THERMAL ANALYSIS OF BRAKE -A REVIEW

Raj Kumar Yadav

Assistant Professor & Head, Department Mechanical Engineering,
AIST Sagar, Madhya Pradesh, India

Vikas Mukhraiya

Assistant Professor, Department Mechanical Engineering,
AIST Sagar, Madhya Pradesh, India

Shwetank Soni

M. Tech Scholar, Department Mechanical Engineering,
AIST Sagar, Madhya Pradesh, India

ABSTRACT

The aim of my research is to find different properties that might help us in future to optimize the working parameters and to increase the performance of the brake system. There is lot of upgrade in the technology of the automobile these days. The applications of the disk brake motivate researches, because disc brakes are used in automobiles, freight vehicles and agricultural machines. The aim of these researches is to realize the optimal function of the given construction, in order to increase the lifetime or the performance. Most brake-researches examine the thermal and tribological behaviour, where the behaviour of the different friction materials was checked at high temperature. Competition on the speed of vehicles going on in the market. But also this speed leads to accidents if vehicle don't stop on time. Disc brakes in the vehicles give much better performance compare to drum to stop the vehicle also the heat generated during braking force can be easily dissipated as disc brakes are open to atmosphere. But the main problem is with the material used in the disc brakes in some vehicle. Manufacturers use disc of steel which have short life span and the weight is bulky near the tire. If disc loses its shape wobbling can caused near the tire causing a big problem. The main motto of this thesis is to improve the strength of the disc by taking various materials for analysis. The design has been taken from real world.

Key words: Disc brake, ANSYS software, Different alloys.

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1. INTRODUCTION

Statistics show that vehicle companies manufactured more and more vehicles in the last few years. From 2001 to 2007 the number of cars increased, in 2007 there were 73 million cars manufactured, this number decreased and in 2009 the number of manufactured cars was 62 million. After the economic crisis the quantity of manufacturing increased again and by the end of 2014 there were 90 million cars produced. There are no cars without a brake system, which brake system can be of two types: disc brake and drum brake. The applications of the disk brake motivate researches, because disc brakes are used in automobiles, freight vehicles and agricultural machines. The aim of these researches is to realize the optimal function of the given construction, in order to increase the lifetime or the performance. Most brake-researches examine the thermal and tribological behaviour, where the behaviour of the different friction materials was checked at high temperature. In the examination various methods were used to check properties of the parts of the brake system. Sometimes a real system, sometimes a model was used to examine the properties of the parts. Nowadays we often use computer software in research because these programs are suitable to model the environment and can compare lots of different constructions.

2. LITERATURE REVIEW

In basic working operation, a disc or drum brake system has to reduce wheel speed when a driver desires vehicle deceleration. The kinetic energy generated by a vehicle in terms of wheel speed is converted into heat energy due to the application of the brake system. The friction force between disc/drum and brake pad/brake shoe applies friction torque to the wheel in the opposite direction of the car's movement. This result in the reduction of vehicle speed and heat energy occurring in the brake disc/drum causes a temperature increment in the disc/drum swept area during the brake application. This physical action of the brake disc/drum causes heat conduction to the adjacent braking system components [1]. Lee [2] stated that inconsistent dissipation of heat inside the brake disc could cause deformation of the disc. Even worst, the disc deformation could also cause friction loss and consequently led to brake fade [3]. Furthermore, high temperatures of the brake disc could cause cracking in the brake disc material due to high thermal stresses. On top of that these factors also cause vibration [4, 5]. It is become common in the brake research RESEARCH A. Belhocine et al., Tribology in Industry Vol. 36, No. 4 (2014) 406-418 407 community to fully utilize finite element approach in order to identify and predict disc/drum brake structural performance. For instance, Koetniyom [6] performed temperature analysis on brake discs under heavy operating conditions. He found that the physical shape of vehicle brake discs play a significant role in determining the temperature characteristics including the overall brake efficiency. Kamnerdtong et al. [7] attempted to link the interaction between mechanical and thermal effects with disc movements and heat caused by frictions. They concluded that, from finite element analysis, temperatures on the disc surface changed at each point over the period, which indicates inconsistent dissipation and temperature differences in each side of the disc. Hence, inconsistent contact between disc and pad could affect material deformation. Belhocine et al. [8] used the finite element Software ANSYS to study the thermal behaviour of the dry contact between the discs of brake pads at the time of braking phase. Temperature distribution obtained by the transient thermal analysis was used in the calculations of the stresses on disc surface. Abdullah and Schlattmann [9] used finite element method to calculate the heat generated on the surfaces of friction clutch and temperature distribution for case of bands contact between flywheel and clutch disc, and between the clutch disc and pressure plate (one bad central and two bands) and compared with case of full contact between surfaces for single engagement and repeated engagements. In other work, Abdullah et al. [10] used the finite element method used to study the contact pressure and stresses during the full engagement period of the clutches using different contact algorithms. Moreover, sensitivity study for the contact pressure was presented to indicate the importance of the contact stiffness between contact surfaces. Akhtar et al. [11] employed finite element (FE) method to explain the transient thermoelastic phenomena of a dry clutch system. The effect of sliding speed on contact pressure distribution, temperature and heat flux generated along the frictional surfaces was analyzed. Sowjanya and Suresh [12] conducted a static

