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STRUCTURAL ANALYSIS OF GAS TURBINE BLADE BY USING ANSYS

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Abstract-The gas turbine obtains its power by utilizing the energy of burnt gases and the air which is at high temperature and pressure by expanding through the several rings of fixed and moving blades. Since the turbine blades are working at high temperature and pressure there are extreme stresses developed on turbine blades. The first centrifugal stresses act on the blade due to high angular speeds, and second is thermal stresses that arise due to temperature gradient within the blade material. The present paper is review of various analyses done on turbine blades and there are various factors effects on turbine blade. This paper will be helpful for those who are working in the area of power plants.
Keywords: Turbine Blade, Stress, Strain and Deformation.

1. INTRODUCTION

Gas turbines have become one of the most important prime movers especially in aircraft propulsion, land-based power generation, and industrial applications. The gas turbine is a power plant, which produces comparatively greater energy per unit size and weight. Its compactness, low weight and multiple fuel application make it a natural power plant for many applications. It is clear from Brayton cycle that the increase in pressure ratio increases the gas turbine thermal efficiency accompanied with increase in Turbine Entry Temperature (TET). The increase in pressure ratio increases the overall efficiency at a given temperature. However, increasing the pressure ratio beyond a certain value at any given TET can actually result in lowering the overall cycle efficiency.

2. LITERATURE SURVEY

S.Gowreesh et.al [1] studied on the first stage rotor blade of a two stage gas turbine has been Analysed for structural, thermal, modal analysis using ANSYS 15.0.which is powerful Finite Element Method software. The temperature distribution in the rotor blade has been evaluated using this software. The design features of the turbine segment of the gas turbine have been taken from the preliminary design of a power turbine for maximization of an existing The purpose of turbine technology is to extract the maximum quantity of energy from the working fluid to convert it into useful work with maximum efficiency by means of a plant having maximum turbo jet engine. It has been felt that a detail study can be carried out on the temperature effects to have a clear understanding of the combined mechanical and thermal stresses.

Kauthalkar et.al. [2] The purpose of turbine technology is to extract, maximum quantity of energy from the working fluid to convert it into useful work with maximum efficiency. That means, the Gas turbine having maximum reliability, minimum cost, minimum supervision and minimum starting time. The gas turbine obtains its power by utilizing the energy of burnt gases and the air. This is at high temperature and pressure by expanding through the several rings of fixed and moving blades. A high pressure of order 4 to 10 bar of working fluid which is essential for expansion, a compressor is required. The quantity of working fluid and speed required are more so generally a centrifugal or axial compressor is required. The turbine drives the compressor so it is coupled to the turbine shaft.

John.v et.al. [3] studied on the design and analysis of Gas turbine blade, CATIA is used for design of solid model and ANSYS software for analysis for FEA .model generated, by applying boundary condition, this paper also includes specific post-processing and life assessment of blade .HOW the program makes effective use of the ANSYS pre-processor to mesh complex turbine blade geometries and apply boundary conditions. Here under we presented how Designing of a turbine blade is done in CATIA with the help of co-ordinate generated on CMM. And to demonstrate the pre-processing capabilities, static and dynamic stress analysis results, generation of Campbell and Interference diagrams and life assessment. The principal aim of this paper is to get the natural frequencies and mode shade of the turbine blade.

V. Raga Deepu et.al. [4] Studied on a Gas turbine is a device designed to convert the heat energy of fuel in to useful work such as mechanical shaft power. Turbine Blades are most important components in a gas turbine power plant. A blade can be defined as the medium of transfer of energy from the gases to the turbine rotor. The turbine blades are mainly affected due to static loads. Also the temperature has significant effect on the blades. Therefore the coupled (static and thermal) analysis of turbine blades is carried out using finite element analysis software ANSYS.

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3. DEFINITION OF PROBLEM

The definition of the problem is to know the response of the stresses on the blade to the variations in gas temperatures & turbine speeds. In this project we performed structural and thermal analysis by applying various gas temperatures & turbine speeds. By doing above analysis we found stresses developing on blade & the temperature distribution over the blade.
Modelling of the turbine blade is done using CATIA V5, which facilitates collaborative engineering across various disciplines. The static structural analysis of turbine blade is done using ANSYS 15, which is a dedicated finite element package used for determining the variation of stress and deformation across the turbine blade.

