International Journal for Innovative Engineering and Management Research
A Peer Revieved Open Access International Journal
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IJIEMR Transactions, online available on 20th June 2023. Link :http://www.ijiemr.org/downloads.php?vol=Volume-12&issue=ISSUE-06

DOI: 10.48047/IJIEMR/V12/ISSUE 06/17

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Volume 12, Issue 06, Pages: 116-122

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DESIGN AND ANALYSIS OF DISC BRAKE ROTOR

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Abstract

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 – Disk Brake, Structural analysis, Thermal analysis, Ansys

1. INTRODUCTION

In today's growing automotive market, the competition for better performance vehicle is growing enormously. The racing fans involved will surely know the importance of a good brake system not only for safety but also for staying competitive. The disc brake is a device for slowing or stopping the rotation of a wheel. A brake disc usually made of cast iron or ceramic composites includes carbon, Kevlar and silica, is connected to the wheel and the axle, to stop the wheel. A friction material in the form of brake pads is forced mechanically, hydraulically, pneumatically or electromagnetically against both sides of the disc. This friction causes the disc and attach n braking system are used in a vehicle. A friction brake generates frictional forces as two end wheels to slow or stop. Generally, the methodologies like regenerative braking and friction or more surfaces rub against each other, to reduce movement. Based on the design configurations, vehicle friction brakes can be grouped into drum and disc brakes. If brake disc is in solid body the heat transfer rate is low. Time taken for cooling the disc is low. If brake disc is in solid body, the area of contact between disc and pads are more. In disc brake system a ventilated disc is widely used in automobile braking system for improved cooling during braking in which the area of contact between disc and pads remains same. Brake assembly which is commonly used in a car

DISC BRAKE

A disc brake is a device, composed of cast iron or ceramic composites that are connected to the wheel hub or axle and a caliper. In order to stop the wheel hub, friction material is automatically or hydraulically forced on both sides of the brake in the form of brake pads. This friction in turn originates the wheel hub and the disc to slow down and stop. Disc brakes use friction to create braking power. Disc brakes create braking power by forcing flat friction pads against sides of rotating disc.Higher applied forces can be used in disc brakes than in drum brakes, because the design of the rotor is stronger than the design of the drum.

Working Principle of disc brake

Disc brake is a very essential brake application device in a vehicle. This part of the brake helps in the slowing and stopping the motion of the vehicle. The principle of disc brake is to produce a braking force on the brake pads which in turn compresses the rotating disc.

Components of disc brake

The main components of a disc brake are:

1. **Rotor**
2. **Brake Pads**
3. **Calliper**

2. MATERIAL PROPERTIES

Table 1 Material Properties

Name	Nickel Chrome Steel	Aluminum Alloy	Gray Cast Iron	Carbon Reinforced polymer
Model type	Linear Elastic Isotropic	Linear Elastic Isotropic	Linear Elastic Isotropic	Linear Elast Isotropic
Default Failure Criterion	Max von Mises Stress	Max von Mises Stress	Max von Mises Stress	Max von Mis Stress
Yield Strength	$1.72339e^{+0.008}$ N/m^2	$1.65e^{+0.008}$ N/m^2	$2.75742e^{+0.008}$ N/m^2	$1.75742e^{+0.008}$ N/m^2
Tensile Strength	$4.13613e^{+0.008}$ N/m^2	$3.0e^{+0.008}$ N/m^2	$4.13613e^{+0.008}$ N/m^2	4127 Mpa
Elastic Modulus	$2e^{+11}$ N/m^2	$7e^{+11}$ N/m^2	$1.9e^{+11}$ N/m^2	$1.94e^{+11}$ N/m^2
Poisson's Ratio	0.28	0.33	0.27	0.3
Mass Density	7800 kg/m^3	2600 kg/m^3	7300 kg/m^3	1800 kg/m^3
Shear Modulus	$7.7e^{+10}$ N/m^2	$3.189e^{+10}$ N/m^2	$5.6e^{+10}$ N/m^2	$8.6e^{+10}$ N/m^2
Isentropic Thermal Conductivity	60.5 W/mk	60.5 W/mk	52 W/mk	700 W/mK
Specific Heat	434 J/kgC	874 J/kgC	447 J/kgC	547 J/kgC

Problem Formulation

ProblemFormulationon disc brakes

If the temperatures reached in braking become too high, deterioration in braking may result, and in extreme conditions complete failure of the braking system can occur. It can be difficult to attribute thermal brake failure to motor vehicle accidents as normal braking operation may return to the vehicle when the temperatures return to below their critical level.

