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Design and Analysis of First Stage 22omw Gas Turbine Rotor Blade

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ABSTRACT
Present work has been carried out on the structural and thermal analysis of first stage hallow rotor blade of a two-stage gas turbine using ANSYS 14 which is the powerful Finite Element Software. Basic model is designed in the CATIA software which is then imported to ANSYS 14.0 By using Titanium alloy, Stainless steel alloy, Aluminum2024 alloy, Inconel 625 alloy and Haste alloy, the static and thermal analysis is carried out. Load conditions are applied on these materials to optimize the gas turbine Rotor blade Material. It is observed that the Maximum temperatures are formed at the blade tip section and are linearly decreasing from the tip of the blade to the root of the blade section. Deflection observed is minimum in the case of Titanium alloy and Stainless steel alloy. All the materials would be in safe position at that temperature and pressure except Haste alloy and Aluminum alloy as mechanical properties i.e. Yield strength are low when compared to the other materials.
Keywords – CATIA,ANSYS,GAS TURBINE ROTOR BLADE, Aluminum 2024 Alloy.

I. INTRODUCTION

CATIA Software is used for modeling and ANSYS is used for analysis.A Gas Turbine, also called a combustion turbine, is a type of internal combustion engine. It has an upstream rotating compressor coupled to a down stream turbine and a combustion chamber in-between.

The basic operation of the gas turbine is similar to that of the steam power plant except that air is used instead of water. Fresh atmospheric air flows through a compressor that brings it to higher pressure. Energy is then added by spraying fuel into the air and igniting it so the combustion generates a high-temperature flow.

The high-temperature high-pressure gas enters a turbine, where it expands down to the exhaust pressure, producing a shaft work output in the process. The turbine shaft work is used to drive the compressor and other devices such as an electric generator that may be coupled to the shaft.

II. 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 11.0.which is a 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 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 F.E.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 preprocessing
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 shafe of
the turbine blade.

In this paper the first stage rotor blade of the gas turbine is created in CATIA V5Software. This model has been analysed using ANSYS11.0. The gas forces namely tangential, axial were determined by constructing velocity triangles at inlet and exist of rotor blades. After containing the heat transfer coefficients and gas forces, the rotor blade was then analysed using ANSYS 11.0 for the couple field (static and thermal) stresses.

III. NOMENCLATURE

Fa Axial force
Fc Centrifugal force
Ft Tangential force
E Young's Modulus
□ □ Deflection
µ Poisson's ratio
□ □ Stress
L Length
D Diameter of shaft
N Speed of Turbine in RPM
α Coefficient of thermal expansion
Re Reynolds Number
Nu Nusselt number
Pr Prandtl number

3.1 Details of Turbine blade

N=3426 Rpm, L=168mm, t=8mm

3.2 Details Of Gas Turbine Blade Material

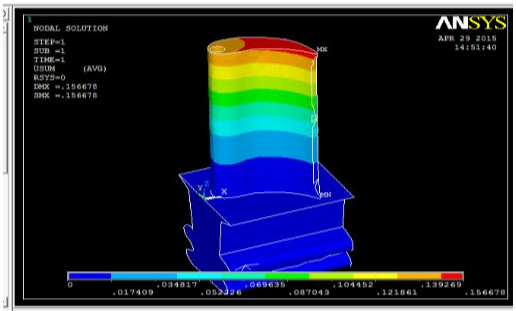
Properties	units	Inconel 625	Haste Alloy X
□	**kg/m^3**	8400	8300
K	**W/m.k^0**	10	25
□	**C^0**	15	16
CP	**J/kg.K^0**	410	450
E	**GPa**	150	144
□		0.331	0.348
M.P	**0_C**	1350	1380
□	**MPa**	1030	360

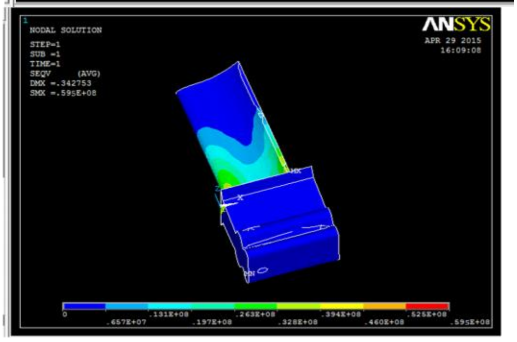
Properties	Units	Titaniun Alloy	Stainless Steel
□	**kg/m^3**	4700	8249
K	**W/m.k^0**	10	20
□	**C^0**	8.8	17.7
CP	**J/kg.K^0**	544	435
E	**GPa**	205	143
□		0.33	0.344
M.P	**0_C**	16.49	1354
□	**MPa**	1000	550

