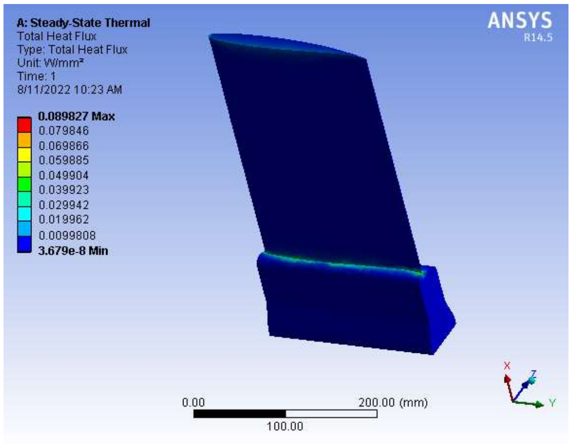


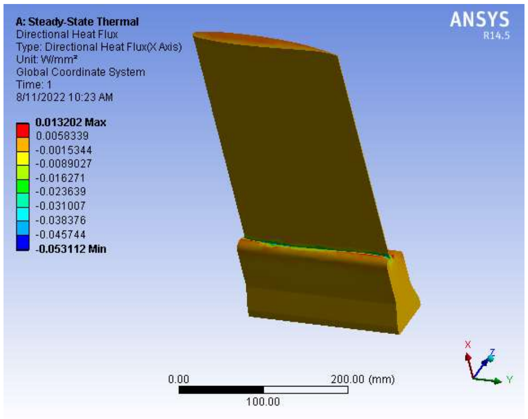
MESH



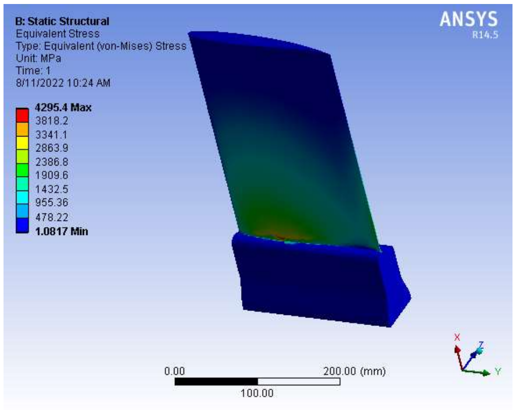
TEMPERATURE



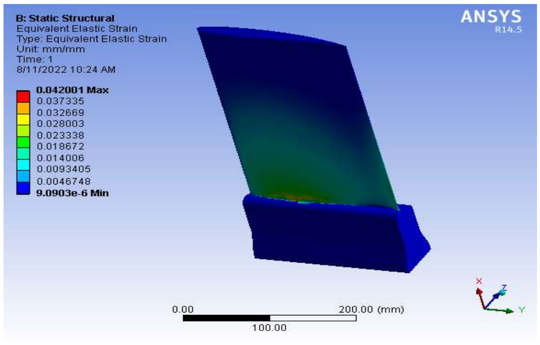
HEATFLUX

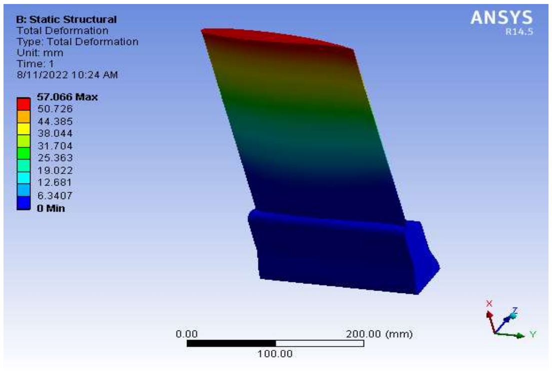


DIRECTIONAL HEAT FLUX



STRESS



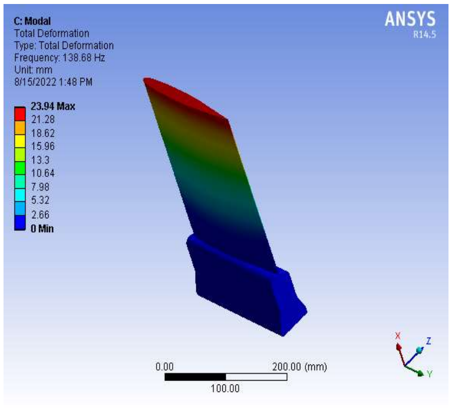


STRAIN

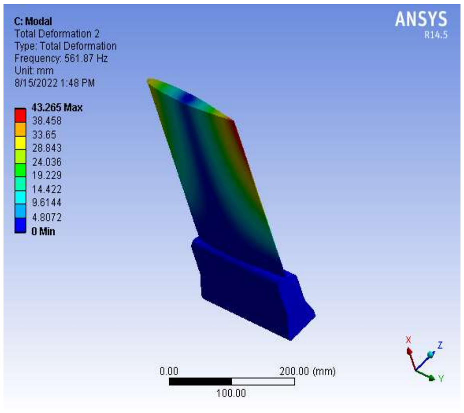
