DEPARTMENT OF MECHANICAL ENGINEERING

K. D. K. COLLEGE OF ENGINEERING, NAGPUR

Rashtrasant Tukadoji Maharaj Nagpur University, Nagpur.

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CERTIFICATE

Certified that the project titled **TO STUDY THE EFFECT OF CHANGE IN TIME OF START UP CONDITIONS IN COLD START AND WARM START IN STEAM TURBINES OF POWER GENERATING UNITS USING FINITE ELEMENT METHOD** is bonafide work done under my guidance and is submitted to Rashtrasant Tukadoji Maharaj Nagpur University, Nagpur for the partial fulfillment of requirement for the award of post-graduation degree, **Master of Technology (M.Tech.)** in Mechanical Engineering Design (M.E.D.)

Dr. C. C. Handa

Guide & Head of the Department

K.D.K.C.E., Nagpur

Dr. D. P. Singh

Principal

K.D.K.C.E., Nagpur

ABSTRACT

The turbine rotor 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 rotor 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.

Rotating elements are historically, areas of research and studies due to their vast utilization in industry. Steam turbine rotor is 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. 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.

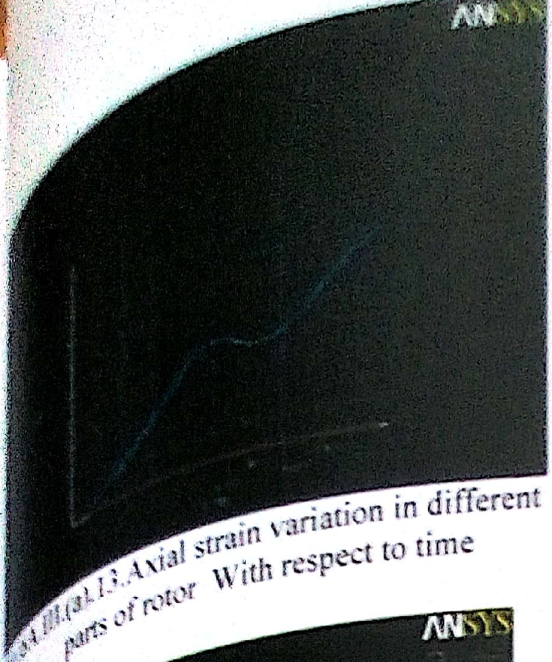

fig.6A.III.(a).13.Axial strain variation in different parts of rotor With respect to time

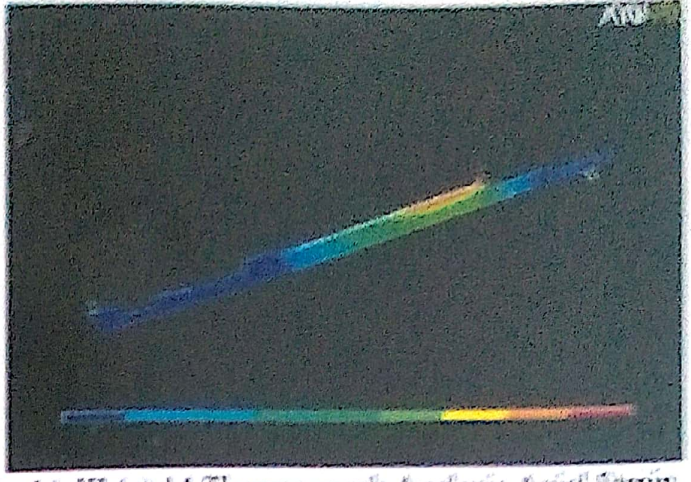

fig.6A.III.(a).14.Thermo-mech Analysis Axial Strain Distribution

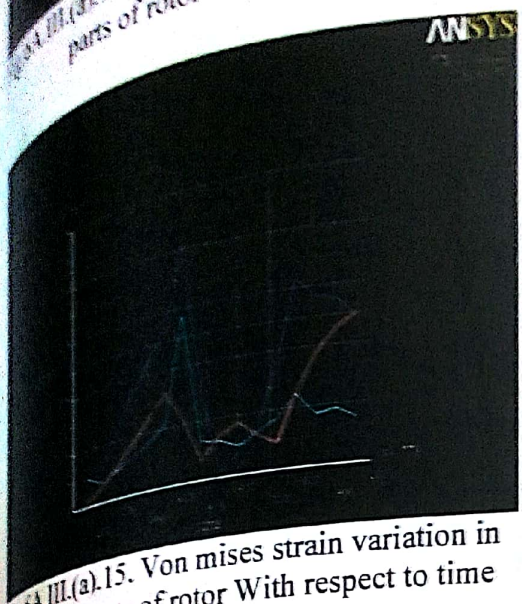

fig.6A.III.(a).15. Von mises strain variation in different parts of rotor With respect to time