structural analysis of the disc brake whose some composite materials were selected to compare the results obtained such as deflection and stresses. In the research developed by Reddy et al. [13], thermal and structural coupled analysis was carried out to find the strength of the disc brake. Gnanesh et al. [14] investigated thermal-structural analysis of solid and vented disc brake disc using FE approach in the case of design with no holes and with holes in the disc. The materials used in the simulation were cast iron, stainless steel and aluminum metal matrix composites. Manjunath and Suresh [15] performed a structural and thermal analysis of the disc brake disc using FE method to determine the deformation and the Von Mises stress established in the disc for the both solid and ventilated discs with two different materials to enhance performance of the disc. In the work carried out by Parab et al. [16], structural and thermal analysis was carried out on the disc brakes using three materials i.e. stainless steel, cast iron and carbon-carbon composite. Structural analysis was done on the disc brake to assess strength of the disc brake, whilst thermal analysis was performed to analyze the thermal effect on the disc brake behavior. In research carried out by Tiwari et al. [17], a transient structural analysis of the disc of disc brake aimed to determine the variation of the stresses and deformation across the disc brake profile. The aim of this paper was to investigate structural and contact behaviours of the brake disc and pads during the braking phase with and without thermal effects. Firstly, total deformation of the disc-pads model at the time of braking and the stress and contact distributions of the brake pads were determined. Later, results of the thermoelastic coupling such as Von Mises stress, contact pressure field and total deformations of the disc and pads were also presented which will be useful in the brake design process for the automobile industry.

3. BRAKE DISC DESIGN

- Firstly carry the old brake disc of Hyundai Santro Xing car from car garage. Analysis each hole, stud, rotor, ventilation slots & his velocity & collect all data like as inner diameter, outer diameter, hub length etc.& follow the brake disc to whole thesis works.
- And we have designed brake disc on designing software like as catia, solid works. with properly correct diameter, length,
- And import on ANSYS for analysis.
- Find out good meshing, total deformation, and equivalent stress.
- Find out total deformation, equivalent stress, equivalent strain, Weight & some other property of brake disc.

Figure 1 Brake Disc Rotor

4. RESULTS

We see that brake disc result is very good for new material alloy like as al-ni-co alloy & titanium alloy. After compare from cast iron & structural steel. After having Modelled Some Error Is Generate in Brake Disc. but through the meshing we decrease the errors & negative points. & apply both materials al-ni-co, titanium. & structural steel. by this process of brake disc we create meshing for decreasing error & negative points.

5. CONCLUSION

In this work, a disc-pad model has been analysed using two approaches, namely mechanical and thermo mechanical analysis. In addition to this, three pad designs are also simulated to identify its influence on the stress distribution. By this methodology we can design brake disc on solid works. With standard data of brake disc. In this methodology of brake disc we create meshing for decreasing error & negative points. After modelling & meshing we calculate specific perimeter & variable data like as force & moment of inertia static structural result. & heat flux & final temperature for thermal analysis.

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