4. MODELLING AND ANALYSIS OF GAS TURBINE BLADE

The blade model profile is generated by using CATIA software. The contour (2D model) is then converted into area and then volume (3D model) was generated by extrusion. The hub is also generated similarly. These two volumes are then combined into single volume. This model of turbine blade is then imported into ANSYS software. The blade is then analysed sequentially with structural analysis. Surface of the blade is applied with Surface element for applying the convection loads. The loads considered for structural analysis are centrifugal, axial & tangential forces.
The model is created and analysed using various FEA and FEM software (ANSYS, CATIAV5). For automatic mesh generation and node is used. The structural analysis of FEA software is used for the analysis of the rotor blade. The rotor blade was analysed for mechanical stresses, strain and Deformation.

Table-4.1 Material Details

Material 1	Material 2
AISI 4130 Steel (super alloy steel)	Special Metals INCONEL® Alloy 625
Yield strength: 4.6e+008 N/m^2	Yield strength: 1170 N/mm^2
Tensile strength: 5.6e+008 N/m^2	Tensile strength: 1450N/mm^2
Elastic modulus: 2.05e+011 N/m^2	Elastic modulus: 2.18e+011 N/m^2
Poisson's ratio: 0.285	Poisson's ratio: 0.330
Mass density: 7850 kg/m^3	Mass density: 8400 kg/m^3

