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STRUCTURAL AND THERMAL ANALYSIS OF STEAM TURBINE CASING USING ANSYS

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Abstract— Steam turbine is an excellent prime mover to convert heat energy of steam to mechanical energy. In power generation mostly steam turbine is used because of its greater thermal efficiency and higher power-to-weight ratio. Because the turbine generates rotary motion, it is particularly suited to be used to drive an electrical generator – about 80% of all electricity generation in the world is by use of steam turbines. In addition, the realization of critical turbine components need improved design and materials, which offer all possibilities for a cost effective and flexible service. High thermal stress gradients were found at the region of casing where fatigue cracks were detected during engine operation. In this work the thermal mechanical analysis of steam turbine casing will be established by finite element method. In this work the temperature and stress distributions for turbine inner casing were calculated by finite element analysis. The three-dimensional model of the Steam Turbine Casing was created using the SOLIDWORKS software. Boundary conditions were given on the finite element model through ANSYS.

Index Terms— 3D CAD model, Ansys Analysis, Comparing Results, Designs

1 Introduction

The steam energy is converted mechanical work by expansion through the turbine. The expansion takes place through a series of fixed blades (nozzles) and moving blades each row of fixed blades and moving blades is called a stage. The moving blades rotate on the central turbine rotor and the fixed blades are concentrically arranged within the circular turbine casing which is substantially designed to withstand the steam pressure.

- To analyse steam turbine casing geometry using Ansys for different materials.
- To obtain the various contour in the form of temperature, pressure, velocity and heat flux.
- To Observe the effect of turbine Material on the performance of system.
- Result comparison for both materials

Steam turbines consist essentially of a casing to which stationary blades are fixed on the inside and a rotor carrying moving blades on the periphery. The rotor is fitted inside the casing with the rows of moving blades penetrating between the rows of fixed blades. Thus, steam flowing through the turbine passes alternately through fixed and moving blades with the fixed blades directing the steam at the right angle for entry into the moving blades. Both casings and rotors must be constructed to minimize damaging thermal stresses and the moving blades must be fitted to the rotor securely to withstand the high centrifugal forces. Where the shaft of the rotor passes through the ends of the casing, a seal is required to prevent steam leakage. Also, within the casing, seals are required to prevent steam from leaking around the blades rather than passing through them. Turbine seals are of the labyrinth type where there is no mechanical contact between the fixed and rotating parts. Leakage is thus not really eliminated but merely controlled to minimal amounts. The shafts of the rotors are carried on bearings and are linked together and to the electrical generator. Bearings must be properly aligned to accommodate the natural gravitational bending of the shaft. Allowance must also be made for differential expansion between the rotors and the casings during thermal transients.

2 Methodology

Initially, we have gone through the literature and read some articles available online related to piston design and analysis than after discussing with the project guide we have confirm the project. Firstly, we created the piston model with flat surface with the help of CATIA and SOLIDWORKS and imported the model to the ANSYS software for analysis and get the final results.

Same as for the second design, we prepared the model and import it to the ANSYS for analysis. After the analysis we get the final report, then after getting both the reports we compared the results of both the piston models and make the final report.

2.1 Proposed Method

1. Analysis of literature and review some articles.
2. After discussion with guide, we have confirm the project.
3. Create CAD design of steam turbine casing.
4. Import the design to the Ansys.
5. Analysis the final result of material 1.
6. Repeat the steps for material 2.
7. Compare the result of both the materials and make final report.

3 GEOMETRIES

3.1 CAD Model 1

CAD model preparation in SOLIDWORKS software

- We have been supplied with the file of the Steam turbine Casing; We have designed the Steam turbine Casing according to the dimensions supplied to me in SOLIDWORKS. The following figures show the development of the design in the SOLIDWORKS.

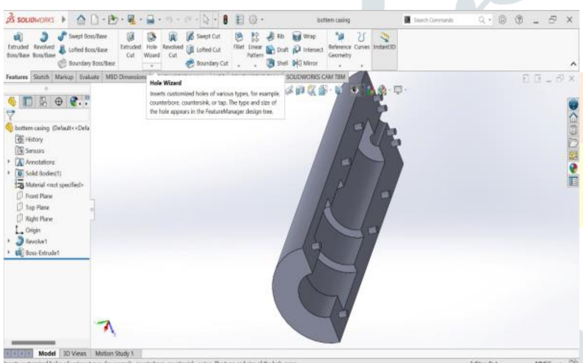


Fig 1.1

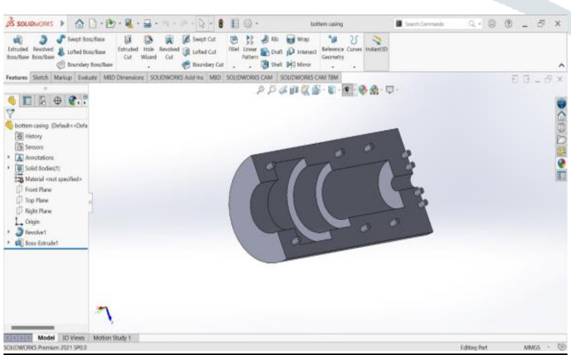


Fig 1.2

4. Importing to Ansys

Importing the model to the ANSYS software for analysis and performed different operation on the design with the help of static structural method i.e.,

