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Research Paper

Analysis of Brake Drum of Two Wheeler Through Approach of Reverse Engineering by Using Ansys Software

Engineering

KEYWORDS : Brake drum, Al alloy brake drum, Computer Aided Modeling, Finite Element Analysis, Inventor professional, Ansys workbench.

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ABSTRACT

Brake system is the most significant safety aspect of an automobile. A common misconception about brakes is that brakes squeeze against a drum or disc, and the pressure of the squeezing action slows the vehicle down. Actually brakes use friction of brake shoes and drums to convert kinetic energy developed by the vehicle into heat energy. This heat must be efficiently dissipated to the surroundings by the brake components because this will affect the braking performance of a vehicle. In present work modeling dimensions are taken by direct measurement of Hero Honda Passion brake drum (i.e. through reverse engineering approach). Computer aided modeling of brake drum is done on Inventor professional 2012 Software, and its finite element analysis is done through Ansys workbench 14.0 software. Both stress analysis and thermal analysis is done under different braking time and operational conditions. We find that temperature rise in the surface of brake drum also depends upon the time of braking.

Introduction

Drum brakes were the first types of brakes used on motor vehicles. Nowadays, over 100 years after the first usage, drum brakes are still used on the rear wheels of most vehicles. The drum brake is used widely as the rear brake particularly for small car and motorcycle. The leading-trailing shoe design is used extensively as rear brake on passenger cars and light weight pickup trucks. Most of the front-wheel-drive vehicles use rear leading-trailing shoe brakes. Such design provided low sensitivity to lining friction changes and has stable torque production (Limpert, 1999) V.Hima Vital,et al,(2008). A brake is a mechanical device which is used to absorb the energy possessed by a moving system or mechanism by means of friction. The primary purpose of the brake is to slow down or completely stop the motion of a moving system, such as a rotating disc/drum, machine or vehicle. Many aspects of slowing and stopping a vehicle are controlled by simple physics dealing with the deceleration of a body in motion. The simplest way to stop a vehicle is to convert the kinetic energy into heat energy. The energy absorbed by brakes is dissipated in the form of heat. The heat is dissipated in surrounding, air, water etc. Rolla H.Taloyr et al,(1941). The braking equipment of a vehicle includes all of its brake system that is all of reducing velocity of a moving vehicle, reducing its rate of acceleration, increasing its rate of deceleration, halting the acceleration, increasing its rate of deceleration, halting the vehicle and preventing the vehicle from returning movement once it is stationary. Akshat Sharma et al, (2013) .A drum brake is a brake that uses friction caused by a set of shoes or pads that press against a rotating drum shaped part called a brake drum. The brake drum is generally made of cast iron that rotates with the wheel. When a driver applies the brakes, the lining pushes radially against the inner surface of the drum, and the ensuing friction slows or stops rotation of the wheel and axle, and thus the vehicle.

Internal expanding shoe brakes are most commonly used in automobiles. In an automobile, the wheel is fitted on a wheel drum. The brake shoes come in contact with inner surface of this drum to apply brakes. The construction of internal expanding mechanical brake .The whole assembly consists of a pair of brake shoes along with brake linings, a retractor spring two anchor pins a cam and a brake drum. Brake linings are fitted on outer surface of each brake shoe. The brake shoes are hinged at one end by anchor pins. Other end of brake shoe is operated by a cam to expand it out against brake drum. A retracting spring brings back shoes in their original position when brakes are not applied. The brake drum Braking System closes inside it the whole mechanism to protect it from dust and first. A plate holds whole assembly and fits to car axle. It acts as a base to fasten the brake shoes and other operating mechanism. Braking power is obtained when the brake shoes are pushed against the inner surface of the drum which rotates together with the axle. Drum brakes are mainly used for the rear wheels of passenger cars and trucks while disc brakes are used exclusively for front brakes because of their greater direction stability. The backing plate is a pressed steel plate, bolted to the rear axle housing. Since the brake shoes are fitted to the backing plate, all of the braking force acts on the backing plate.

A drum brake has a hollow drum that turns with the wheel. Its open back is covered by a stationary back plate on which there are two curved shoes carrying friction linings. The shoes are forced outwards by hydraulic pressure moving pistons in the brake's wheel cylinders, so pressing the linings against the inside of the drum to slow or stop it. Anup kumar et,al(2014).

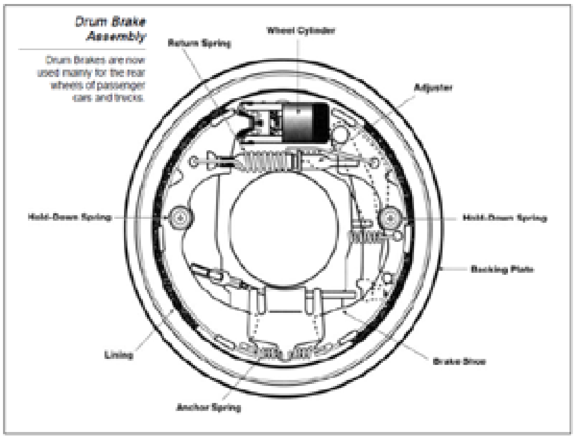

Figure1 Drum brake assembly

Optimal design of today's brake systems is found using additional calculations based on Finite element methods. For both types of brake systems, drum brakes and disk brakes. Results include deformation, stress distribution, contact pressure and showing which regions of the contact area are in sticking or sliding condition. Sourav Das et,al (2013) . A parametric modeling of a drum brake based on 3-D Finite Element Methods for non-contact analysis is presented. Many parameters are examined during this study such as the effect of drum-lining interface stiffness, coefficient of friction, and line pressure on the interface contact. It is shown that the Unsymmetrical modal analysis is efficient enough to solve this linear problem after transforming the non-linear behavior of the contact between the drum

