ISSN (e): 2250 – 3005 || Vol, 04 || Issue, 10 || October– 2014 ||
International Journal of Computational Engineering Research (IJCER)

Design & Analysis of a Disc Brake using Fea

Velveeta Lakshmikanth Chowdary[1], N. Amara Nageswara Rao[2]
[1]PG student, Department of mechanical engineering, Nimra institute of science & technology, Ibrahimpattanam
[2]Guide (Assoc.Prof), Department of mechanical engineering, Nimra institute of science & technology, Ibrahimpattanam

ABSTRACT:

Disc brake consists of a cast iron disc bolted to the wheel hub and a stationary housing called caliper. The caliper is connected to some stationary part of the vehicle like the axle casing or the stub axle as is cast in two parts each part containing a piston. In between each piston and the disc there is a friction pad held in position by retaining pins, spring plates. The passages are so connected to another one for bleeding. Each cylinder contains rubber sealing ring between the cylinder and piston Due to the application of brakes on the disc brake rotor, heat generation takes place due to friction and this temperature so generated has to be conducted and dispersed across the disc rotor cross section. The aim of this paper was to investigate the temperature fields and also structural fields of the solid disc brake during short and emergency braking with four different materials. The distribution of the temperature depends on the various factors such as friction, surface roughness and speed. The effect of the angular velocity and the contact pressure induces the temperature rise of disc brake. The finite element simulation for two-dimensional model was preferred due to the heat flux ratio constantly distributed in circumferential direction. We will take down the value of temperature, friction contact power, nodal displacement and deformation for different pressure condition using analysis software with four materials namely cast iron, cast steel, aluminum and carbon fiber reinforced plastic. Presently the Disc brakes are made up of cast iron and cast steel. With the value at the hand we can determine the best suitable material for the brake drum with higher life span. The detailed drawings of all parts are to be furnished.

Keywords: *Ansys, Brake Drum, Disc Brake, Friction Pad, Wheel Hub, Pro-e.*

I. INTRODUCTION

- **CLASSIFICATION OF BRAKES**

The mechanical brakes according to the direction of acting force may be divided into the following two groups:

a) Radial brakes:

In these brakes the force acting on the brakes drum is in radial direction. The radial brakes may be subdivided into external brakes and internal brakes.

b) **Axial Brakes**:

In these brakes the force acting on the brake drum is only in the axial direction. i.e. Disk brakes, Cone brakes.

c) Disc brake

A disk brake consists of a cast iron disk bolted to the wheel hub and a stationary housing called caliper. The caliper is connected to some stationary part of the vehicle like the axle casing or the stub axle as is cast in two parts each part containing a piston. In between each piston and the disk there is a friction pad held in position by retaining pins, spring plates etc. passages are drilled in the caliper for the fluid to enter or leave each housing. The passages are also connected to another one for bleeding. Each cylinder contains rubber-sealing ring between the cylinder and piston.

- **Disc brake working:**

The disc brake is a wheel brake which slows rotation of the wheel by the friction caused by pushing brake pads against a brake disc with a set of calipers. The brake disc (or rotor in American English) is usually made of cast iron, but may in some cases be made of composites such as reinforced carbon–carbon or ceramic matrix composites. This is connected to the wheel and/or the axle. To stop the wheel, friction material in the form of brake pads, mounted on a device called a brake caliper, is forced mechanically, hydraulically, pneumatically or electromagnetically against both sides of the disc. Friction causes the disc and attached wheel to slow or stop. Brakes convert motion to heat, and if the brakes get too hot, they become less effective, a phenomenon known as brake fade. Disc-style brakes development and use began in England in the 1890s. The first caliper-type automobile disc brake was patented by Frederick William Lanchester in his Birmingham, UK factory in 1902 and used successfully on Lanchester cars. Compared to drum brakes, disc brakes offer better stopping performance, because the disc is more readily cooled. As a consequence discs are less prone to the "brake fade"; and disc brakes recover more quickly from immersion (wet brakes are less effective). Most drum brake designs have at least one leading shoe, which gives a servo-effect. By contrast, a disc brake has no self-servo effect and its braking force is always proportional to the pressure placed on the brake pad by the braking system via any brake servo, braking pedal or lever, this tends to give the driver better "feel" to avoid impending lockup. Drums are also prone to "bell mouthing", and trap worn lining material within the assembly, both causes of various braking problems.