DEFORMATION

ANALYSIS OF 10%-0.6 TURBINE BLADE USING Ni ALLOY 942 GRADE

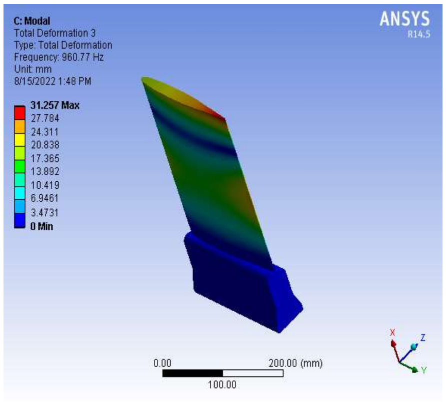
VIBRATIONAL RESULTS



DEFORMATION 1



DEFORMATION 2



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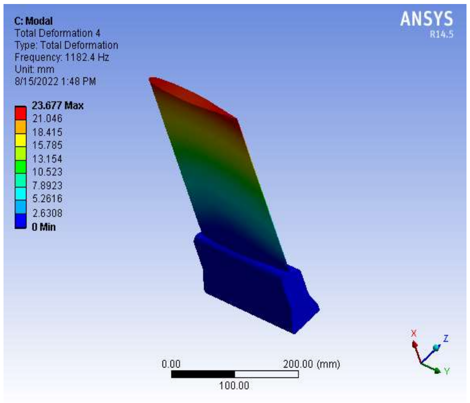

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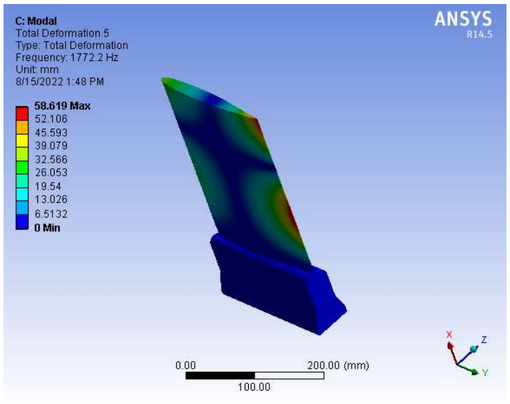