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and the lining to a linear behavior. Ibrahim Ahmed1et al,(2014) A multi objective optimization design model of drum brake with the goals of maximizing the efficiency factor of braking, minimizing the volume of drum brake, and minimizing the temperature rise of brake, in order to better meet the requirements of engineering practice. And the results of optimizing the new brake model indicate that DECell obviously outperforms the compared popular algorithm NSGA-II concerning the number of obtained brake design parameter sets, the speed, and stability for finding them. It is an effective algorithm that can be applied to solve the drum brake parameters optimization and other complicated engineering problems. P. Ioannidis et al,(2003). To establish a brake test rig capable of measuring the performance of a drum brake at different operational and environmental conditions, the effects of dry and humid environment are considered under different applied forces and vehicle sliding speed. The experimental results showed a slight increase in the friction coefficients between drum and brake lining with increasing pressure or speed at dry and wet conditions. Nouby M. Ghazaly et al, (2014).Brake torque is reduced in the absence of cooling so the result shows to eliminate brake fade if the cooling is very effective. Brake fading is due to temperature rise of brake shoe and brake drum. The heat generated due to braking rises the temperature reducing the coefficient of friction at the interface of brake shoe and brake drum. The reduced coefficient of friction reduces the brake torque, thus reduces the brake effectiveness. It was observed that brake torque was reduced by 25% in the absence of cooling as the brake cooling improved the brake fade reduced(Brake torque improved). Yi Zhang et al,

Methods and Material

To create a CAD MODEL of brake drum we find existing brake drum of Hero Honda Passion from market for reverse engineering .Through the approach of reverse engineering we can measure all the visible outer dimensions manually with specified measuring instruments to create accurate and scaled model. To find out accurate feature location like holes plane angles etc. CMM is done. Using CAD software we can create CAD model of brake drum as per measurement data we Import the CAD Model (IGES) in the Ansys Workbench 14.5 for pre-processing and then the stress and thermal analysis is done on the brake drum. The Analysis involves the discritization called meshing, boundary conditions and loading. For analysis we take Aluminium as the material .The Aluminium has been selected based on the properties required for the existing brake drum. The aluminium has been selected as matrix for manufacturing the MMC based on the ease of manufacturing.

Specifications of brake drum

Inner diameter (mm) = 110.

Outer diameter (mm) = 164

Outer Width (mm) = 10

Inner Width (mm) = 38

Contact an angle per shoe = 120°

Width of Shoe (mm) = 25

No. of shoes = 2

Material properties of brake drum

Material = Aluminium

Density (g/cm3) = 2.7

Tensile Strength (Mpa) = 241

Young's modulus (x10^3N/mm2) = 70

Thermal conductivity(cal/cm2/cm/25 oC) = 0.42-0.46

Cofficient of thermal expansion(ppm/0c) = 24

Poisson's ratio = 0.3

Mass = 1.246

Boundary conditions

Force = 1662.5 N

Pressure = 0.129 Mpa

Heat flux = 25.7611W/mm2

Solid Modeling: The first step was to prepare a solid model of the brake drum. This was carried out by using Inventor professional 2012 Software. The detailed drawing was provided

Figure2 Brake drum model

Analysis: Brake drum finite element analysis is done through Ansys workbench 14.0 software. Both stress analysis and thermal analysis is done under different braking time and operational conditions.

Stress Analysis: For stress analysis the model are imported separately into Ansys workbench and then material properties and meshing is applied on the models and we get the different stresses and deformation of the brake drum.

Boundary Conditions: For Stress analysis, pressure is applied on the internal surface of the cylindrical face of the brake drum, and the hub of the brake drum where the wheel of the vehicle rests is supported with the fixed support.