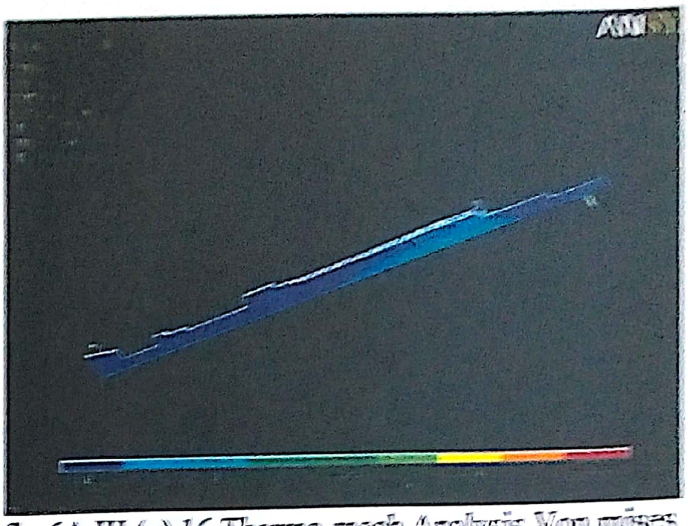

fig.6A.III.(a).16.Thermo-mech Analysis Von mises Strain Distribution

T.6A..III.1.(a) Maximum Transient Thermo-mechanical Stresses and Thermo-mechanical Strain Values in Warm start Cycle (130 Minutes)

Sr.No.	Particulars	Value	Time Step	Physical Location
1	Max.Von Mises Stress	502 Mpa	3600 Secs(60 Mins)	9th Stage(Groove)
2	Max. Hoop Stress	118 Mpa	3600 Secs(60 Mins)	Axis line below first 5 stages
3	Max. Radial Stress	61 Mpa	3600 Secs(60 Mins)	6th Stage(Groove)
4	Max.Axial Stress	193 Mpa	3600 Secs(60 Mins)	Axis line below first 13 stages
5	Max.Von Mises Strain	2.61E-03	3600 Secs(60 Mins)	9th Stage(Groove)
6	Max.Hoop Strain	8.41E-03	7800 Sec(130 Mins)	First Stage(Entry Point)
7	Max. Radial Strain	8.41E-03	7800 Sec(130 Mins)	First Stage(Entry Point)
8	Max.Axial Strain	8.41E-03	7800 Sec(130 Mins)	First Stage(Entry Point)

CONCLUSION AND FUTURE SCOPE

CONCLUSION

From the comparative results tabulated in the Table Nos. 7(V), 7(VI), 7(VII) & 7(VIII) it is observed that

1). The thermo-mechanical von mises stress values for reduced cold and warm start up cycle are higher than the actual cold and warm start up cycle.

2). Although the thermo-mechanical von mises stresses for reduced cold start up cycle of 440 minutes (353 Mpa) and for reduced warm start up cycle of 160 minutes (337 Mpa) are higher as compared to the thermo-mechanical stresses for the actual cold & warm start up cycle respectively, these values are below the allowable yield and tensile strength of the material.

3). The thermo-mechanical stress values for the other reduced cold start up cycle (320 mins) and reduced warm start up cycle (130 mins) are quite higher than the allowable yield and tensile strength of the material and hence cannot be considered as feasible start up cycles.

CHECKING FOR STRESSES

T.9.1 MECHANICAL PROPERTIES OF MATERIAL 30CR1MO1V ON ELEVATED TEMPERATURE

Test Temperature		0.2% Yield Strength		Tensile Strength	
°F	°C	ksi	MPa	ksi	MPa
200	93	170	1172	204	1407
400	204	163	1124	198	1365
600	316	159	1096	195	1344
800	427	156	1076	191	1317
1000	**538**	**155**	**1069**	**185**	**1276**
1200	649	149	1027	168	1158
1400	760	110	758	110	758