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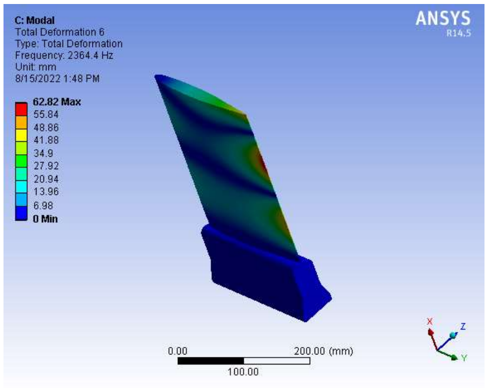
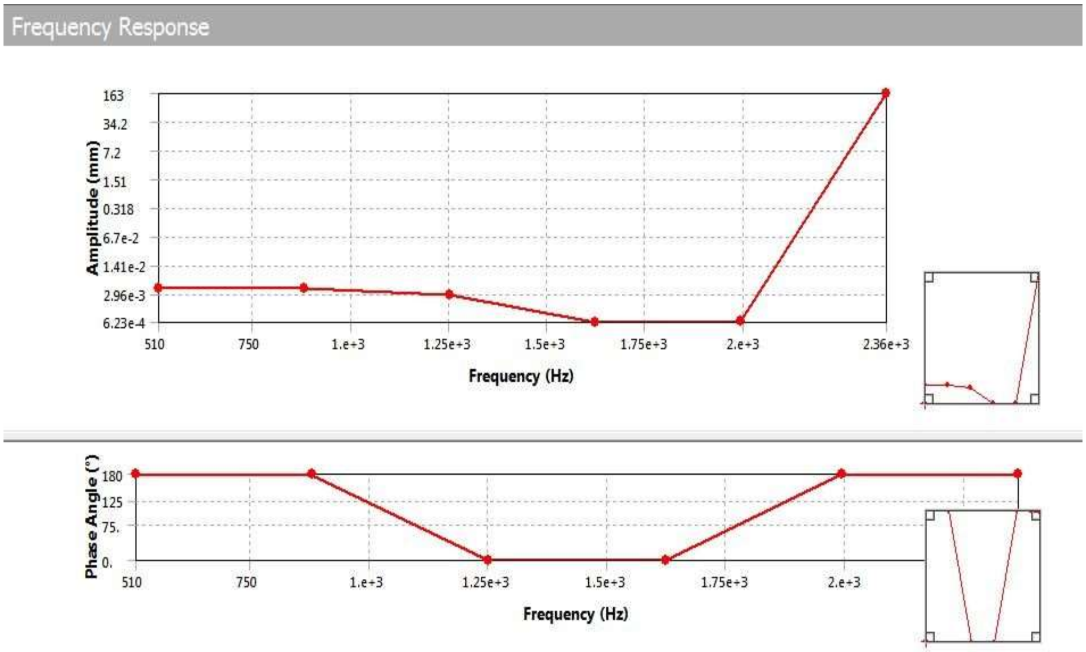
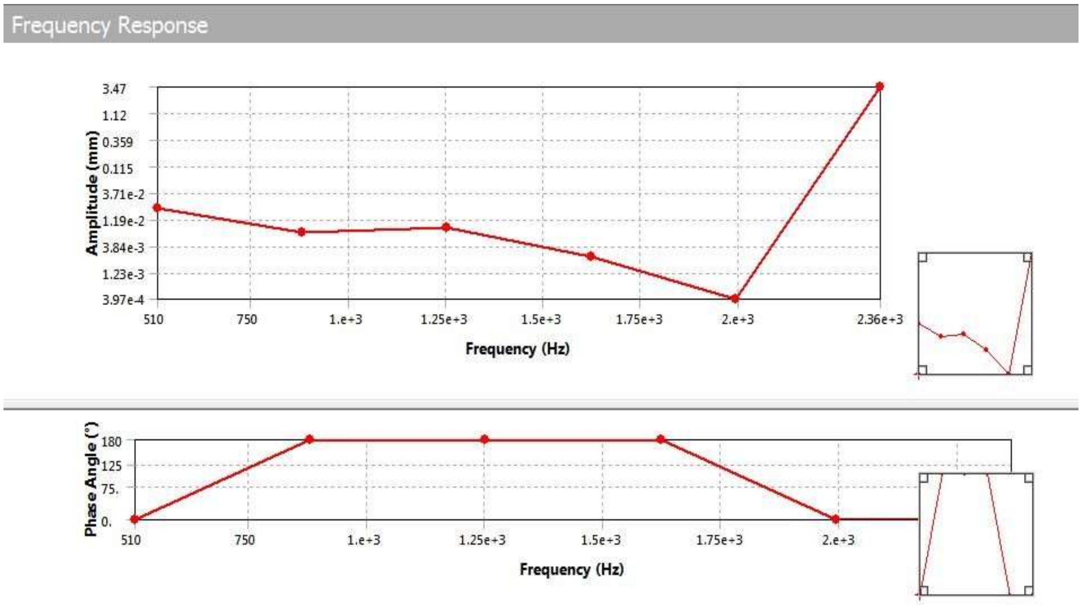


