Design and analysis of drum brake by fea: A Review

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***Abstract*- 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 drum brake. The drum brake is a mechanical device which inhibits motion by the concept of friction generate in a set of shoes or pads. During the brake applied the brake drum components experience high temperature and thermal stress. Due to this the drum brake material should possess a high thermal conductivity, thermal capacity and high strength. So the analysis takes place on both the thermal stresses and mechanical stress. Generally, safety parts of cars and trucks are brakes, the common material are used for drum brake is cast iron. A model is created with the help of software CATIA V5 and structural and thermal analysis are performed in ANSYS 16.0 work bench software. A static and thermal analysis of different materials such as grey cast iron, aluminium metal matrix composite 1, aluminium metal matrix composite 2 and stainless steel for a brake drum will be done. Steady state condition is studied for all the four materials. A comparison of all the four results is done and aluminium metal matrix composite 2 material is proved better than the other materials.**

***Keywords*: - Drum brake, Static analysis, Thermal analysis, Ansys, Catia.**

I. INTRODUCTION

Brake drum was invented by Louis Renault in 1902. He used woven asbestos lining for the brake drum lining as no alternative dissipated heat like the asbestos lining, though Maybach has used a less sophisticated brake drum. In the first brake drums, levers and rods or cables operated the shoes mechanically. From the mid-1930's, oil pressure in a small wheel cylinder and pistons operated the brakes, though small vehicles continued with purely mechanical systems for decades. Some designs have two wheel cylinders. The shoes in brake drums wear thinner, and brakes required regular adjustment until the introduction of self-adjusting brake drums in 1950's. The brake drum is used widely on road vehicles and consists of a drum attached to the rotating wheel. The drum has an internal machined cylindrical surface. Inside the drum and protected from the environment are two shoes lined with friction material which can be pivoted to make a forced contact with the internal cylindrical surface. A drum brake unit consists of two brake shoes mounted on a stationary backing plate. When the brake pedal is pressed, a hydraulically activated wheel cylinder pushes the shoes out to contact a rotating drum which creates friction and slows the vehicle. As the pedal is released, return springs retract the shoes to their original position.

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.

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.

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.

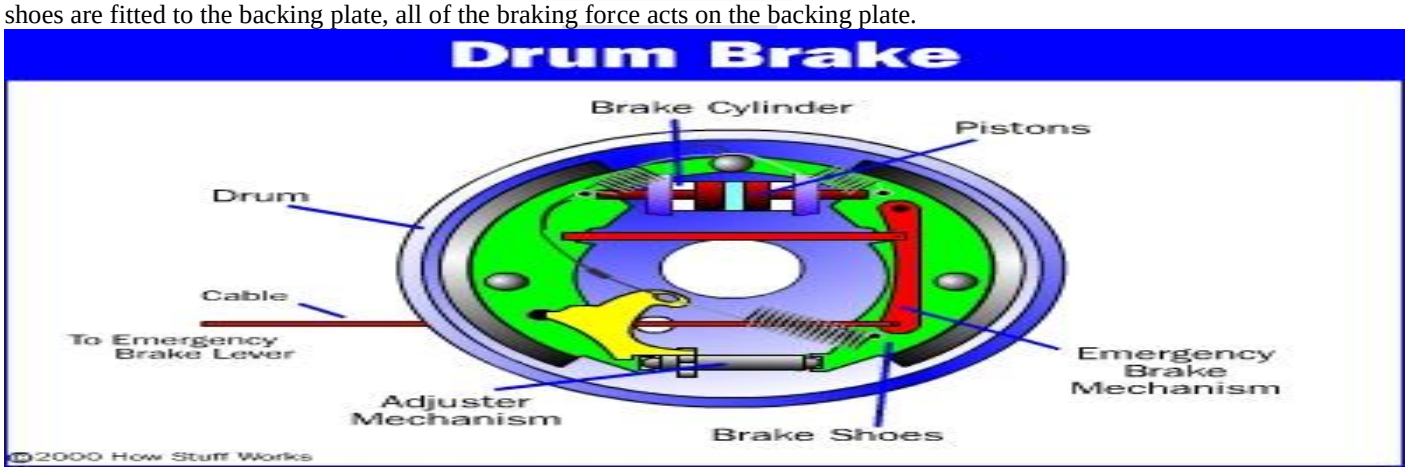

Fig: - drum brake

II. LITERATURE REVIEW

[1] L.SRAVANI

This paper describe that the brake drum is experiences high temperatures and develop thermal stresses during application of brakes. In addition, the application of shoe pressure gives rise to mechanical loads. So the analysis takes into account both the thermal stresses and mechanical stresses together. Requirements not only in performance but also in comfort, serviceability and working lifetime are high and rising. The brake pad with the friction material, the counter body and caliper, can be modeled. This project we design the model of drum brake (drum, & pads) in solid works 2016 and structural and thermal analysis are performed in ansys work bench software.