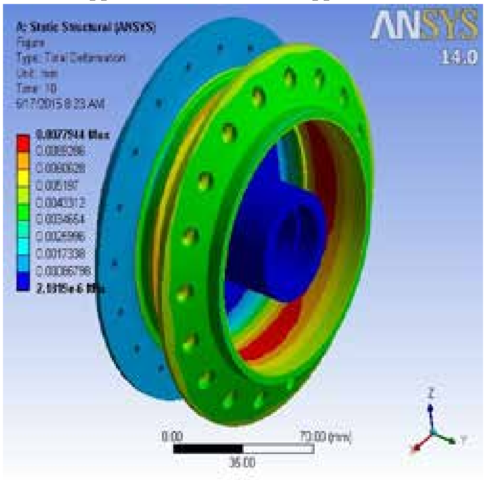

Figure3 Deformation for Aluminium

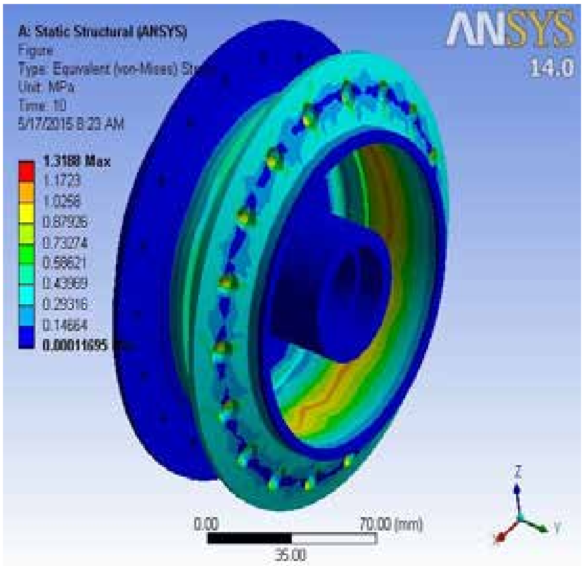

Figure4 Stresses for Aluminum

Thermal Analysis: For thermal analysis we assign the calculated heat flux on the inner face of brake drum. We calculate the heat flux on two conditions:

Gradual braking (time=15sec) at 80kmph

Sudden braking (time=5 sec)at 80kmph

Boundary Conditions: For heat transfer analysis heat flux is applied on the internal surface of the cylindrical face of the brake drum, and the hub of the brake drum where the wheel of the vehicle rests is supported with the fixed support.

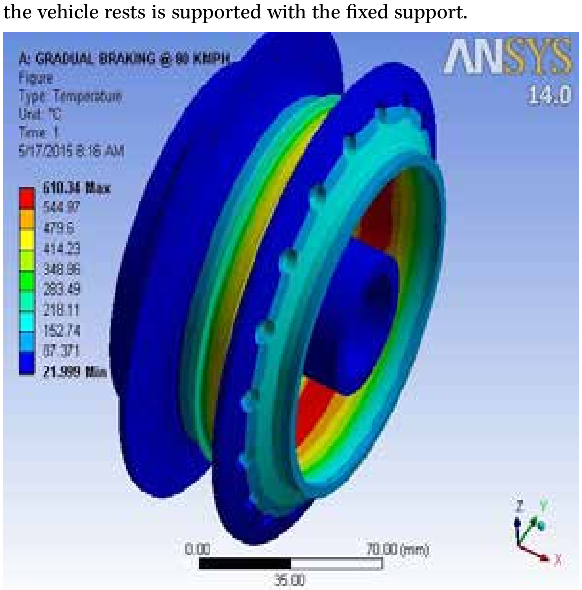

Figure5 Aluminium (gradual braking)

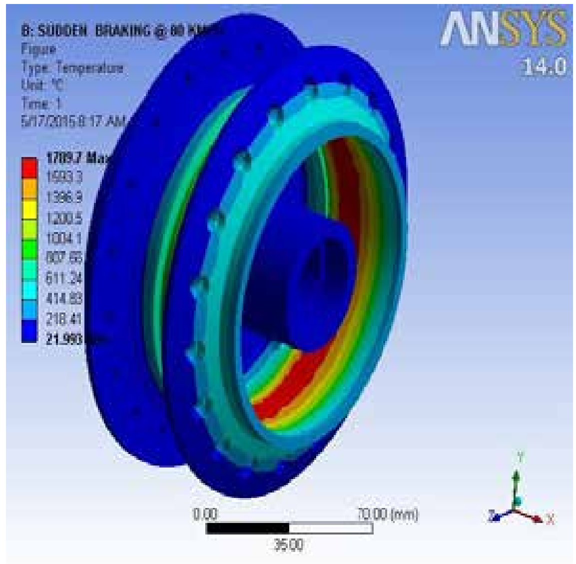

Figure6 Aluminium (sudden braking)

Results and Discussions

Stress analysis

Material	Deformation(mm)		Stress(mpa)	
	Max	Min.	Max.	Min.
Aluminium	0.0077944	0.0021819	1.3188	0.00011695

Thermal analysis

Material	Braking time	Max.temp	Min.temp.	outer face temp.
Aluminium	15	610	21.999	414.23
Aluminium	5	1789.7	21.993	1200

Figure7 Temp. at different braking time

Conclusion

The deformation and the stress induced in the aluminium alloy brake drum during the application of brake force have been determined using finite element analysis. Thermal analysis has been carried finite element analysis to determine the temperature raise during braking. While braking from a speed of 80km/h at a constant deceleration of4.44 m/sec2 at sudden braking and 1.481m/sec2 at gradual braking, it is observed that the temperature rises in brake drum surface during sudden braking. During sudden braking, the temperature rise in brake drum is found to be 65 to 66 % more than the gradual braking. It concludes that temperature rise in the surface of brake drum depends upon the time of braking.

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