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FEA Analysis of Brake using Ansys - A Review

Vineet Kumar Dwivedi[1], Arvind Singh[2]
Research Scholar[1], Asst. Professor[2]
Millennium Institute of Technology Bhopal, 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. 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. 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 worldFEA simulation is performed and the material behaviour on displacement, stress, contact pressure, contact status is obtained using software ANSYS 16.0 and finally a good comparison is performed. These are the parameters which are mostly used for comparison - stress distribution, strain distribution, deformation, heat flux, elastic stress, elastic strain, shear stress and strain. The obtained result will be beneficial for further use in this field.

Keywords : ANSYS16.0, FEA, DISC BRAKE, Simulation.

I. INTRODUCTION

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.

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.

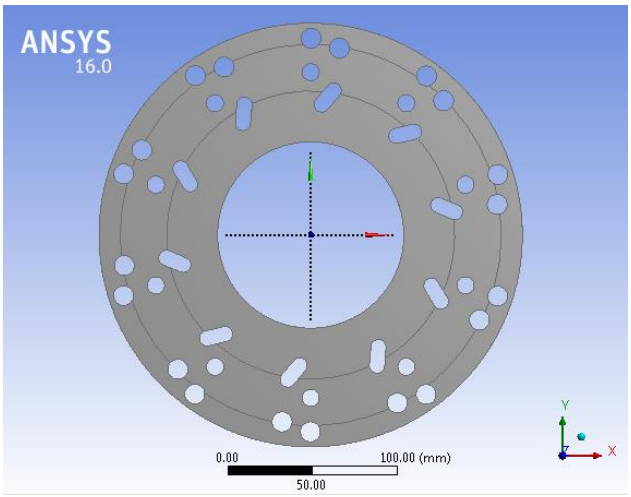
II. Working of Disk Brake

When the driver applies pressure on the brake paddle, hydraulic pressure pushes the piston out from their housing. The pistons, in turn, press the brake pads against the moving disk faces, causing friction and hence slowing it down. Hydraulic pressure is equally applied by the hydraulic fluid to the floating pistons on either side. When the driver takes his foot off the brake paddle, hydraulic pressure on the friction pads is released; The piston move inwards and break their contact with the disk.

III. Literature Review

Year	Name	Work	Outcomes
2017	Pravin Mohan Patel, S. Sudheendra	The new modular caliper was analyzed for pressure and tangential load sand the results were studied for displacements / deformation and stresses with temperature effects.	The existing caliper was analyzed with a new material Al 2219-T87 for Stress and displacement. The maximum stress was lower for Al 2219 than the Al 6061 brake caliper.
September 2016	K. Gowthami, K. Balaji	The maximum temperature obtained for aluminium alloy brake drum is 32.83°C which is less compared to the maximum temperature prevailing in cast iron brake drum and stainless steel 304 brake drum.	Aluminium alloy material is proved better than the other materials considered in this investigation
2015	Mohammed Nazeer, Supriya Koppula	The main purpose of this study is to analysis the thermo mechanical behavior of the dry contact of the brake disc during the braking phase.	Analysis is performed on given boundary conditions, the alloy steel performing good compared to other two materials.
2014	Ali Belhocine Abd. Rahim Abu Bakar	The paper highlights the effects of using a fixed caliper, different friction coefficients and different speeds of the disc on the stress concentration, structural deformation and contact pressure of brake disc and pads, respectively.	The bolt holes and outer side of the fins could first damage due to high stress concentration for single and double piston case, respectively There is no significant change in disc-pad deformation
April 2014	Abhishek Kumar Tiwari	In this present work, an attempt has been made to investigate the effect of stiffness, strength and variations in disc brake rotor design on the predicted stress	By observing analysis results, Aluminum alloys are suitable material for Disc Brake.
June 2014	R. LAKSHMANAIK	The computational results are presented for the distribution of heat flux and temperature on each friction surface between the contacting bodies.	The vibrations and weight are less for cast iron Alloy than other two materials.