[2] K. Gowthami

This paper describe that the drum brake uses the concept of friction to decelerate. During the brake operation heat is ejected out this causes damage to the brake. In this condition the drum material should possess a high thermal conductivity, thermal capacity and high strength. A thermal analysis of different materials such as aluminium alloy, cast iron and stainless steel 304 for a brake drum will be done. Steady state condition are studied. Transient state analysis, for regular 30 seconds, 90, 120 and 210, temperature distribution and thermal flux is studied. A comparison of all the three results is done and aluminium alloy material is proved better than the other materials.

[3] Meenakshi Kushal

The aim of this paper is to optimize the design of Hero Honda Passion brake drum. Optimization is done by changing the material of the brake drum, under different braking time and operational conditions. Brake drum is optimized to obtained different stresses, deformation values, rise in temperature on different braking time and heat transfer rate. Optimized results obtained are compared for Aluminium and CE (Controlled Expansion) material alloys. It concludes that the CE (Controlled Expansion) alloys can be a better candidate material for the brake drum applications of light commercial vehicles and it also increases the braking performance.

[4] Simon George

This paper describe the modern development in the field of material technology gave rose to hybrid materials such as composites that paved the way for engineers to explore the possibility of substitute material which can perform efficiently and effectively than conventional materials. The present work is concentrated on the development of a particulate reinforced composite material for an automobile brake drum in place of conventional material such as cast iron and aluminium alloys are heavier and can be replace by lightweight aluminium hybrid composites. It is observed that this composition has enhanced mechanical and physical properties and FEA analysis shows the projected improvement which enables it to be used in practical application such as drum brakes.

[5] Zaidi Mohd Ripin

This paper describe the drum brake squeal is modelled as friction excited vibration based on the binary flutter mechanism which requires the convergence of two modes experimentally identified using Modal Assurance Criterion. Transient analysis is carried out to determine the brake drum response under braking condition and the model produces squeal mode at 2026 Hz comparable to the measured squeal frequency of 1950 Hz. There are limited combinations of the location of center of pressure of the shoes that cause squeal. The amplitude of the limit cycle of the drum brake squeal can be reduced by increasing damping, mode frequency separation and reducing the contact stiffness.

[6] **A. Rehman**

This paper describe the work reported to analyze the suitability of Aluminum alloy–Silicon Carbide MMC (Al–SiC MMC) in the automobile brake drum applications in comparison with cast iron (CI) brake drum. A brake drum dynamometer test rig was developed for the purpose. Al–SiC MMC was reinforced with 10% and 15% SiC particle by weight. The effect of heat treatment of the Al–SiC MMC brake drum was also studied. Performance was mainly evaluated on the basis of brake drum coefficient of friction (m). Scanning electron microscope was also used to study the effect of braking on the sliding surface of the brake drum.

[7] Liu Hongpu

This paper describe the design and study on the type parameter of the brakes. On the basis of the principles of discretization, discretize the structural pattern of the brake drum. Select the typical characteristic of the brake assemblies and the individual parts of the 3d parameterization modeling work, to build a model for parameterization library calls.

[8] O.P. Singh

This paper systematically analyzed and report of the failures of the drum components and observed during high-g braking on spoke wheels of a motorcycle. During high speed brake applications of the drum brake were found the excessive wear on the drum liner made of cast iron. Metallurgical analysis (chemical analysis, hardness test and microstructure analysis) of the liner revealed that excessive wear on the liner was not due to any change in material properties. Then, further investigate the problem and use of experimental testing methodology to simulate these failures. This unusual failure was further investigated using three-dimensional steady state finite element analysis (FEA) of both cast and spoke wheels and

apply boundary condition to determining the thermal and structural conditions. It was found that the failure of the brake system in the spoke wheels was due to excessive thermal expansion of the brake panel and the drum beyond the specified limit. An optimum range of labyrinth clearance between the brake drum and the brake panel was recommended for the brake system of cast and spoke wheels.

[9] M.A. Maleque

The aim of this paper is to develop the material selection method and select the optimum material for the application of brake disc system emphasizing on the substitution of this cast iron by any other lightweight material. Two methods are introduced for the selection of materials, such as cost per unit property and digital logic methods. Material performance requirements were analyzed and alternative solutions were evaluated among cast iron, aluminium alloy, titanium alloy, ceramics and composites. Mechanical properties including compressive strength, friction coefficient, wear resistance, thermal conductivity and specific gravity as well as cost, were used as the key parameters in the material selection stages. The analysis led to aluminium metal matrix composite as the most appropriate material for brake disc system.