5. STRAIN RESULT

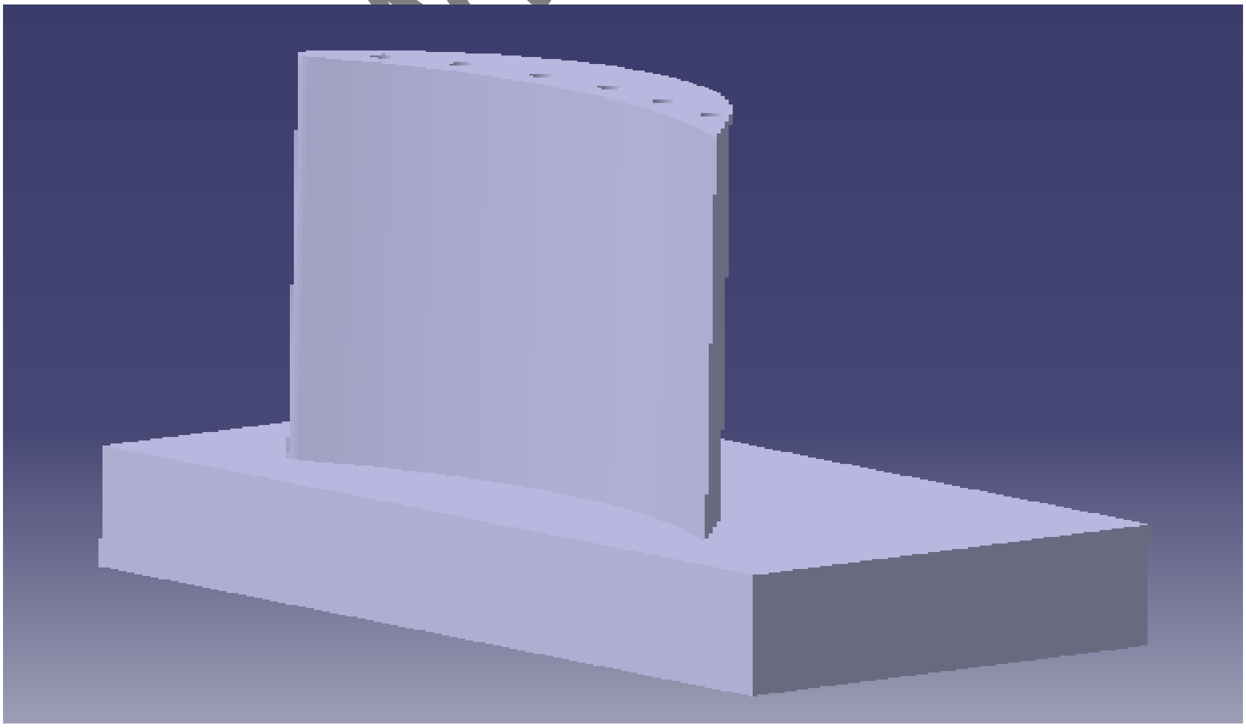

Fig 5.1 Analysis Model of Turbine Blade

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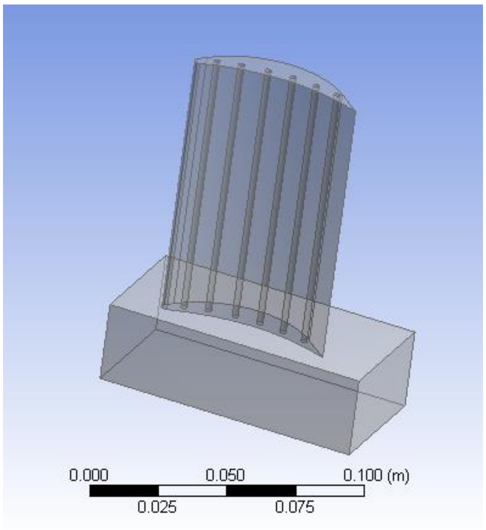

Fig. 5.2 Applying Boundary Condition

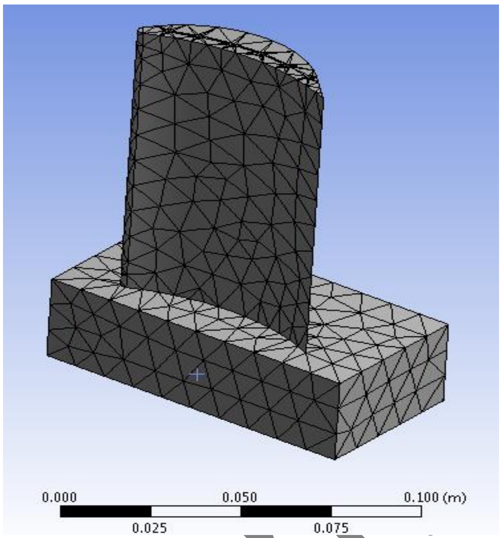

Fig. 5.3 Applying Pressure

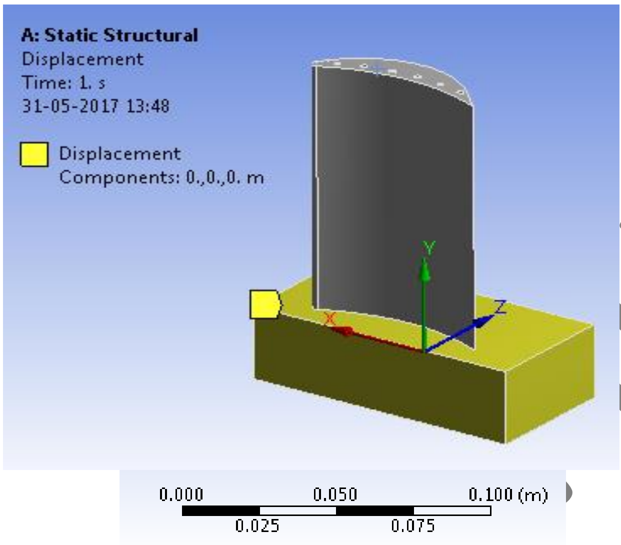

Fig. 5.4 Material-1 AISI 4130 Steel (Super Alloy Steel)