Model



Design considerations

- Larger diameter rotors more will be brake power with the same amount of clamp force than a smaller diameter rotor. ν The higher the frictional coefficient of the pad, more brake power will be generated.
- Depends upon the type of material used for the brake rotor.
- Speed Sensitive – Coefficient of friction drops as the speed of the vehicle increases.
- Pressure Sensitive - Coefficient of friction typically drops as more clamp force is generated.
- Temperature Sensitive - Coefficient of friction typically drops as the temperature of the brake system increases.
- More surface area of brake system, better heat dissipation via convection.

IV. Methodology

List of activities that has been performed in order to achieve our goal is enlisted below:

- Study of parameters
- Study of boundary conditions.
- Selection of software
- Application of FEA.
- Result and Conclusion

Finite Element Method

- Definition

The finite element method is a numerical technique which is commercially used for the finding of an approximate solution of partial differential equation as well as integral equation. In some solving partial differential equations the first problem is to create an equation that approximate the equation which is to be studied. It means that during calculations the error should not accumulate, thereby causing the output as to be meaningless.

- **Heat transfer analysis using the Finite Element Method**

In order to perform a multidimensional heat transfer analysis the Finite Element Method can be utilized. This type of solution method is based on the use of elements which represents the body of the object. Each element expresses the physical, geometrical and material properties of the structure. The elements consist of nodes in which a shape function describes the node value changes along the elements. The number of nodes of an element can vary, but generally three- or four node elements are used in a 2D-analysis, while for 3D-analysis four- or eight node elements are commonly used. Depending on the type of analysis that is conducted, each node has a certain number of degrees of freedom.

The finite element analysis consists of a computer model of a material or designs that are stressed and analyzed for specific results. It is often used either for the refinement of existing product or for any new design. The modification of existing design or product or a structure is utilized to qualify the product for a new service condition. Sometimes in structural failure, FEA may help for the determination of design modification to meet the new conditions. Generally two types of analysis are used in manufacturing industry: 2D modeling and 3D modeling. In case of 2D modeling the analysis runs on a normal computer, it leads to lesser accurate results. On the other hand 3D modeling gives more accurate results by sacrificing the ability to run on all but the fastest computers effectively. The complex nature of linear systems is less as comparing with the non linear systems. Non linear systems accounts for plastic deformation and many are also capable of testing a material all the way to fracture of a material.

- **Advantages of finite element method**

a. Solving of non linear problems can be easily performed.
b. Formulation is easy in FEM, allows solving of different problems.
c. Domains having more than one material are easily analyzed.
d. Selecting approximation of higher degree polynomial can improve the accuracy of results.
e. Method can be used for any irregular shaped domain.
f. It can be used in all types of boundary conditions.
g. Generation of algebraic equations can be easily done and solved.
h. A generalized code can be developed for analysis if required for a large class of problems.

Study of parameters

Following properties will be analyzed in ANSYS 16.0 using FEA.

- Stress (Von Mises)
- Stress (In Shear)
- Strain (Elastic)
- Deformation
- Temperature distribution
- Heat Flux

V. CONCLUSION

After going through literature review of various authors it can be concluded that, Aluminum alloys have been widely used in automotive piston and other thermal applications because of good mechanical and thermal properties, lightweight structures, environmental and other attractive properties. But to manufacturing the disc brake the basic Al alloys are unbeneficial and may not fulfill the basic requirements of disc brake. And produced various unwanted stresses in components during the manufacturing. By controlling the environmental boundary conditions life span of disc can be improved. The heat transfer system directly affects the performance and the emission characteristics of the vehicle. For improvement in the performance of an engine, it is necessary to control the temperature in disc. Mechanical and thermal properties of aluminum based disc chiefly depend on the heat treatment, type of load applied and working atmosphere.

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