KARMAVIR DADASAHEB KANNAMWAR COLLEGE OF ENGINEERING, NAGPUR

DEPARTMENT OF MECHANICAL ENGINEERING

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CERTIFICATE

Certified that the project titled **“EFFECT OF THERMAL SHOCK AND THERMAL LOAD FOR STEAM TURBINE BLADE FOR STUDYING ENDURANCE AND CREEP USING FINITE ELEMENT ANALYSIS”** is a bonafide work done under my guidance and is submitted to **Rashtrasant Tukadoji Maharaj Nagpur University, Nagpur** for the partial fulfillment of the requirements for the award of Post Graduation Degree, **Master of Technology(M.Tech.) in Mechanical Engineering Design.(MED)**

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ABSTRACT

The turbine blade of steam turbine rotor is subjected to temperature variations in short periods of time due to the start and stop cycles of the turbine. This causes sudden changes in the temperature with transient thermal stresses being induced into the turbine rotor. The transient effect is due to the changes in the material properties like Density, Specific heat and Young's Modulus. The estimate of thermal stresses induced in the turbine blade is important in determining the startup cycle of a steam turbine. Thermal gradients developed during thermal transients are the key source of stress generation in the rotor. Evaluation of stresses are essential for finding the fatigue as well as the creep induced in the component.

Rotating discs are historically, areas of research and studies due to their vast utilization in industry. Steam turbine blades are one of the examples to name. Transient thermal analysis is the thermal analysis wherein boundary conditions and properties change with time. This to say that the constraints such as ambient temperature, thermal coefficient, material properties etc. are time dependent. Transient thermal analysis is important in analyzing models that are subjected to material properties and boundary conditions that vary with time and temperature.

There are many Finite element packages available for conducting the transient thermal analysis, fatigue analysis and creep analysis. Some of the packages are NASTRAN,ABAQUS,ANSYS, NISA, PRO-MECHANICA etc. These packages allow the designer to vary the ambient temperature with time, vary the convective heat transfer coefficients and heat flux with time/temperature, and also allow heat generation to be applied.

A significant amount of design effort invested to determine the optimal process Parameters for start-up (e.g. steam temperatures, run-up and loading gradients), in order to achieve the fastest possible starts without exceeding allowable material stress limits.

