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# Analysis of a Compessor Rotor using Finite Element Analysis

Munagunuri Suneel Babu*, N.Amaranageswararao**
*PG student, Department of mechanical engineering, Nimra institute of science & technology, Ibrahimpattanam.
**Guide(Assoc.Prof), Department of mechanical engineering, Nimra institute of science & technology, Ibrahimpattanam

## Abstract—

The compressor compresses its working fluid by first accelerating the fluid and then diffusing it to obtain a pressure increase. In an axial flow compressor, air passes from one stage to the next, each stage raising the pressure slightly. The energy level of air or gas flowing through it is increased by the action of the rotor blades which exert a torque on the fluid which is supplied by an electric motor or a steam or a gas turbine.

In this present work we are taken the existing model of transonic compressor test rotors which contains 18 blades. The model was modeled in Pro-E Creo 5.0 with existing dimensions and analyzed using Ansys14.5. For the analysis we are taken two different materials and compared the values.

For the further extension we changed the existing mode by decreasing the number of blades and analyzed with different materials. The developed stress values of the existing model are compares with the modified models.

Our objective is to increase the performance of the rotor blade by changing the materials and the model. From the observation we will suggest which model is suitable for the compressor rotor.

***Keywords— Ansys14.5,*** *compressor* ***, chromium steel , Pro-E Creo 5.0,*** *Rotor &* ***Titanium (g-5)***

## I. INTRODUCTION

An **compressor** is a machine that can continuously pressurise gases. It is a rotating, airfoil-based compressor in which the gas or working fluid principally flows parallel to the axis of rotation. This differs from other rotating compressors such as centrifugal compressors, axi-centrifugal compressors and mixed-flow compressors where the fluid flow will include a "radial component" through the compressor. The energy level of the fluid increases as it flows through the compressor due to the action of the rotor blades which exert a torque on the fluid. The stationary blades slow the fluid, converting the circumferential component of flow into pressure. Compressors are typically driven by anelectric motor or a steam or a gas turbine.

Axial flow compressors produce a continuous flow of compressed gas, and have the benefits of high efficiency and large mass flow rate, particularly in relation to their size and cross-section. They do, however, require several rows of airfoils to achieve a large pressure rise, making them complex and expensive relative to other designs (e.g. centrifugal compressors).

Axial compressors are integral to the design of large gas turbines such as jet engines, high speed ship engines, and small scale power stations. They are also used in industrial applications such as large volume air separation plants,blast furnace air, fluid catalytic cracking air, and propane dehydrogenation. Due to high performance, high reliability and flexible operation during the flight envelope, they are also used in aerospace engines.

## II. MODELING BY USING PRO-E

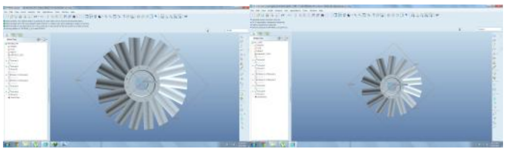

Fig.1&2 Actual 18 & modified14 blades model

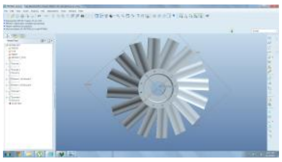

Fig.3 Modified 16 blades model

## III. ANALYSIS BY USING ANSYS

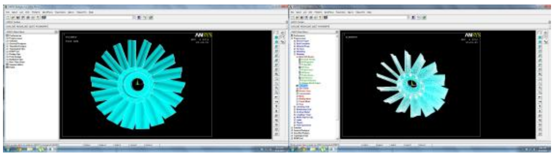

Fig.4&5 Imported model & Meshed model

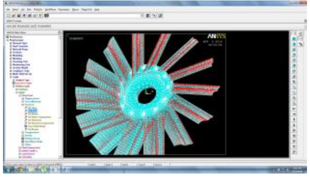

Fig.6 Loads applied model

## IV. RESULTS & DISCUSSION

Actual 18 blade model:

- For chromium steel

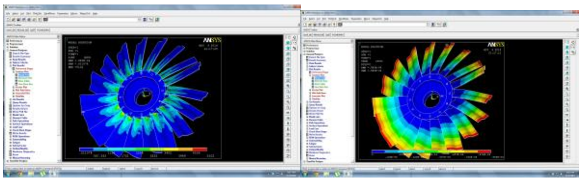

Fig.7&8Stress intensity & Deformed shape

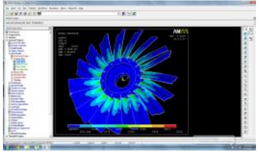

Fig.9 Vonmises stress

- For Titanium (g-5)