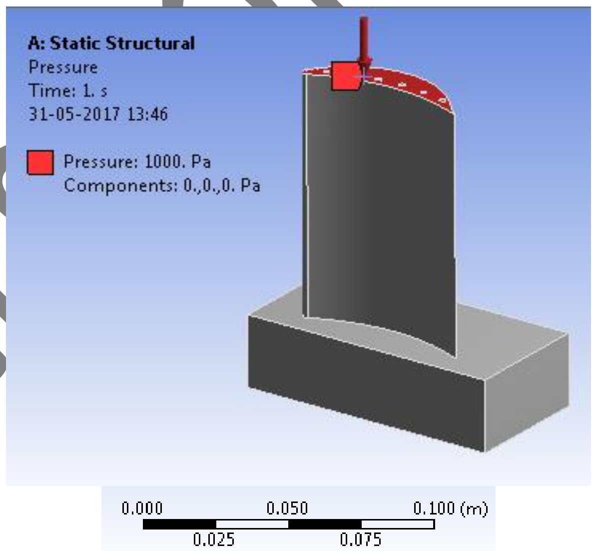

Fig. 5.5 Material-2 INCONEL® Alloy 625

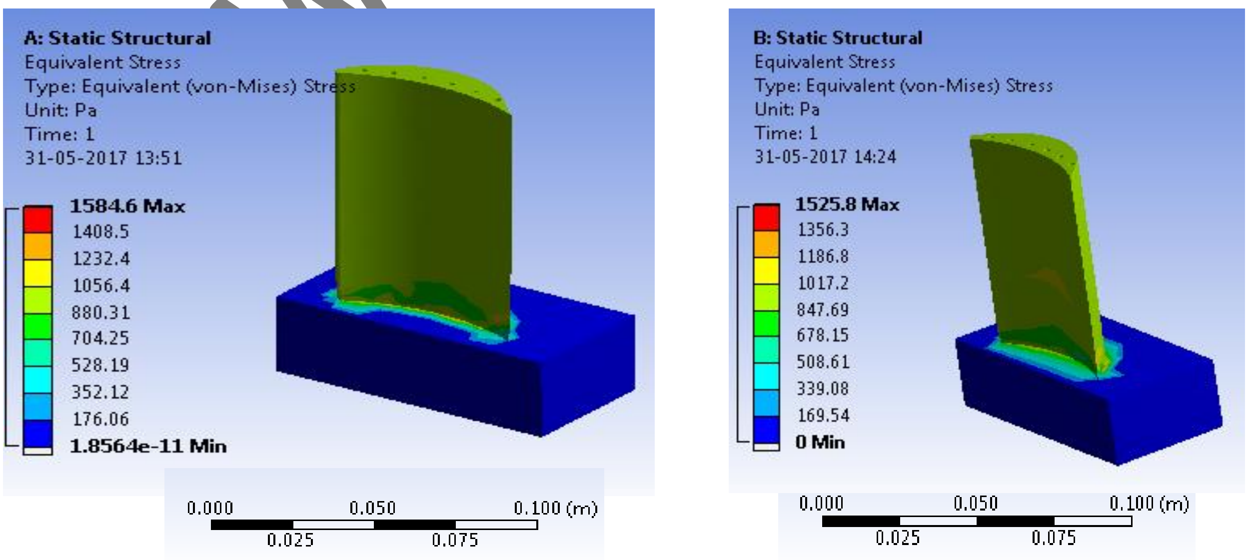

Fig. 5.6 Stress Result

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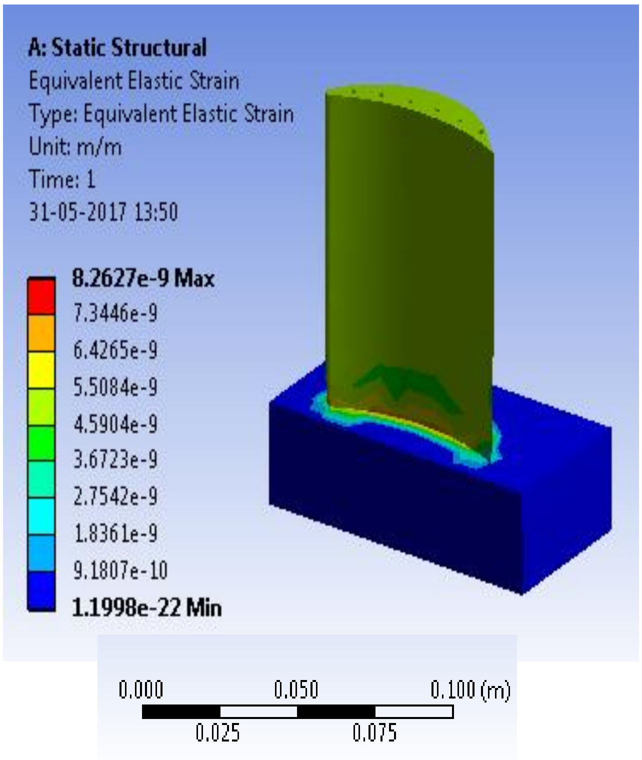


Fig. 5.7 Material-1 AISI 4130 Steel (super alloy steel)