IV. RESULTS AND DISCUSSION

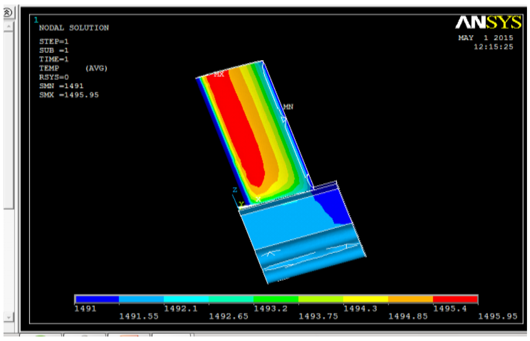
For Inconel 625

Von misses Stress for Inconel 625 Alloy is 625 N/mm^2



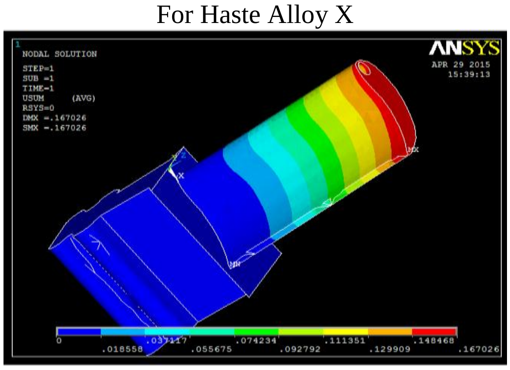


Deformation for inconel 625 alloy is 0.1556675 mm

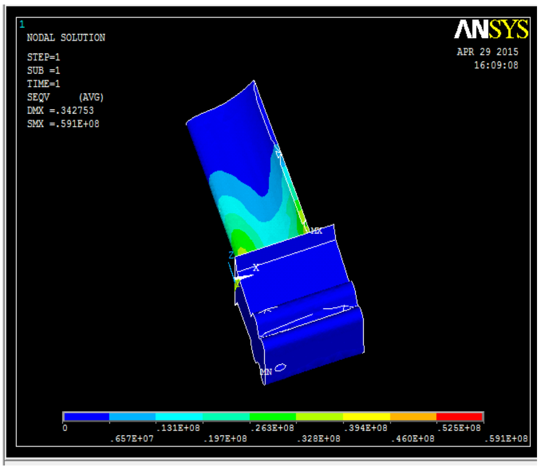


Thermal Flux for inconel 625 alloy is 0.63026 w/mm2

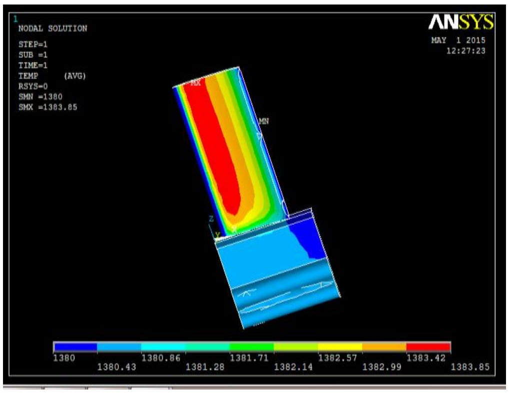
For Haste Alloy X



Von Misses Stress for Haste Alloy X is 413N/mm^2

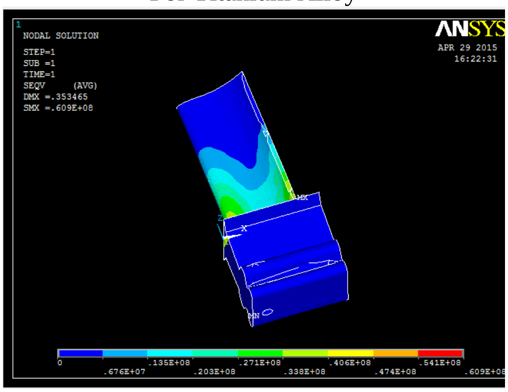


Deformation for Haste Alloy X is 0.1670 mm

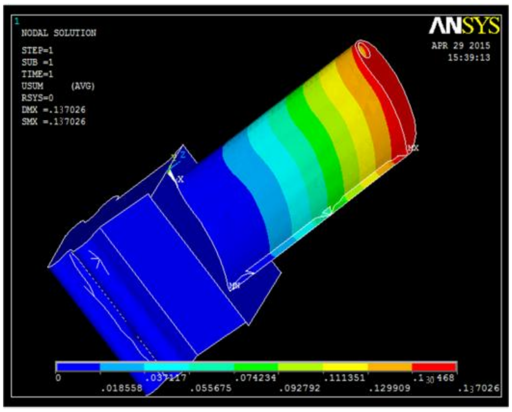


Thermal Flux for Haste Alloy X is 0.490218 **W/mm^2**

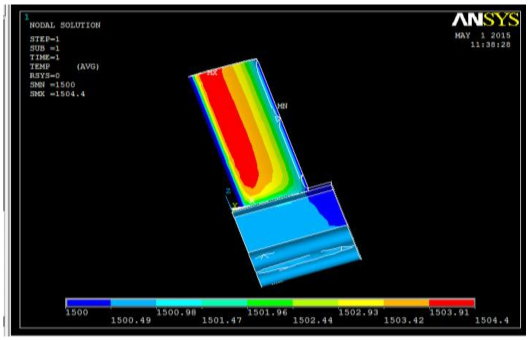
For Titanium Alloy



Von Misses Stress for Titanium Alloy X is 609N/mm^2

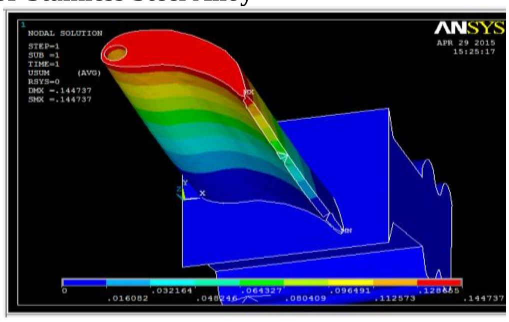


Deformation for Haste Titanium Alloy is 0.137026 mm

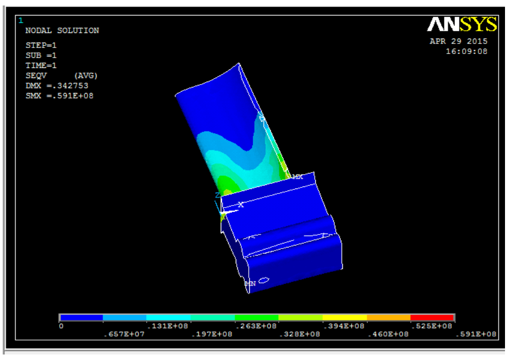