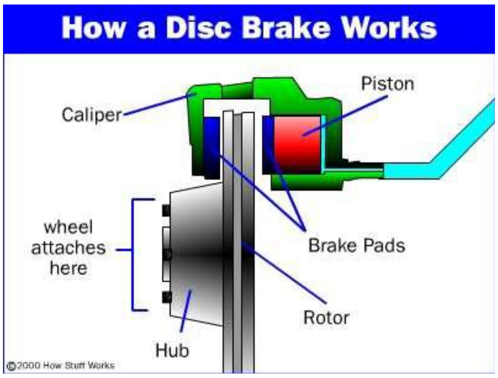


Fig. 1 Disk Brake

II. MODELING BY USING PRO-E

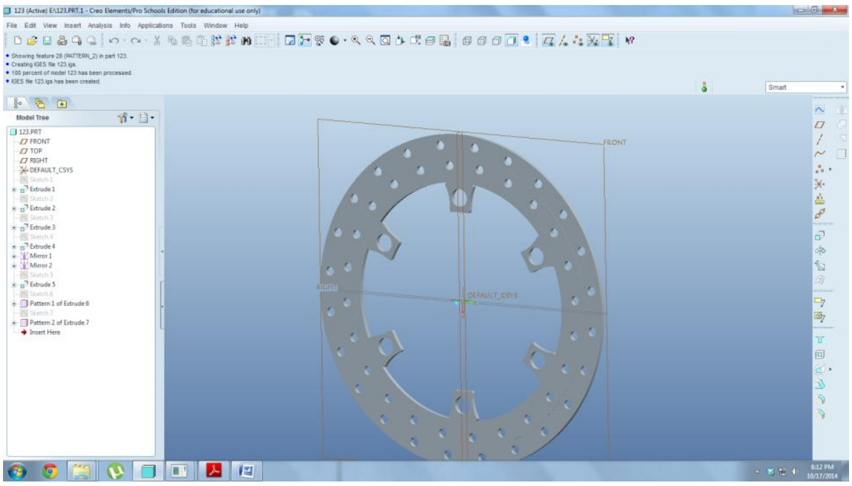


Fig.2 Disc brake model in Pro-e

III. RESULTS & DISCUSSION:

- **Thermal Analysis- Nickel Chrome Steel**

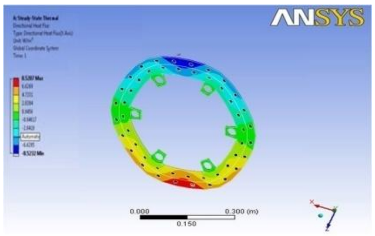


Fig.3 Temperature

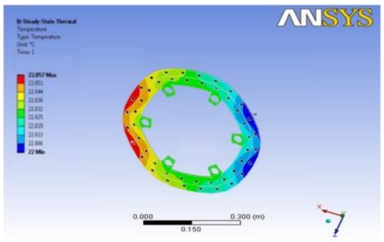


Fig.4 Directional heat Flux

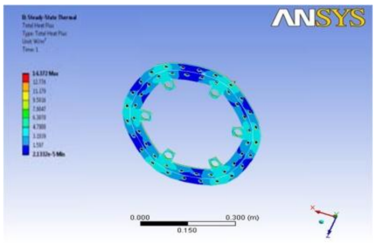


Fig.5 Total Heat Flux

- **Thermal Analysis- Aluminium Alloy**

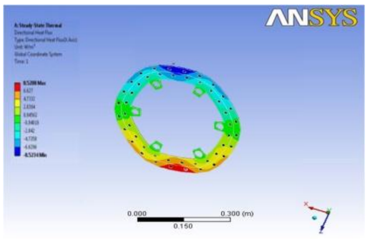


Fig.6 Temperature

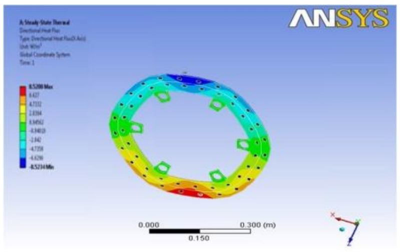


Fig.7 Directional heat Flux

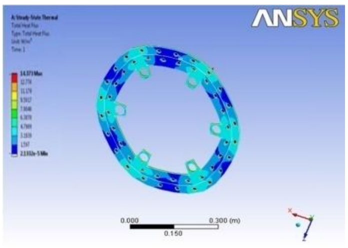


Fig.8 Total Heat Flux

- **Thermal Analysis- Cast Iron**

