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A review on Design and Experimentation of Test Rig for measuring Effectiveness of Brake Pad

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Abstract

Design and experimentation of test rig for measuring the effectiveness of brake pad aimed at estimating the performance of brake pad of a bike under numerous braking conditions and there by assist in the disc project and analysis.
The enhance brake rotor is more examined with the thermal and vibrational analysis. The optimize disc heat dissipation is discover effective than the current brake rotor. The vibration analysis is done by finding the mode shapes and its effects are also compared.
An analysis into practice of new materials is essential which improve braking efficiency and provide better stability to vehicle. We will be using two alternate materials fly ash and c-c composites. This investigation can be done using ANSYS software along with the modeling software CATIA V5.Analysis done on real model of disc brake rotor of Bajaj pulsar 180 and disc brake Rotor of different material in one Disc brake rotor. Therefore, it gives optimize stress, deformation & weight of the improved disc brake rotor & also good heat dissipation.

Keywords:*Brake disc, Rotor, Thermal analysis, PRO-E, ANSYS software.*

1. Introduction

In design optimization problem there are aims and limitations that must be met. With mechanical design, size, weight, strength, and cost are a few of the many restraints that may need to be taken into concern when designing for a set of objectives. Altered materials fly ash and c-c composites are used to compare with the current material. These materials are compared and analyzed using present model, from which the best solution is chosen. The best material is then enhanced upon iteratively. These iterations are in essence series of trial and error that can regularly need many cycles, each of which can be expensive and time consuming. With finite element analysis and optimization, other difficult problems can be solved more rapidly, reducing the amount of physical testing for a new material. This helps address the cases whereon-optimal projects might carry on to be used to cut the time, cost, and danger of trying to find a better design. FEA methods are used to make disc brake rotor with material which is lighter and gives good results than the current rotor. The analyses will be taken with the help of sensors which are more accurate than manually taken results.

2. Literature Survey

"Design modification & optimization in stress, deformation & weight of Disc brake rotor" which studies about on disc brake rotor by modeling & analysis of dissimilar shapes of holes of dissimilar vehicle's disc brake rotor with identical outer diameter & inner location of holes on wheel hub as Bajaj Pulsar 150.Analysis done on actual model of disc brake rotor of Bajaj pulsar 150 and disc brake Rotor of dissimilar shapes of holes of different vehicle's in one Disc brake rotor. Therefore, it gives optimize stress, deformation & weight of the revised disc brake rotor & also good heat dissipation.[1]

In this paper carbon ceramic matrix disc brake material use for computing normal force, shear force and piston force and also calculating the brake distance of disc brake. The typical disc brake two wheelers model using in Ansys and done the Thermal analysis and Modal analysis also calculate the deflection and Heat flux, Temperature of disc brake model. This is important to know action force and friction force on the disc brake of new material, how disc brake works more well, which can help to decrease the accident that may occur in each day. [2]

By applying brake, shoe pad is grip the disc of disc brake due to that stopping of their rotation and altering kinetic energy in to Heat energy due to speedily apply handbrake there is thermal stress produce of disc. Paper presentation on calculating the thermal stress on disc of 150 cc pulsar.[3]

Thermal and Static structure analysis is done on disc brake using material such as grey cast iron, stainless steel, structural steel and aluminum alloy bye changing the shape of ventilated models. A evaluation between analytical and results obtained from FEM from temperature and von misses stresses are prepared. A comparison is made amongst four unlike materials for analysis of thermal and structural thermal analysis of disc brake. [4]

The aim was to design a rotor with minimum stress level and that continues similar structural performance asrotors that are presently commercially available. The optimum solution of modified rotor designs is finding out by relating its results with them and with the present rotor. The improve brake rotor is more examined with the thermal and vibrational analysis. The optimize disc heat dissipation is discover effective than the present brake rotor. The vibration analysis is done by finding the mode shapes and its results are also equated. [5]

In this project, "Structure Optimization of the disc brake", the action force, friction force and brake torque

on rotor disc are calculated by the basic formulations of disc brake. The purpose is to compare between the rotor disc of a standard motorbike "Bajaj Pulsar" and a non-standard rotor disc to learn out the relationship value between brake torque, rotor disc dimension etc.[6]

3. Problem Statement

The effectiveness of the brake pad depends upon the type of disc which is used. The material used for brake pads is asbestos and suggesting any alternate material for the brake pads is quite a costlier thing. So alternatively, if we want to increase the effectiveness of brake pads we can use alternate materials for the disc rotor. After using the alternate materials for disc if the wear rate is less than the existing brake pad our goal is achieved.

In the present work the aim is to find optimize disc rotor solution which should be efficient than the existing model brake disc rotor of Bajaj 180 cc. The structural shape optimization technique will be used to optimize the disc brake rotor and then validate it in thermal and vibrational analysis.