[10] Jinchun Huang

This paper used a numerical modeling approach in a drum brake system. The brake system model is based on the modal information extracted from finite element models for individual brake components. The component models of drum and shoes are coupled by the shoe lining material which is modeled as springs located at the centroids of discretized drum and shoe interface elements. The developed multi degree of freedom coupled brake system model is a linear non-self-ad joint system. Its vibrational characteristics are determined by a complex eigenvalue analysis. The study shows that both the frequency separation between two system modes due to static coupling and their associated mode shapes play an important role in mode merging. Mode merging and veering are identified as two important features of modes exhibiting strong interactions, and those modes are likely candidates that lead to coupled-mode instability. Techniques are developed for a parameter sensitivity analysis with respect to lining stiffness and the stiffness of the brake actuation system. The influence of lining friction coefficient on the propensity to squeal is also discussed.

[11] J. M. LEE

This paper describe that the stability of drum brake squeal may be due to change of cross section of the shoes. The squeal is considered as a noise induced by the self-excited vibration of the drum brake which makes the brake unstable. The drum and the shoes are assumed as a uniform ring and non-uniform arches, respectively, for modelling the brake. For a reasonable method of modelling, the vibration characteristics of the brake and their relations to the squeal are discussed based on the results of modal tests. The influences of brake design parameters upon the squeal are investigated, and a minor change of the cross-section is proposed to reduce the squeal. The effect of the minor change is verified through noise dynamometer tests. In addition, the effect of asymmetry of the drum, which can be built by mass addition, is presented.

III. CONCLUSION

From the above literature survey we find that there are many researchers done analysis on drum brake and material taken by them are such as cast iron, aluminium alloy, aluminium metal matrix and composite materials.

The various factors such as: - Material is economically less strength by weight ratio, less weight, less deformation, minimum temperature at the surface, high coefficient of friction and High wear resistance on the brake liner is attributed to the higher temperature generated due to seizure between the brake drum and the panel.

From above literature survey (9) M.A. Maleque we find that the analysis on disk brake the aluminium metal matrix composite 1, 2 materials are higher performance index than other materials.

Then, I have decided that I will do the analysis of drum brake by taking the materials such as grey cast iron, aluminium metal matrix composite 1, 2 and titanium alloy and find out the total deformation, maximum stress, heat flux and maximum temperature.

REFERENCES

[1] Dvsrbm Subramanyam, L.Sravani, Design and Analysis of Drum Brakes, International Journal of Research In Advance Engineering Technology, Volume-6, pp. - 257-269.

[2] K. Gowthami, K. Balaji, Designing And Analysis Of Brake Drum, International Journal For Research In Applied Science & Engineering Technology (Ijraset), Volume 4, pp-135-142.

[3] Meenakshi Kushal, Suman Sharma, Optimization Of Design Of Brake Drum Of Two Wheeler Through Approach Of Reverse Engineering By Using Ansys Software, IOSR Journal Of Mechanical And Civil Engineering (IOSR-JMCE), Volume 12,pp- 70-75.

[4] Simon George, Arun LR, Guru Prasad BS , Analysis Of Composite Drum Brake Using FEA Approach, International Journal Of Engineering Trends And Technology (IJETT), Volume 4, pp.- 3398-3402.

[5] Choe-Yung Teoh, Zaidi Mohd Ripin, Muhammad Najib Abdul Hamid, Analysis Of Friction Excited Vibration Of Drum Brake Squeal, International Journal Of Mechanical Sciences 67 (2013) 59–69.

[6] A.Rehman, S.Das, G.Dixit, Analysis of Stir Die Cast Al–Sic Composite Brake Drums Based On Coefficient Of Friction, Tribology International 51 (2012) 36–41.

[7] Liu Hongpu, Peng Erbao, The Study Of The Parameterization Of The Drum Brake Design Based On UG, Energy Procedia 17 (2012) 279 – 285.
[8] O.P. Singh, S. Mohan, K. Venkata Mangaraju, M. Jayamathy, R. Babu, Thermal Seizures In Automotive Drum Brakes, Engineering Failure Analysis 17 (2010) 1155–1172.
[9] M.A. Maleque, S.Dyuti, M.M. Rahman, Material Selection Method in Design of Automotive Brake Disc, Volume- 3, pp-978-988.
[10] Jinchun Huang, Charlesm. Krousgrill, Anil K. Bajaj, Modeling Of Automotive Drum Brakes for Squeal And Parameter Sensitivity Analysis, Journal Of Sound And Vibration 289 (2006) 245–263.
[11] M. Lee, S. W. Yoo, J. H. Kim, C. G. Ahn, A Study On The Squeal Of A Drum Brake Which Has Shoes Of Non-Uniform Cross-Section, Journal Of Sound And Vibration (2001) 240(5), 789-808.