DEFORMATION 6

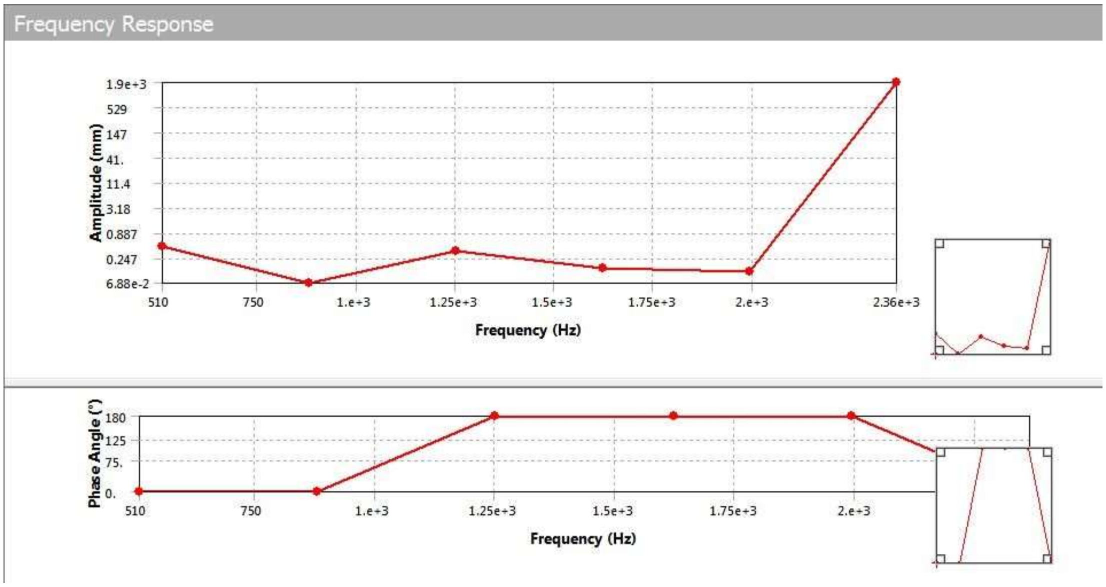
HARMONIC RESULTS



DIRECTIONAL DEFORMATION x- AXIS



DIRECTIONAL DEFORMATION Y-AXIS



DIRECTIONAL DEFORMATION Z- AXIS

HEAT FLUX RESULTS TABLE:

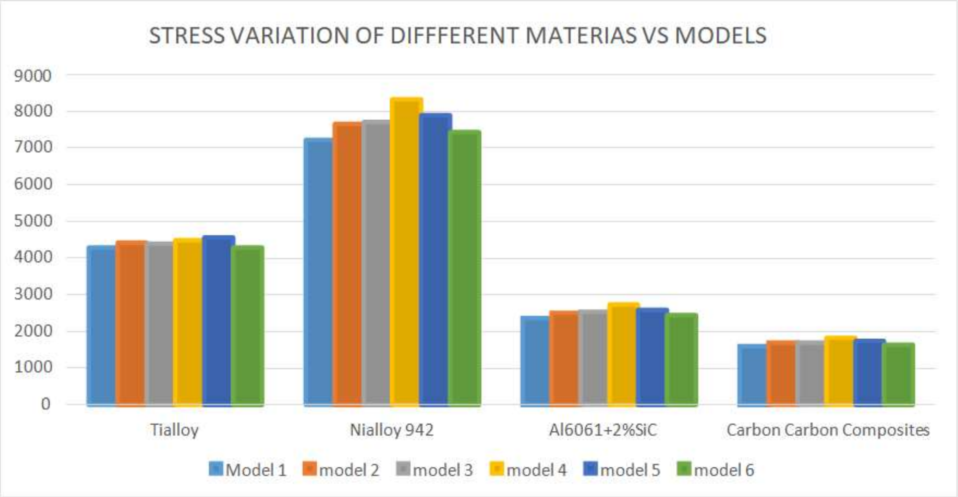
	Model1	Model2	MODEL3	MODEL4	MODEL5	MODEL6
Tialloy	0.089827	0.059921	0.059825	0.089904	0.0754	0.063632
Nialloy942	0.090552	0.060309	0.060206	0.090629	0.075899	0.064038
Al 6061 +2%SiC	0.090698	0.060387	0.060282	0.090775	0.075999	0.06412
Carboncarbon composites	0.090363	0.060208	0.060107	0.09044	0.075769	0.063932