4. Method of Analysis

The CAD model is prepared in CATIA. The CAE Analysis is done in Ansys 14.5. The static structural analysis is done to determine the stress and deformation for all the materials. The best optimized is found out in Comparison with the existing model and other samples. The thermal analysis is done to check the thermal behavior with change in the surface area. The modal analysis is done and found out the mode shape for the material. The experimental analysis is done with the prepared set for both the thermal analysis and for the static structural analysis. The Comparison of three will be validating the results.

5. Experimental setup

The experimental setup consists of

- 3-Phase, 2 HP, 1440 Rpm Motor.
- Shaft
- Caliper
- Hydraulic Brake Assembly
- Frame
- Variable frequency device and
- Sensors to measure temperature,

Frequency, noise, and acceleration.

Fig.1 Experimental Setup

5.1 Input Parameter for Disc brake of Bajaj Pulsar 180 cc

Rotor disc dimension = 260 mm. (260×10^{-3} m)
Rotor disc material = Cast Steel
Pad brake area = 1692 mm^2 (1692×10^{-6} m^2)
Pad brake material = Asbestos
Permissible temperature = 250 ºC
Maximum pressure = 1 MPa
Vehicle speed = 100 Km/hr. [3]
Mass of vehicle =150 Kg.
Different materials are considered for selecting the optimized design and the properties are detailed in Table 1

Table 1 Technical specification of different materials

Material	Cast Steel	Aluminum Fly ash	CC-Composite
Density (kg/m3)	7850	2633	1700
Thermal conductivity (W/mK)	60.5	110.5	40
Thermal expansion (10-6/k)	12	16	0.4

5.2 Coupled field analysis with different materials

The results shown below are of ventilated disc brakes made up of cast steel, Aluminum Fly ash, CC-Composite. These results are obtained after applying thermal and modal conditions and performing coupled field analysis. The maximum values of temperatures, total heat flux, total deformation are interpreted in the form of colors such as blue s minimum, green is intermediate and red is maximum temperature.

6. Results and Discussion

6.1. Model of pulsar 180cc in CATIA V5

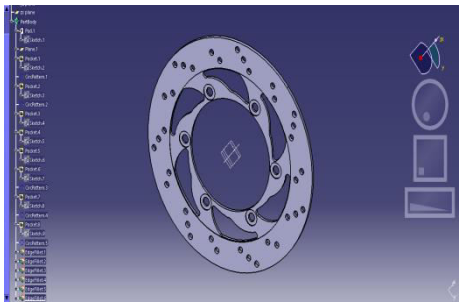

Figure 2 Modeling of Original disc brake of Pulsar in CATIA

6.2. Thermal Analysis

The Experimental thermal analysis will be done on disc brake rotor. Brake is applied periodically to reduce or to stop the disc. While put on the break the friction is generated between the disc and brake pad. These friction forces oppose the motion of disc, due to the friction between the disc and brake pad heat is produced in the disc and it dispense over the disc. Heat produced in the disc is dissipated by the conduction and convection mode of heat transfer.

