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AN OBSERVATIONAL ANALYSIS OF THERMAL AND STATISTICAL PROPERTIES OF A TURBINE BLADE OF TURBOCHARGER

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ABSTRACT

This paper borders around analysis of rotary engine blade. The blade could be a rotating half that converts mechanical energy into energy. rotary engine blade is important a part of turbocharger that has shown increasing growth of failure damaging rotary engine disk. It deals with Static and thermal analysis of rotary engine blade that is created from metal 718 to estimate its performance. The causes of failure for rotary engine blade have additionally been distinguished. The investigation has been done exploitation SoildWorks 2012 and ANSYS ten.0 software. SolidWorks 2012 is employed for modeling of rotary engine blade and analysis has been done by ANSYS ten.0 software. an effort has been created to analyze the impact of iatrogenic stresses, pressure and temperature on the rotary engine blade. A structural analysis has been meted out to analyze the stresses and displacements of the rotary engine blade. A thermal analysis has been meted out to analyze the thermal gradient and thermal stress.

Index Terms: ANSYS, FEA, INCONEL 718, Turbine blade, SolidWorks

I. INTRODUCTION

A turbocharger could be a rotary engine driven forced induction device wont to enable additional power to be created by associate engine of a given size. A turbocharger will increase mass of air coming into the engine cylinder sanctioning additional fuel burning in engine cylinder to provide additional power. Performance is improved as energy is recovered from exhaust waste. In exhaust gas turbocharging exhaust gas energy is employed to drive rotary engine. The rotary engine is coupled to mechanical device, which pulls in combustion air, compresses it so is equipped to engine recess.

The turbocharger was fictional by Swiss engineer king Buchi (1879-1959), World Health Organization received a patent in 1905 for employing a mechanical device driven by exhaust gasses to force air into an enclosed combustion engine to extend power output however it took another twenty years for the concept to return to fulfillment. king Buchi explicit in his 1905 patent that burning engines have terribly low potency as a result of common fraction of the energy is lost through exhaust heat. He wished to capture that heat and use it to enhance the engine.

The main part in turbocharger is central housing assembly of that rotary engine is main part. The break down and failures of turbo machineries are influencing like of import damages, hazards to public life and most significantly the price to repairs .To avoid these, it's obvious that the blading of turbo machinery should be created structurally stronger.

II. FINITE ELEMENT ANALYSIS OVERVIEW

Finite part analysis (FEA) involves resolution of engineering issues exploitation computers. Engineering structures that have complicated pure mathematics and hundreds, ar either terribly tough to investigate or haven't any theoretical resolution. However, in FEA, a structure of this kind are often simply analyzed. industrial FEA programs, written so a user will solve a fancy engineering issues while not knowing the governing equations or the arithmetic, the user is needed solely to understand the pure mathematics of the structure and its boundary conditions. FEA software package provides an entire resolution together with deflections, stresses and reactions.

FEA is Explained in 3 steps

- **Preprocess**

Using a CAD program the structure is modeled. A model consists of several elements that collectively represent the entire structure. The geometry of the structure, the constraints, loads and mechanical properties of the structure are defined. Thus, in pre-processing, the entire structure is completely defined by the geometric model. The structure represented by nodes and elements is called mesh.

- **Answers**

This phase can be performed in the Model Solution task of the simulation application, or in an equivalent external finite element solver. Model Solution can solve for linear and nonlinear static, dynamics, buckling, heat transfer, and potential flow analysis problems.

- **Afterprocess**

CAD program is utilized to manipulate the data for generating deflected shape of the structure, creating stress plots, animation. Graphical representation of the results is useful in understanding behavior of the structure.

Modeling and meshing of turbine blade.

Modelling by using SolidWorks 2012

The geometry of turbine is drafted based on the dimensions of geometric parameters. SOLIDWORKS 2012 software is used for modeling of turbine blade. Solid modeling of axial turbine with 64 numbers of rotor blades with hub and shaft is shown in fig. 1. A single rotor blade geometry is modeled in SOLIDWORKS 2012 and is saved in IGES format as it will be used for analysis purpose is shown in fig. 2.

Fig. a Turbine blade of rotor assembly

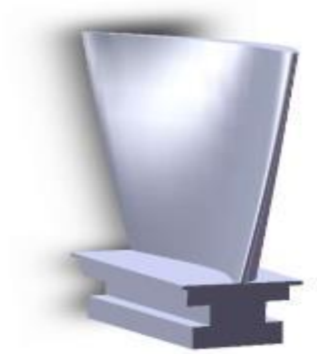

Fig. b Single turbine blade

Meshing using ANSYS 10.0

Turbine blade model is imported in ANSYS, and is meshed properly in Mechanical APDL ANSYS to divide it into elements and nodes. Tetramesh is used for turbine blade, and element size length is 1 mm. Quality checks and mesh optimization for elements were also performed taking into consideration of aspect ratio, distortion, stretch.