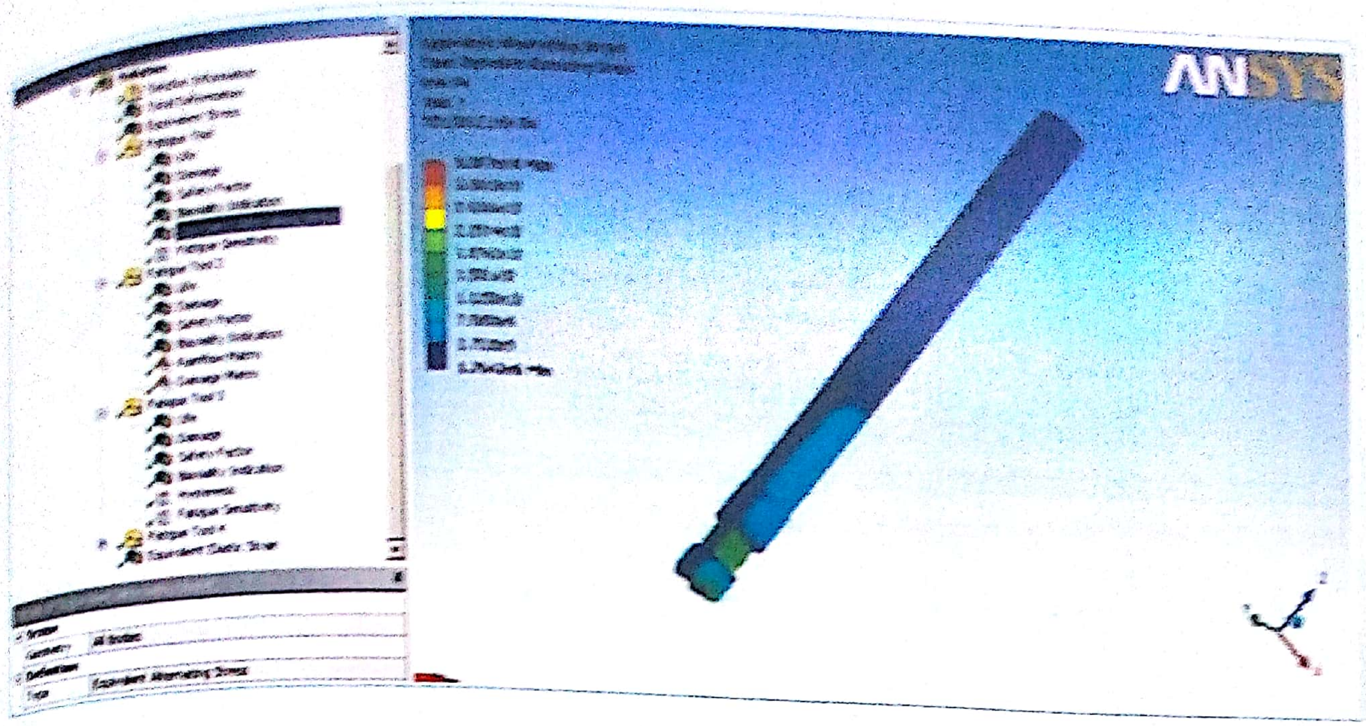

Figure 8.3: Results for Equivalent alternating stress

8.5 RESULTS FOR CREEP STRAINS VS TIME:

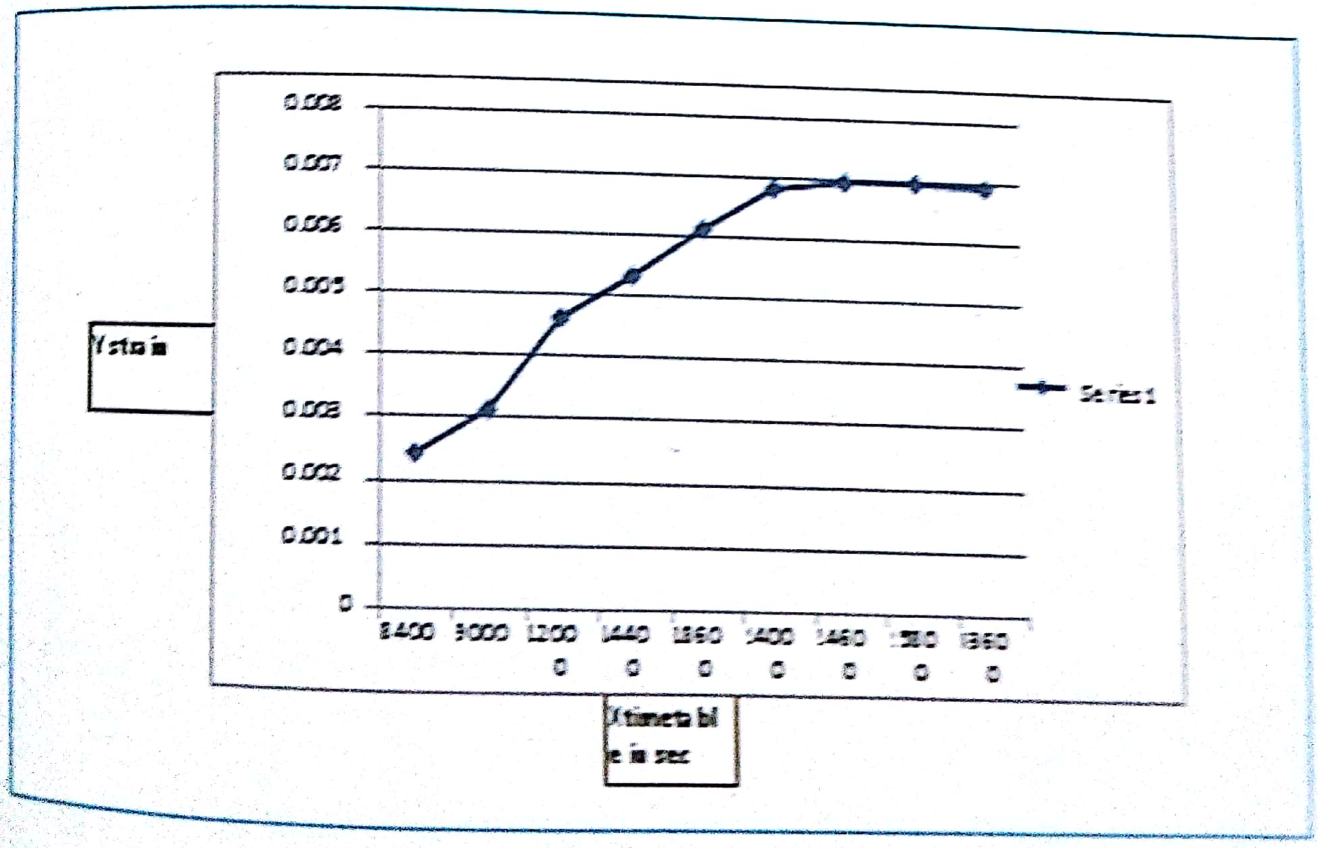

Figure 8.4: Graph between creep strain (Y axis) Vs Time (X axis)

CONCLUSION

CONCLUSIONS ARE AS FOLLOWS:

9.1 In this work the effect of thermal shock and thermal loads were studied on the steam turbine blade in order to learn endurance and creep which are the prime reasons to failure in the components operating at high temperature.

9.2 The Thermal analysis is carried out for cold start cycle. For cold start cycle the ambient temperature was 45 deg C and maximum temperature was 540 deg C for cycle duration of 560 minutes (33600) Seconds .The speed of the turbine rotor was 3000 rpm .Initially the steam enters on the turbine blade at 140 minutes at the temperature of 250 degree Celsius. Thermal stresses are evaluated as a result of thermal loads by finite element method

9.3 These vonmises (equivalent) stresses and the shear stress are the inputs to the fatigue analysis. For constant amplitude loading the results are obtained in the form of S-N curve (alternating stress amplitude Vs number of cycles to failure) .The curve obtained represents no endurance limit which means that the component will fail at every number of cycles.

9.4 After the fatigue analysis is done, creep phenomenon is studied for the blade attached to the rotor running at the speed of 3000 rpm and the steam temperature is at 540 degree Celsius. At the end of 33600 seconds (10^5cycles) the creep strains were found as 0.007 which is very less. Hence failure due to creep phenomenon does not occur.