Thermal and Structural Analysis of Two Wheeler Disc Brake

Prashant P. Suryawanshi  
BE Student  
Department of Mechanical Engineering  
G.H. Raisoni C.O.E.M., Chas, Ahmednagar, Maharashtra, India

Amol R. Tanpure  
BE Student  
Department of Mechanical Engineering  
G.H. Raisoni C.O.E.M., Chas, Ahmednagar, Maharashtra, India

Sachin R. Dhatrak  
BE Student  
Department of Mechanical Engineering  
G.H. Raisoni C.O.E.M., Chas, Ahmednagar, Maharashtra, India

Bhavesh C. Lokhande  
BE Student  
Department of Mechanical Engineering  
G.H. Raisoni C.O.E.M., Chas, Ahmednagar, Maharashtra, India

Rohan D. Hucche  
Assistant Professor  
Department of Mechanical Engineering  
G.H. Raisoni C.O.E.M., Chas, Ahmednagar, Maharashtra, India

Abstract

The conventional brake system having safe design on the basis of rigidity and strength. But it is often that in practical manner stress is induce in brake which affect on the result of stopping. To avoid this affection we have to improve brake performance for that material, design, modification is done on the basis structural and thermal analysis. As the brake functioning the heat is generated in the disc it increases thermal variation for that ventilated area is provided which having ability to withstand against this variation. The study is about to compare the result of standard APACHE RTR 180 DISC BRAKE Material with testing of different material. Which gives the suggestion for best material for the disc.

Keywords: Structural Analysis, Thermal Analysis, Compare the Results

I. INTRODUCTION

The disc brake is a device which specially use for slowing or stopping the rotation of a wheel. Repetitive braking of the vehicle going generates heat during each braking movements. The finite element method is a powerful method which are used for the numerical solutions of a wide range of engineering problems. The disc brake is a wheel brake which slows rotation of the wheel by the friction which caused by pushing brake pads towards a brake disc with a set of calipers. Brakes convert motion to heat, and if the brakes get too hot, they become less effective, this phenomenon known as brake fade. Disc brake consisting structural steel disc bolted to the wheel hub and a stationary housing which is known as caliper. The caliper is connected to some stationary part of the vehicle like the stub axle as is cast in two parts each part consist of a piston. In between each piston and the disc there is a frictional pad hold in position by detainments pins, spring plates. The passages are so connected to another one for bleeding. Each cylinder contains rubber-sealing ring which placed between the cylinder and piston. In this paper study about a transient analysis of the thermo elastic problem which occurs in disk brakes with frictional heat generation, by using the finite element analysis (FEA) method is explained in details. The compare results are showing for the dispersion of the temperature on the friction surface which are between the contacting surface namely disc and pad. The action force, friction force and brake torque on rotor disc are calculate by basic formulae of disc brake and ANSYS software. The aim is to compare between the rotor disc of a standard motorcycle “APACHE RTR 180” and a non-standard rotor disc material to find out the relationship value between brake torque, rotor disc dimension etc.

A. Proper function of disc brake

The sliding-caliper disk brake is similar to the floating-caliper disk brake only the difference is that sliding-caliper is suspended from rubber bushings on bolts. This allows the caliper to sliding on the bolts when the brakes are applied.

Proper function of the brake depends on:
1) The rotor must be straight and smooth,
2) The caliper mechanism must be properly aligned with the rotor,
3) The pads must be positioned perfectly,
4) There must be enough "pad" left,

Disc brakes and especially hydraulic disc brakes are provide generally more stopping power than rim brakes. However, a rim caliper system fitted with decent brake blocks has more than enough power which is for a typical rider on a road bike. So the most likely drop-bar bike type that is more beneficial from disc brakes, in terms of needing more pure power, are touring bikes transporting heavy loads. As discussed earlier, since a majority of the automobiles use friction brakes, the scope of this study is enhance to disc and drum brakes, which are the two types of friction brakes. In drum brakes, the friction is generate by brake shoes, whereas in disc brakes, the friction is generate by the material is known as brake pads. In addition to the basic function of slowing down the vehicle (deceleration), automotive brakes also deal with lead with the absorption of kinetic energy. Modern brakes are associated with electronic assistance and hence, are known as electronic brake systems (EBS) as a whole. An EBS is having any of the functions such as Anti-lock brake system (ABS), electronic stability program (ESP), electronic brake force distribution (EBD), traction control system (TCS), etc. With all these electronic regarding functions, modern automotive brakes are not limited purpose it is use to deceleration only, but they also play an important role in the driver's assistance and driver safety. Increasing national and international regulations against vehicle safety, regulations for vehicle stopping distance, and changing customer view in the direction of personal safety.

II. DESIGN CALCULATION

A. Specifications of the Disc Brake

| Specification for Front disc. | Outer Diameter=270mm & Inner Diameter=160mm |
| Specification for Rear disc. | Outer Diameter=200mm & Inner Diameter=120mm. |
| Specification for Caliper piston diameter. | 30mm. |

In this project study standard of two wheeler name “APACHE” model RTR 180 Factor;
Rotor disc dimension = 270 mm.
(Rotor disc material = Gray cast iron)
Pad brake area = 2000 mm² (2000×10⁻⁶ m²)
Pad brake material = Asbestos
Coefficient of friction (Wet) = 0.08-0.12
Coefficient of friction (Dry) = 0.2-0.5
Assume,
Maximum temperature = 250 °C
Maximum pressure = 1 MPA (10⁶ Pa)

B. Tangential Force between Pad and Rotor (Inner Face), \( F_{TRI} \)

\[
F_{TRI} = \mu_1 F_{RI}
\]

Where \( F_{TRI} \) = Normal force between pad brake and rotor (inner)
\( \mu_1 \) = Coefficient of friction = 0.5
\( F_{RI} = P \max/2 \times A \) (pad brake area).
So, \( F_{TRI} = \mu_1 F_{RI} \)
\( F_{TRI} = (0.5) (0.5) (1\times10^6 \text{ N/m}^2) (2000\times10^{-6} \text{ m}^2) \)
\( F_{TRI} = 500 \text{ N.} \)
C. Brake Torque ($T_B$)

With the assumption of equal coefficients of friction and normal forces $F_R$ on the inner and outer faces:

$$T_B = F_T \cdot R$$

Where $T_B$ = Brake torque

$\mu$ = Coefficient of friction

$F_T$ = Total normal forces on disc brake, $F_{TRI} + F_{TRO}$

$F_T = 1000 \text{ N}.$

$R$ = Radius of rotor disc.

So, $T_B = (1000) \times (135\times10^{-3})$

$T_B = 134.7 \text{ N-M}$

III. RESULTS

![Fig. 2: Thermal Analysis of disc brake von misses stress.]

![Fig. 3: Thermal analysis of Disc Brake deflection in Vector sum.]

IV. CONCLUSIONS

The Thermal and Structural Analysis provide useful design and improve the brake Performance of disk brake system. For structural analysis result of both experimental will be found the safe brake disc design on the basis of strength and rigidity criteria. Comparing the different results obtained from analysis.
REFERENCES