STRESS RESULTS TABLE:

	Model1	Model2	MODEL3	MODEL4	MODEL5	MODEL6
Tialloy	4295.4	4419.2	4397.7	4492	4564	4292.9
Nialloy942	7221.8	7665.1	7714.5	8332.3	7901.2	7437.6
Al 6061 +2%SiC	2372	2517.6	2533.8	2736.7	2595.1	2442.9
Carbon carboncomposites	1602.9	1694.1	1701.3	1825	1745.2	1636.7

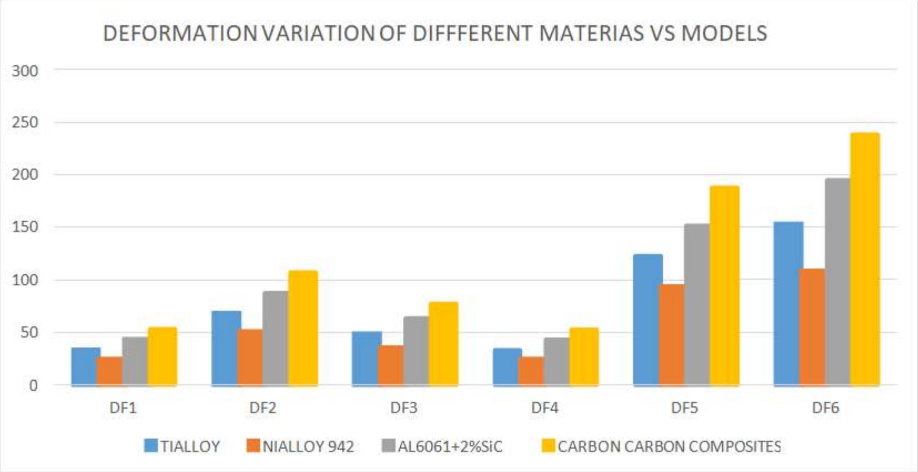
DEFORMATION RESULTS TABLE:

	Model1	Model2	MODEL3	MODEL4	MODEL5	MODEL6
Tialloy	57.066	57.07	58.156	56.886	56.896	57.933
Nialloy942	64.493	64.619	65.783	64.286	64.41	65.522
Al 6061 +2%SiC	20.759	20.8	21.174	20.692	20.732	21.09
Carbon carbon composites	29.151	29.2	29.73	29.057	29.106	29.613