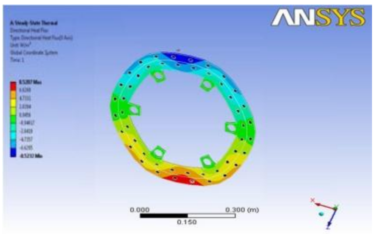


Fig.9 Temperature

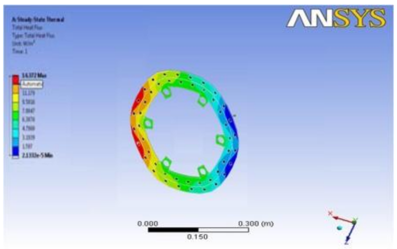


Fig.10 Directional heat Flux

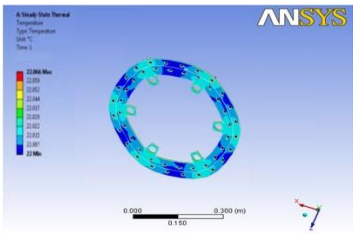


Fig.11 Total Heat Flux

- **Thermal Analysis- Carbon Reinforced Polymer**

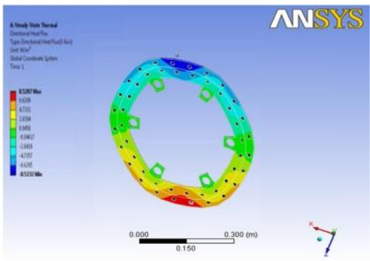


Fig.12 Temperature

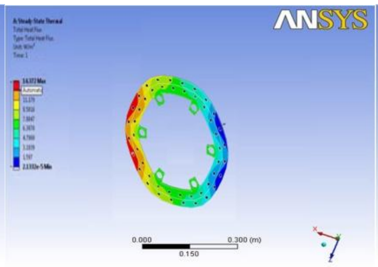


Fig.13 Directional heat Flux

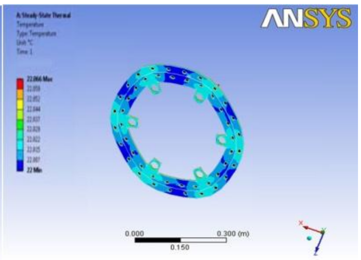
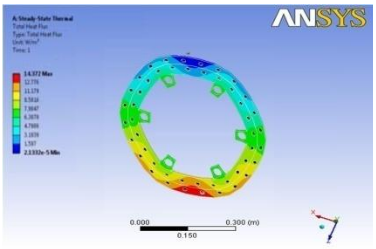
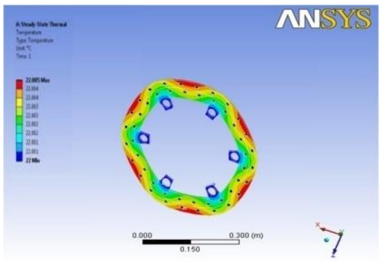


Fig.14 Total Heat Flux

- **Structural Analysis- Nickel Chrome Steel**





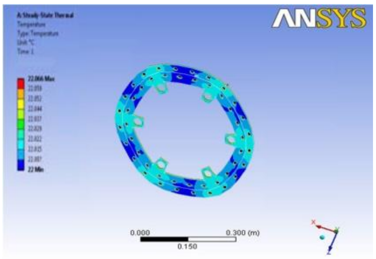
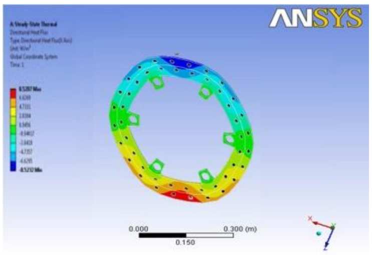
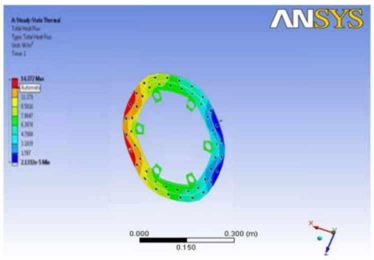