Thermal Flux for Haste Alloy X is 0.747055 **W/mm^2**

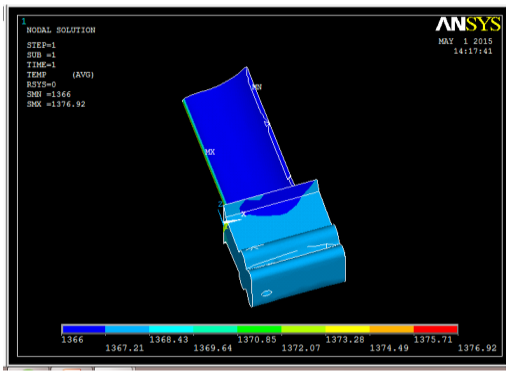
For Stainless Steel Alloy



Von Misses Stress for Stainless Steel Alloy is 0.14473 N/mm^2



Deformation for Stainless Steel Allloy is 0.14473 mm



Thermal Flux for Haste Alloy X is 1.07965 **W/mm^2**

	VonMisses Stress	**Deformation (mm)**	**Thermal Flux(w/mm2**
Inconel 625	595	0.1556675	0.63026
Haste Alloy X	413	0.1670	0490218
Stainless Steel	591	0.14473	1.09765
Titanium	609	0.137026	0.747055

V. CONCLUSIONS

The finite element analysis of gas turbine rotor blade is carried out using 8 nodded brick element. The static and thermal analyses are carried out. It is found out that -Maximum von misses stress observed in inconel 625 alloy and it is within the safe limit Maximum deformation obtained in stainless steel i,e 0.1670

For Stainless steel maximum thermal flux is 1.0975

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