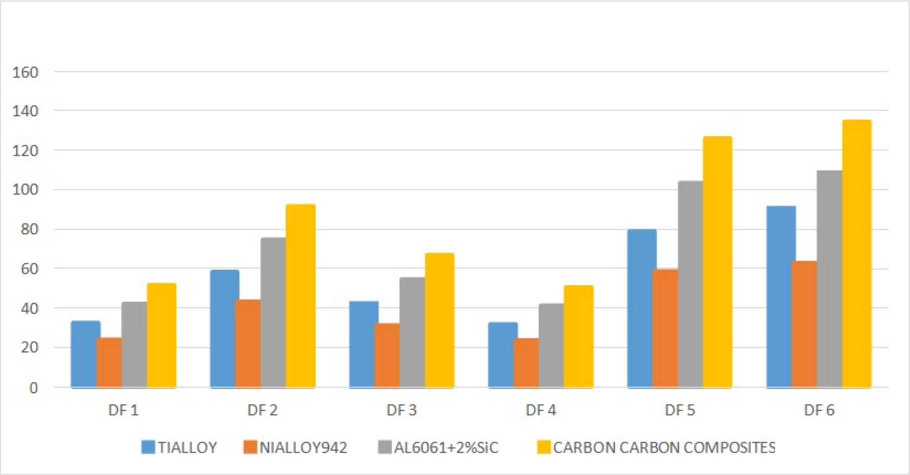


STRESS VARATION GRAPHS

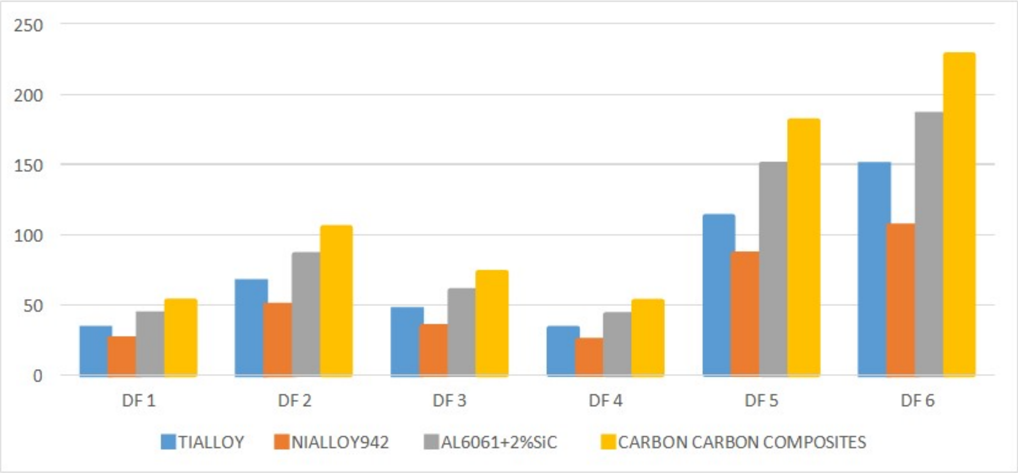
VIBRATIONAL ANALYSIS GRAPHS:



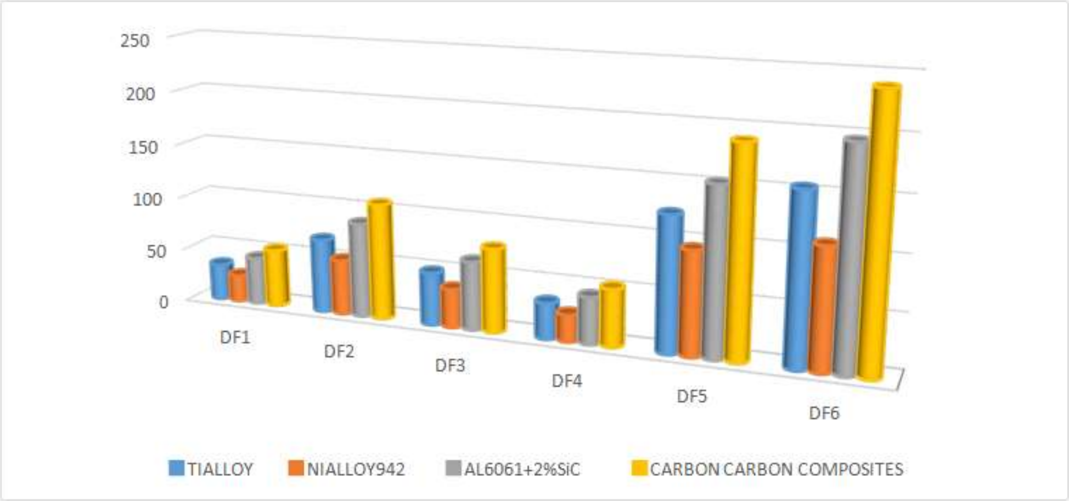
MODEL 1



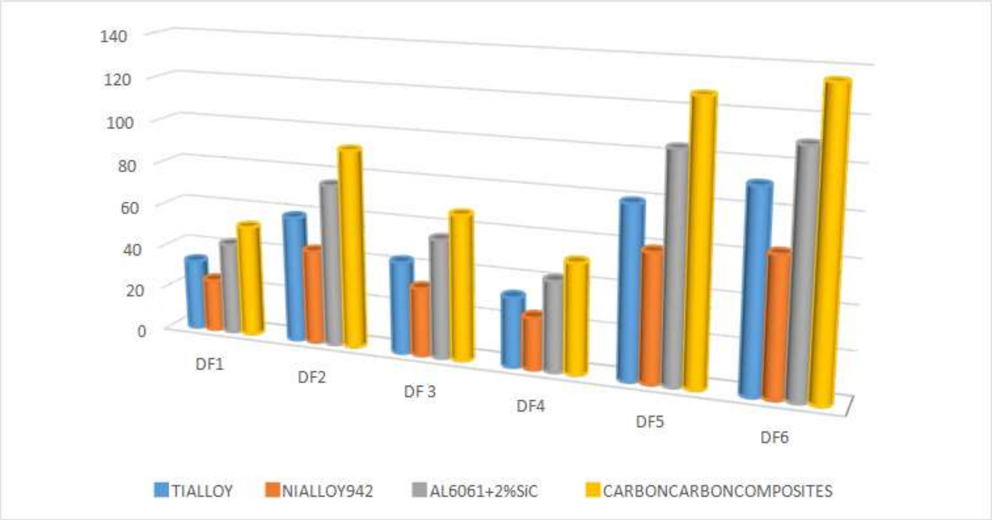
MODEL 2



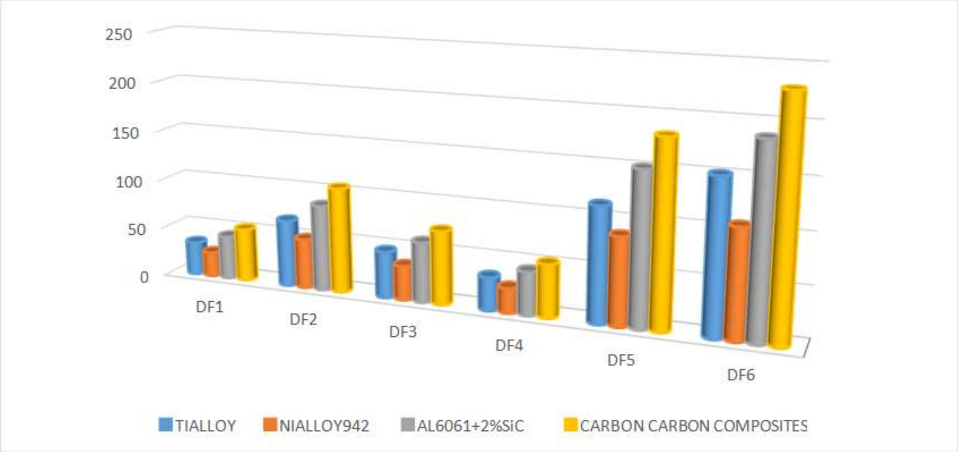
MODEL 3



MODEL 4



MODEL5



MODEL 6

CONCLUSION

In this assingment, we used the available CMM point data to design a turbine blade using the 3D modelling programme catia. NACA data source used for CMM statatics. By using various pressures for various levels of speed, we are conducting structural, thermal, model, and harmonic analysis in this endeavour. To get improved results. Some modifications are made as well as changing the blade angles in this thesis using the NACA series. To get improved results, some modifiactions are made as well as changing the blade angles in this thesis using the NACA series. In our endeavour, wer’e using thermal analysis to determine how the temperature is distributed across the blade. Temperature is also applied during thermal reasearch, which verifies the thermnal properties of the blade. We discovered stresses forming on the blade and its mode shape throgh the a for mentioned analysis. Additionally, we are creating graphs for each outcome. To deteremine the thermal stresses, structural and thermal studies are carried out in ANSYS.CATIA is the standard in 3D product design, featuring industry-leading productivity tools that promote best practicies in design

Therefore, all of the findings from the anlysis are tabulated in tabular and graphical format,

- We can see from the findings that the temperature decreases when composites are used, and theat there is little difference between the models developed here.
- The heat flow graph shows that when the model number is changed from model 1 to model 6, the heat flux decreases.
- The flux is satisfied for the model 4 using the composite material al 6061+ 2% SiC, according to all the findings.
- Based on the static findings, composites are used to reduce the stress in this situation. We can infer from the graphical findings that using carbon-carbon composites, the stress is better for models 1 and 6.
- According to deformation findings here, composite materials have also out performed alloys in terms of results.
- Any model from 1to model 6 for carbon-carbon composited and Al 6061

  +2%SiC material has the best results, according the above graphs.
- From the vibrational anlaysis, we can see that as the frequency rises,all models and even materials experience an increase in deformation that is followed by a decline.
- So from the final results we can connclude that the model 1 or model 6 using composite materials can be used.

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