Fig.15 Equivalent Stress **Fig.16 Total Deformation** **Fig.17 Strain Energy**

- **Structural Analysis- Aluminium Alloy**





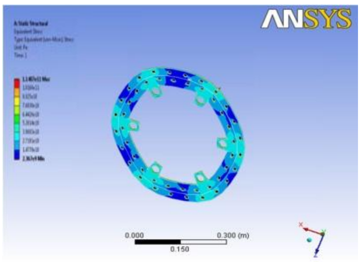
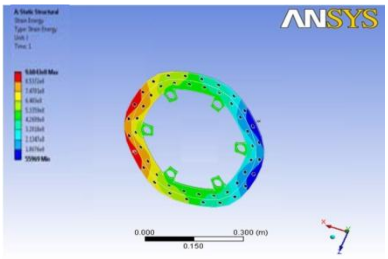
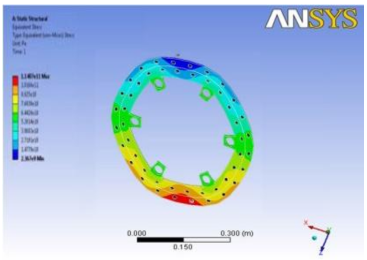


Fig.18 Equivalent Stress **Fig.19 Total Deformation** **Fig.20 Strain Energy**

- **Structural Analysis- Cast Iron**





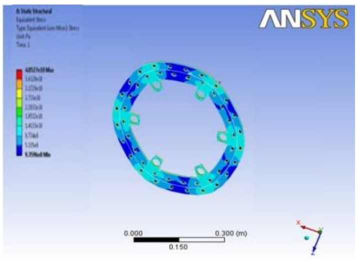
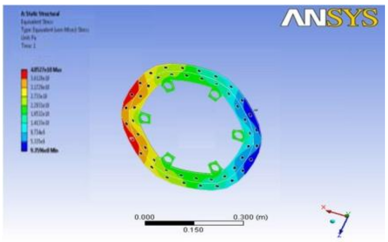
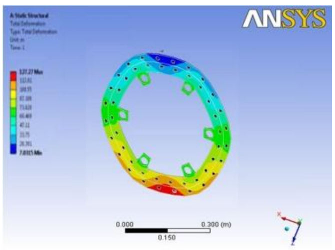


Fig.21 Equivalent Stress **Fig.22 Total Deformation** **Fig.23 Strain Energy**

- **Structural Analysis- Carbon Reinforced Polymer**





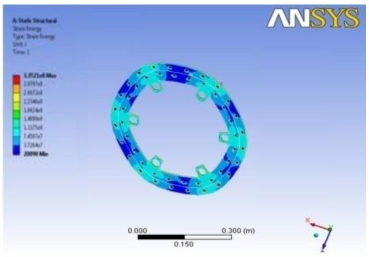


Fig.24 Equivalent Stress **Fig.25 Total Deformation** **Fig.26 Strain Energy**

IV. CONCLUSION

The model was modeled by using Pro-E and in the format of IGES which is a readable format of analysis software. By observing the Structural analysis and Thermal analysis results using Aluminum alloy and Carbon Reinforced Polymer the stress values are within the permissible stress value. So using Aluminum Alloy and Carbon Reinforced Polymer is safe for Disc Brake. By observing the frequency analysis, the vibrations are less for Aluminum Alloy than other two materials since its natural frequency is less. And also weight of the Aluminum alloy reduces almost 3 times when compared with Alloy Steel and Cast Iron since its density is very less. Thereby mechanical efficiency will be increased. But the strength of Carbon Reinforced material is more than Aluminum Alloy. Since the Thermal Analysis also Carbon Reinforced is also permissible. By observing analysis results, Carbon Reinforced Polymer is best material for Disc Brake.

Future scope:

1. By changing the model dimensions new results can be obtained.
2. By changing the model also better results may obtained.

REFERENCES

[1]. Darle W.Dudley, 1954, Hand book of practical gear design Alec strokes, 1970, High performance of gear design.

[2]. Maitra, G.M, 2004, Hand Book of Gear Design, TataMcGrawHill, New Delhi.

[3]. S.Md.Jalaluddin., 2006, "Machine Design, "Anuradha publications, Chennai.

[4]. Thirupathi Chandrupatla, Ashok D.Belegundu, "Introduction to finite element in Engineering" ,2003.

[5]. Gao C. H., Lin X. Z. (2002), Transient temperature field analysis of a brake in a non-axisymmetric three-dimensional model, J. Mater. Proc. Technol., Vol. 129, No 1, 513–517.

[6]. Nowacki W. (1962), Thermoelasticity, Pergamon Press, Oxford.

[7]. Ramachandra Rao V. T. V. S., Ramasubramanian H. and Seetharamu K. N. (1989), Analysis of temperature field in brake disc for fade assessment, Wärme- und Stoffübertragung, Vol. 24, No 1, 9-17.

[8]. Darle W.Dudley, 1954, Hand book of practical gear design Alec strokes, 1970, High performance of gear design.