Alternate Ways to Minimize the Problems

Many attempts have been made to improve the cooling ability of straight vane ventilated rotors. Zhang (1997) proposed a redesign of vented rotors to include an optimized number of flow passages, improved rounding on inlet vanes, and a long short alternative vane configuration. This design contains twice the number of outlet vanes as inlet vanes, in order to reduced inlet blockages and guide to flow though the exit more easily. The configuration was modeled on CFD software and a 42% increase in flow through the vanes is claimed, however no experimental verification is given. A similar technique was used by to develop a rotor with three times the number of outlet vanes as inlet vanes, providing 35% more flow through the vanes when tested on a model in still air.The cross drilled holes will produce more surface area to heat dissipation. Holes will produce better strength by avoiding unnecessary heating

Objectives

The objective is to design a Disc brake using Catia and carry out the thermal ANSYS on the prepared model using ANSYS Thus we obtained the values of convective heat transfer coefficient and heat flux temperature distribution on disc brake.

- ✓ To find out the best material to be used for maximum possible efficiency.
- ✓ Applying different types of materials.
- ✓ Applying different temperature

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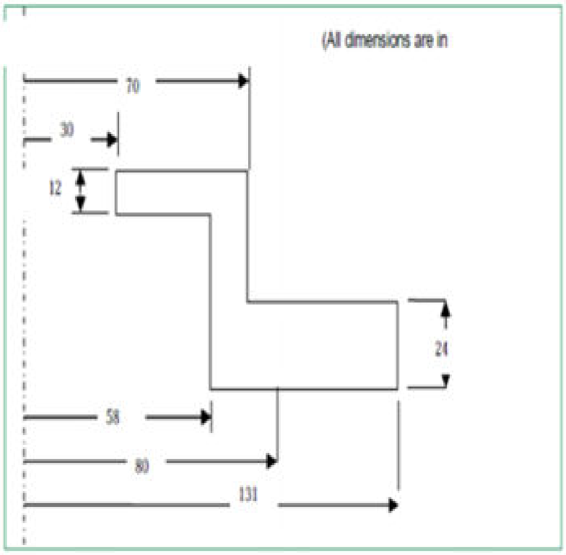
conditions.

- ✓ Applying Thermal analysis on different materials.
- ✓ Generate the required results.

3. **METHODOLOGY**

DESIGN OF PRODUCT IN CATIA



Existing designing of disk brake rotor

Fig -1 disk brakes (dimensions of 24 mm)