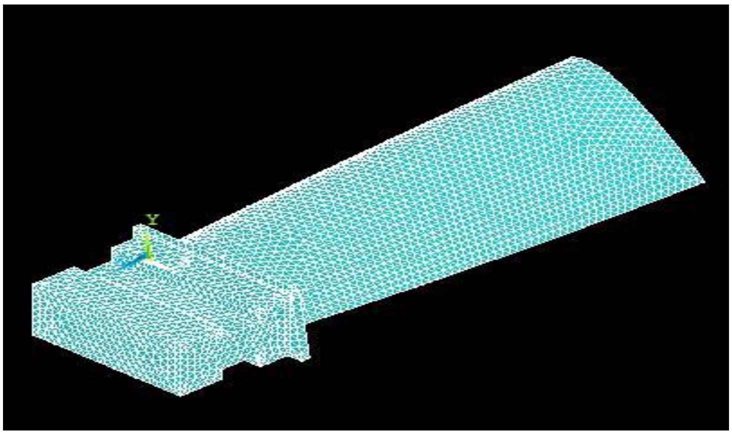

Fig. c Meshed model of turbine blade

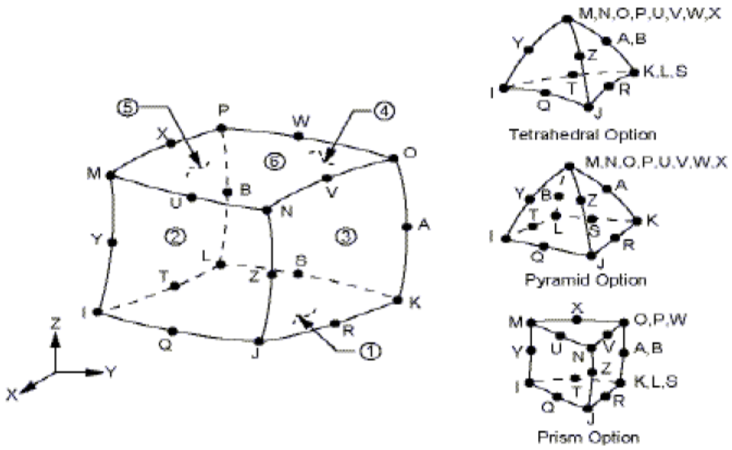

Fig.d 4 Solid 186 3D-node element

SOLID186 is a higher order 3-D 20-node solid element that exhibits quadratic displacement behavior as shown in Fig. 4 is used as element. The element is defined by 20 nodes having three degrees of freedom per node:

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translations in the nodal x, y, and z directions. The element supports plasticity, hyperelasticity, creep, stress stiffening, large deflection, and large strain capabilities.

Nodes: I, J, K, L, M, N, O, P, Q, R, S, T, U, V, W, X, Y, Z, A, B.

Degrees of Freedom: UX, UY, UZ.

Material Properties: EX, EY, EZ, ALPX, ALPY, ALPZ, PRXY, PRYZ, PRXZ, DENS, GXY, GYZ, GXZ, DAMP.

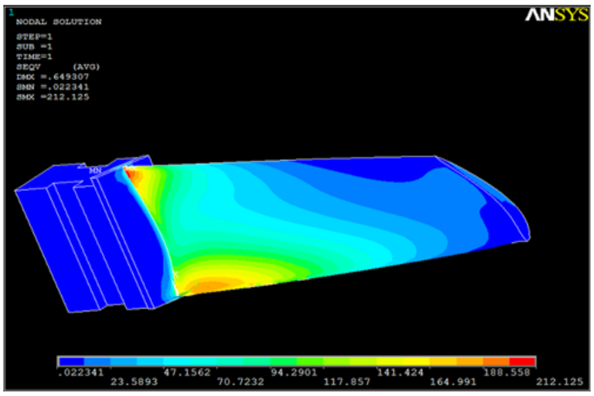
Surface Loads: Pressures.

Body Loads: Temperatures.

III. RESULTS AND DISCUSSION

Static analysis has been carried out to predict stress and displacement. Figure 5-10 shows result for von mises stress, stress in x-direction, stress in y-direction, stress in z-direction, displacement vector sum and displacement in y- direction.

Thermal analysis has been carried out to predict results. Figure 11-12 shows result for thermal gradient and thermal stress. Figure 13 shows the distribution of temperature on surface of turbine blade.