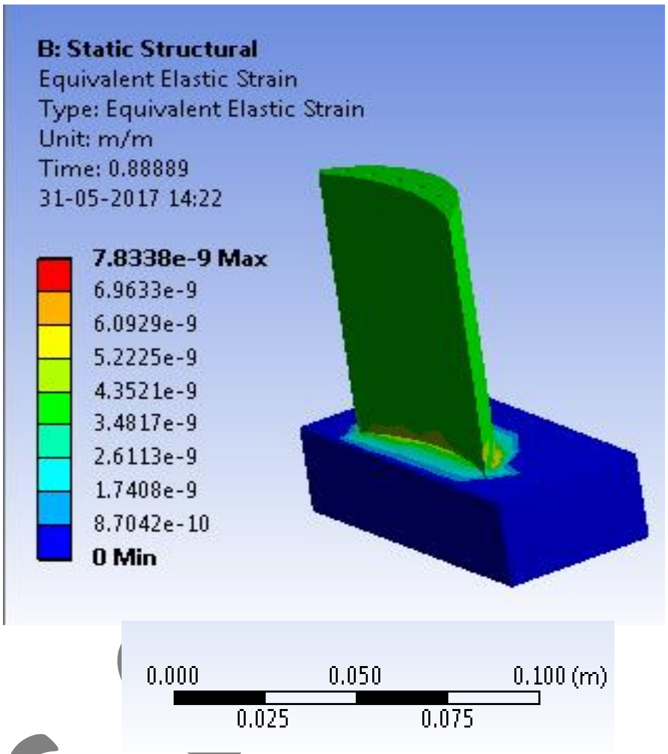
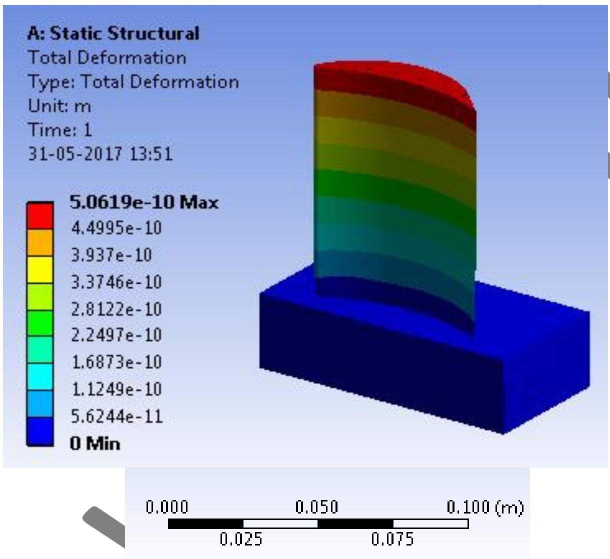


Fig. 5.8 Material-2 INCONEL® Alloy 625



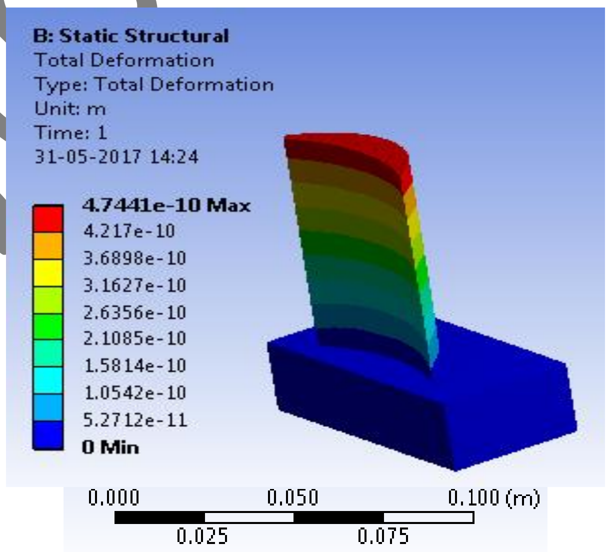


Fig. 5.9 Total Deformation

CONCLUSION

Material	Stress N/mm	Strain N/mm	Deformation
AISI 4130 Steel	1584.6	8.2627e-9	5.0619e-10
INCONEL Alloy 625	1525.5	7.8338e-9	4.7441e-10

From the above results we can conclude that using INCONEL 625 is more beneficial than previous materials, due to low stress, strain and displacement.

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