4. **MODELING OF DISC BRAKE**

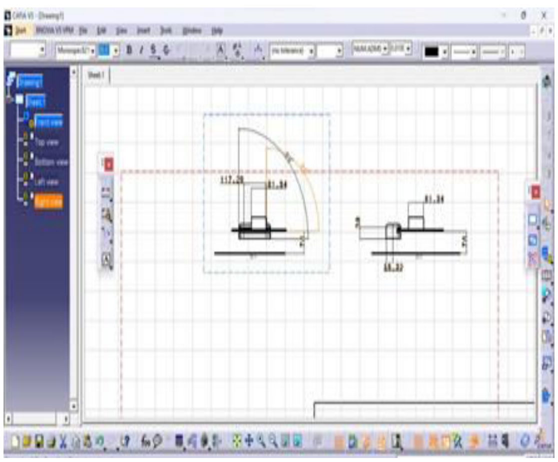


Fig -2 CATIA MODEL

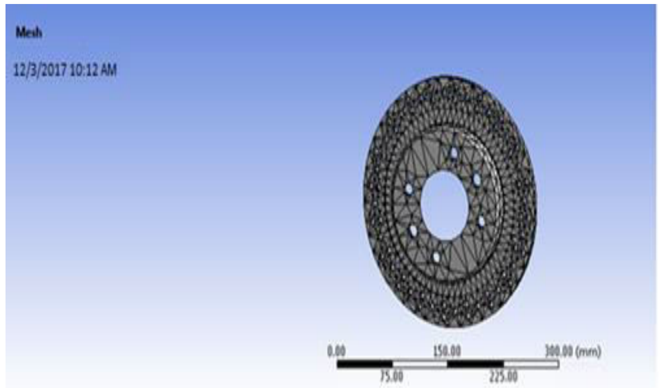


Fig -3MESHING MODEL

Temp, heat flux at 500 ^{0}C

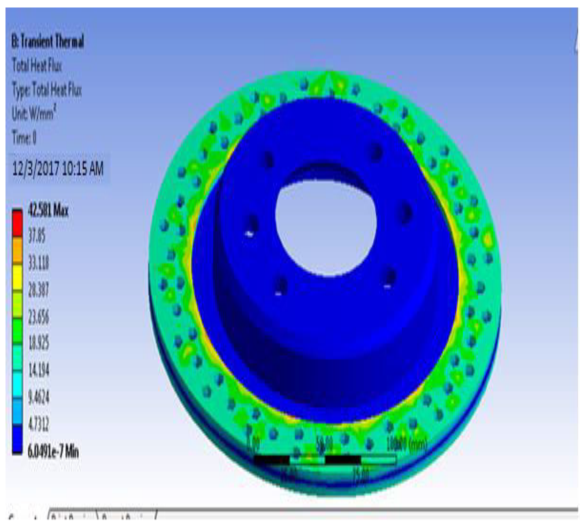


Fig -4 Temperature at 500^{0}C

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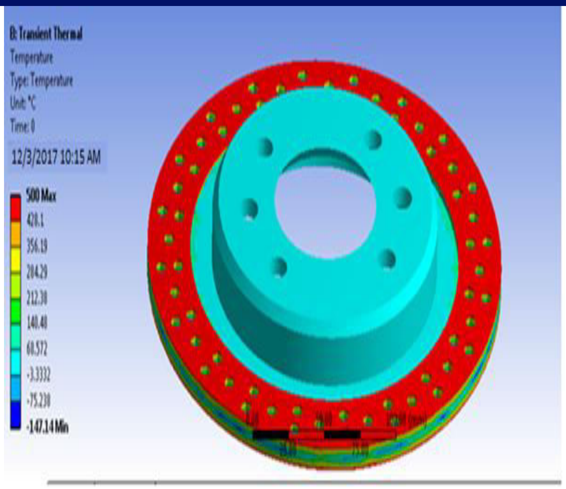

Fig -5 Heat Flux at 500 ^{0}C

5. RESULTS AND DISCUSSION

TABLE 1 DEFORMATION AT VARIOUS LOADS

LOAD(N)	GREY CAST IRON (mm)	ALUMINIUM ALLOY (mm)	NICKEL CHROME STEEL (mm)	CARBON REINFORC POLYMER (mm)
1000	0.022178	0.00588	0.021003	0.021956
2000	0.044356	0.011768	0.042005	0.043912
3000	0.066534	0.017652	0.063008	0.065868
4000	0.088713	0.023536	0.084011	0.087824

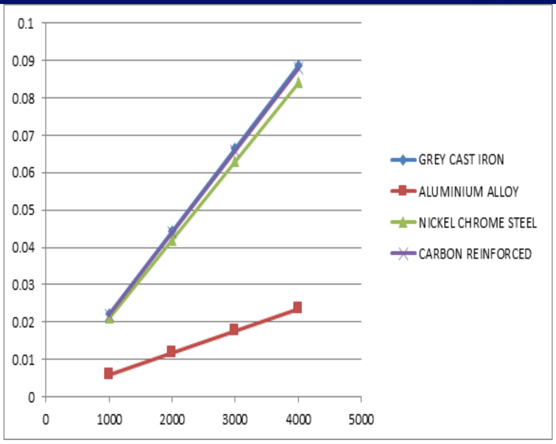

Fig 6Variation of Deformations with respect to loads

6. CONCLUSION

The suitability of aluminium alloy, grey cast iron, nickel chrome steel and carbon reinforced polymer as rotor of a disc brake has been examined by transient thermal analysis and structural analysis. From the results obtained it has been found that the aluminium alloy and carbon reinforced polymer exhibit stress and strain values with in permissible limits. It has also been noticed that both these materials are prone to vibrations with in safe limits. Among these two materials carbon reinforced polymers is preferred as the material has higher specific strength and higher heat flux. Hence, carbon reinforced polymer has been found to be the best choice for the application.

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