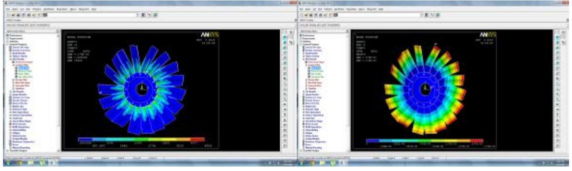

Fig.10&11 Stress intensity& Deformed shape

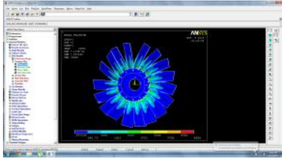

Fig.12 Vonmises stress

**Modified 16 blade model:**

- For chromium steel

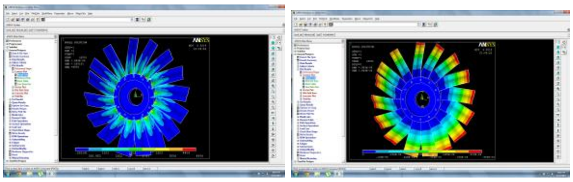

Fig.13 & 14 Stress intensity & Deformed shape

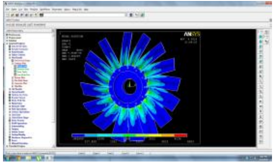

Fig.15 Vonmises stress

- For Titanium (g-5)

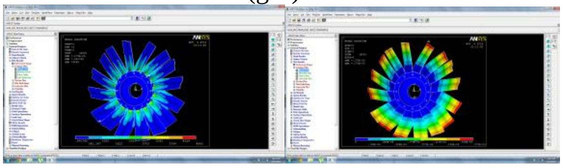

Fig.16 & 17 Stress intensity & Deformed shape

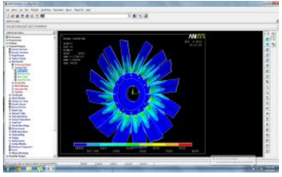

Fig.18 Vonmises stress

**Modified 14 blade model:**

- For chromium steel

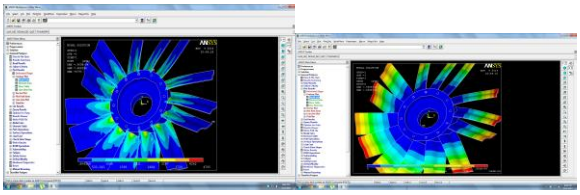

Fig.19 & 20 Stress intensity & Deformed shape

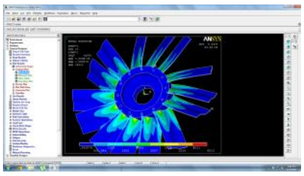

Fig.21 Vonmises stress

- For Titanium (g-5)

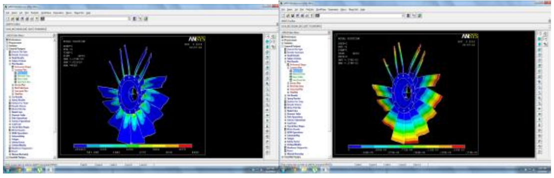

Fig.22& 23 Stress intensity & Deformed shape

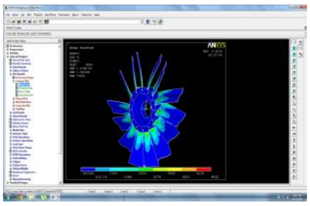

Fig.24 Vonmises stress

## V. RESULTS TABLE

| | ess intensity | | |
|---|---|---|---|
| odel/material used | blades | blades | blades |
| romium steel | 02 | 54 | 95 |
| anium (G-5) alloy | 24 | 65 | 26 |

Table.1 Stress intensity

| | formed shape | | |
|---|---|---|---|
| odel/material used | blades | blades | blades |
| romium steel | 5e4 | 3e4 | 9e4 |
| anium (G-5) alloy | 6e3 | 5e3 | 4e3 |

Table.1 Deformed shape

| | nmisses stress | | |
|---|---|---|---|
| odel/material used | blades | blades | blades |
| romium steel | 32 | 53 | 23 |
| anium (G-5) alloy | 62 | 58 | 32 |

Table.1 Vonmisses stress

## VI. CONCLUSION

The model was created in Pro-E creo-5 and saved in the format of IGES later the saved files was imported into Ansys for the analysis. In the analysis part structural analysis is performed on the two models by changing the material properties.

The obtained results were compared and by the observation we concluding that

## Results comparison by material:

1. For the original 18 blade model the stress values of chromium steel (actual material) are more than the titanium alloy (G-5) so titanium alloy material is best for the original 18 blade model.
2. For the modified 16 blade model the stress values of chromium steel (actual material) are more than the titanium alloy (G-5) so titanium alloy material is best for the original 16 blade model.
3. For the modified 14 blade model the stress values of chromium steel (actual material) are more than the titanium alloy (G-5) so titanium alloy material is best for the original 14 blade model.

   So we conclude that titanium alloy is best for rotor than chromium steel.

## Results comparison by the model:

If we compare the model stress values the number of stress values are increased with number of blades increased so here our observation is that by reducing the blades the stress values are reduced for the efficiency of the rotor we have to use composite materials with this by the reduction of blades also efficiency increased.

## Future scope:

1. By changing the blade dimensions the efficiency may increased.
2. By using composite materials the efficiency may obtained.
3. By varying the thickness of the rotor the efficiency may increased.

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