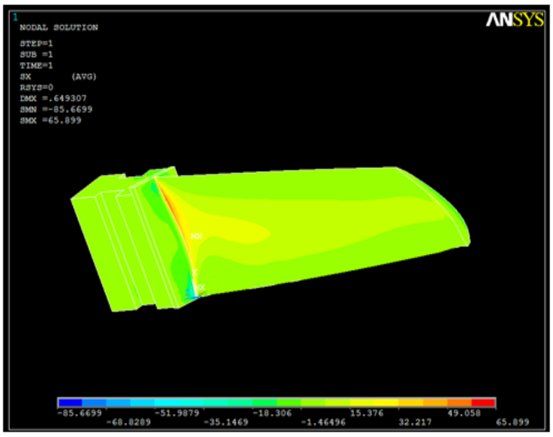
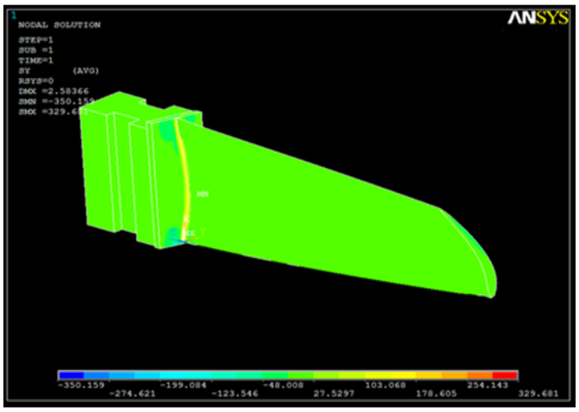


Fig. e Von mises stress **Fig. f Stress in X-direction**



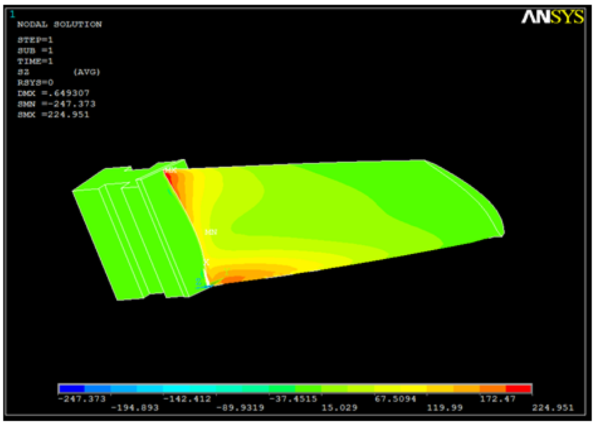
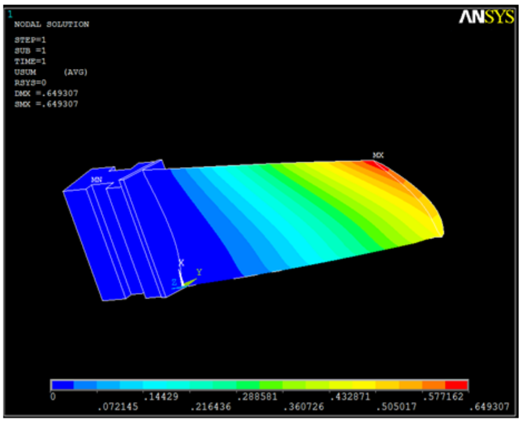


Fig.g Stress in Y-Direction **Fig. h Stress in Z-Direction**



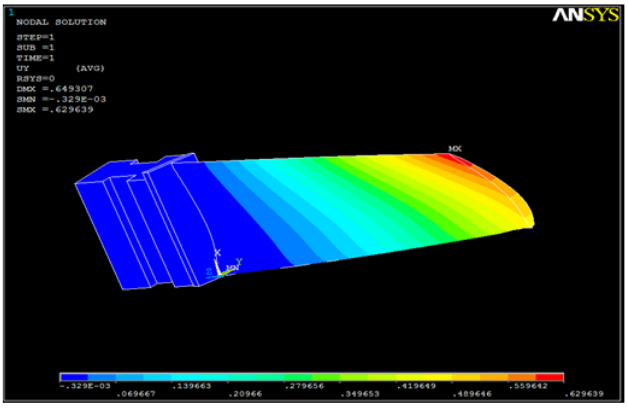


Fig. i Vector sum displacement **Fig. j Y-component displacement**

V. CONCLUSION

- Turbine rotor assembly is more vulnerable to failure due to structural and thermal load.
- Distribution of stress along blade was studied by software and it shows that critical region of turbine blade which is between hub and blade requires careful attention.
- Maximum deformation occurs at tip section of blade.
- Periodic maintenance is necessary to satisfy prescribed conditions of turbocharger like clearances, balancing, exhaust gas temperature to avoid vibrations.
- The rotor imbalancing need to look upon critically while carrying out analysis because change in thickness of blade seriously imbalance rotor causing rpm of rotor to be fluctuating and whirling of shaft.
- Structural and thermal analysis is carried out and maximum stress induced is within safe limit.

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