- Total Deformation
- Total Heat Flux
- Directional Heat flex

4.1. Model 1 :

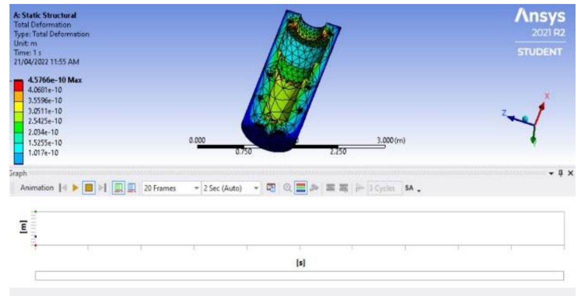


Fig 1.1

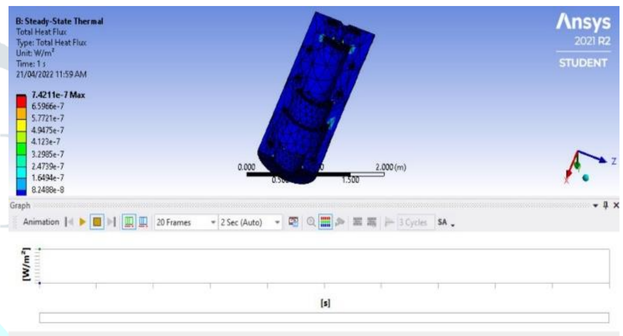


Fig 1.3

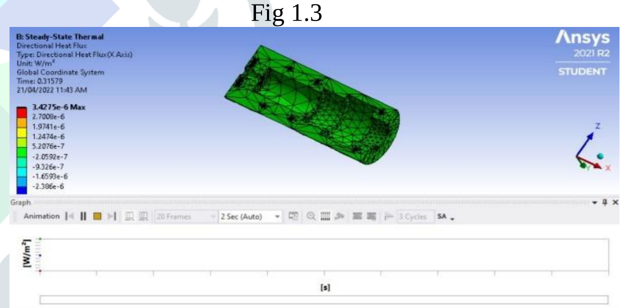


Fig 1.2

Fig 1.4

4.2. Model 2 :

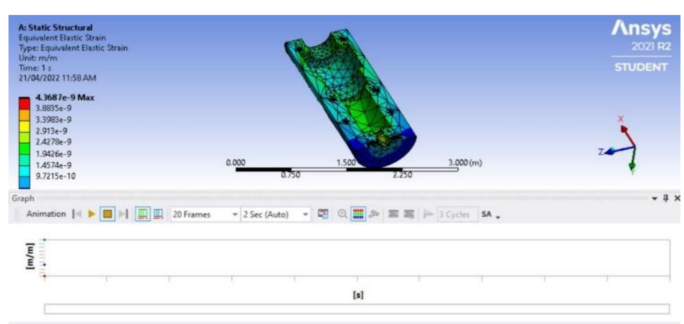


Fig 2.1

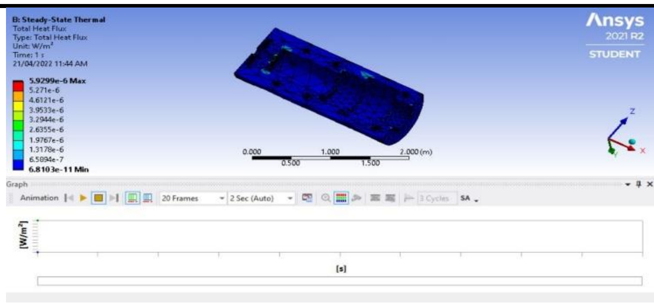


Fig 2.2

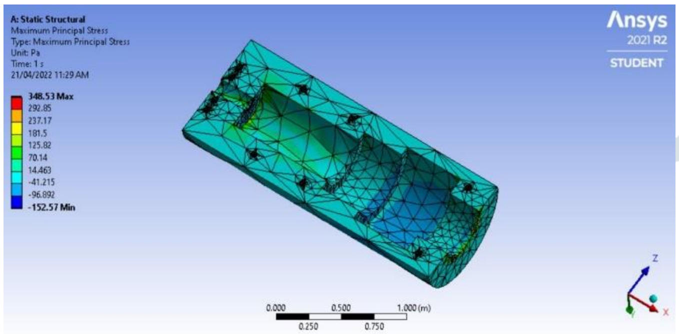


Fig 2.3

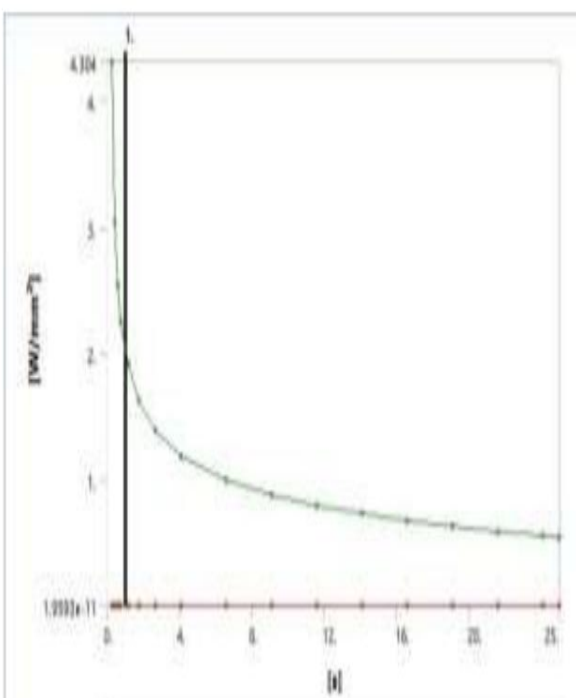
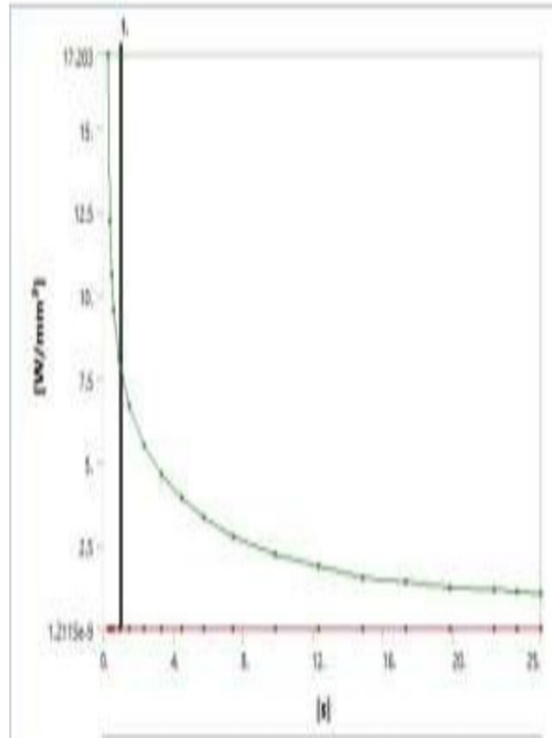


Fig 2.4



5. Result Comparison

Result 1

Young's Modulus Pa	Poisson's Ratio	Bulk Modulus Pa	Shear Modulus Pa	Temperature C
7.1e+010	0.33	6.7686e+010	2.5955e+010	23

Result 2

Young's Modulus Pa	Poisson's Ratio	Bulk Modulus Pa	Shear Modulus Pa	Temperature C
7.904e+010	0.33	7.7686e+010	2.5955e+010	23

With the comparison we can see that the model 2 performance is better than the model 1 and gives better results than the model 1 in different tests performed in ANSYS

S.NO.	MATERIAL	DENSITY Kg/mm^3	THERMAL CONDUCTIVITY	SPECIFIC HEAT	YOUNG'S MODULES	POISSOINS RATIO
1.	Titanium	4620 kg m^-3	21.9 W m^-1 C^-1	522 J kg^-1 C^-1	9.6e+010	0.36
2.	Aluminium	2770 kg m^-3	2.3e-005 C^-1	875 J kg^-1 C^-1	7.1e+010	0.33
3.	Nickle	8.9e-6 kg m^-3	9e-2 C^-1	4.4e J kg^-1 C^-1	2.32+010	0.32

6. CONCLUSIONS

In this present work we selected **ALUMINIUM ALLOY** and **TITANIUM ALLOY** material are used as Casing materials. Also test the heat flux distribution with different casing materials from the above-mentioned materials.

At the initial stage the temperature applied to the casing inside as 320 degree Celsius and outside casing as 22 degrees Celsius and the convention heat transfer distribution was observed as fallows. The Temperature and Heat flux Distribution of Turbine Casing with different materials, for one second has been observed. Also, the temperature and Heat Flux Distributions by time (1s) is shown above

7. ACKNOWLEDGMENT

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