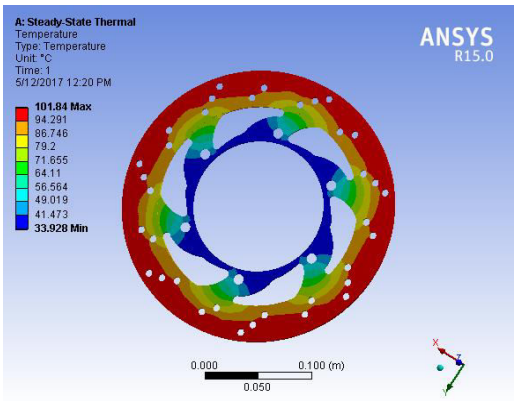

Figure 3 Original Disc

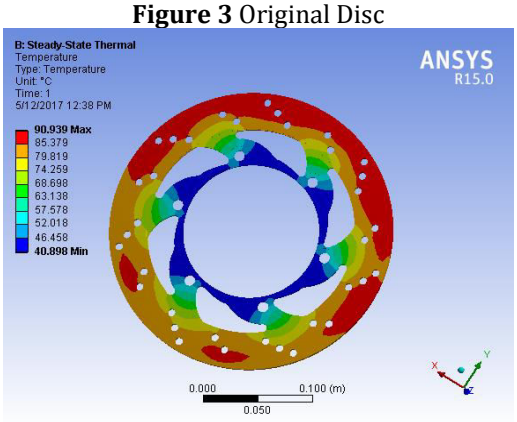

Figure 4 Aluminum Fly Ash

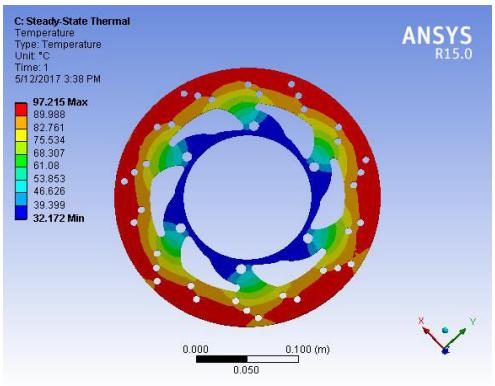

Figure 5 CC-Composite

6.3 Thermal Analysis Result

Table 2 Temperature comparison

Region-wise diameter		Original disc Temp in oC	Al Fly ash Temp in oC	CC-Comp Temp in oC
Region	Diameter			
I	260-240	101.84	90.93	97.22
II	240-220	86.75	79.81	82.76
III	220-200	64.11	63.14	61.08
IV	200-180	49.01	52.02	46.63
V	180-160	33.92	40.9	32.18

The heat dissipation is calculated with the help of surface area and the film coefficient at velocity 22.22 m/s. The maximum heat dissipation is observed in material 2 i.e. Aluminum Fly Ash.

6.4 Modal Analysis

The vibrational analysis is done to find the natural frequency of the optimized disc as well as existing disc and to find out which effect of changing the weight and geometry on the natural frequency of the disc brake rotor. There are six mode shapes we taken to study in modal analysis and check its behavior.

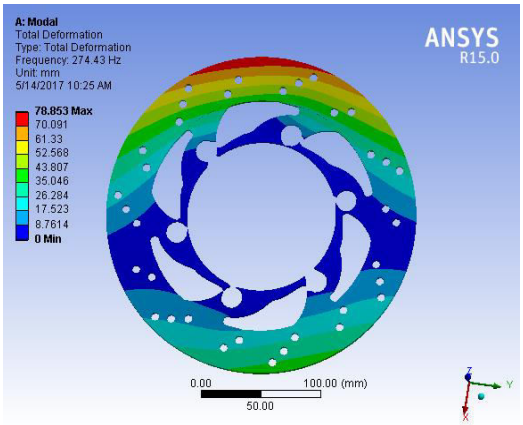

Figure 6 Original Disc at 1st node

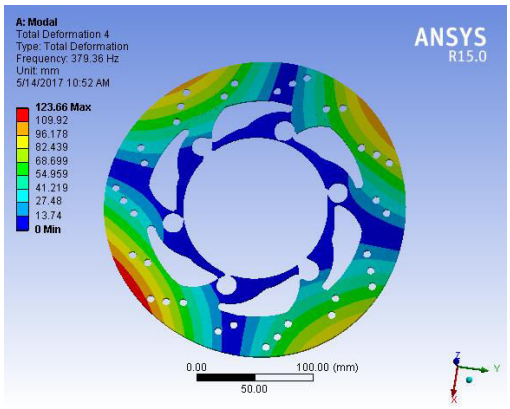

Figure 7 Aluminum Fly ash at 4th node

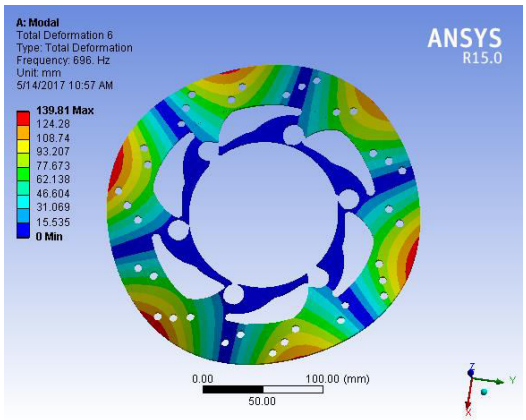

Figure 8 CC-Composite at 6th node

6.5 Modal Analysis Results

Table 2 Frequency Comparison

Mode Shape No.	Original Material Freq Hz	Al Fly Ash Freq Hz	CC-Composite Freq Hz
1	274.43	280.55	295.45
2	284.51	291.36	306.3
3	294.2	300.75	316.73
4	371038	379.36	399.82
5	387.73	395.89	417.43
6	646.49	661.86	696

From modal analysis of the original disc and the alternate materials it is found that CC-Composite have higher natural frequency.

6.7 Weights of selected discs

Table 3 weight comparison

Material	Original	Al Fly Ash	Cc-Composite
Kgs	1.0363	0.34478	0.22443

7. Conclusion

The study shows that the use of alternate materials can improve the braking performance of the disc brake system.

1) The temperature of AL Fly Ash is less as compared to original disc material, so the disc heating will be less and thus it will automatically extend the life of the brake pads.

2) In the modal analysis comparison we found that the natural frequency of CC-Composite is higher than that of original material at different mode shapes.

3) It is also observed that the weight of both the alternate is less than the original material, so ultimately it is going to save the material.

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