Thermal Structural Analysis of Drum Brake Using Finite Element Method

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Abstract- *The drum brake is a mechanical device and they are use in rear part of the car. Which inhibits the rotational motion of the wheel by the action of friction generated between shoe and drum brake. A drum brake system consists of hydraulic wheel cylinder, brake shoes and brake drum. During the brake applied the brake drum components experience high temperature and thermal stress. The most commonly material is use in cast iron and aluminum. So the drum brake material possesses a high conductivity, thermal capacity and high strength of material. It is observed that this composition has enhanced mechanical and physical properties and FEA (finite element analysis) are show the improvement project which enables it to be used in particle application such as drum brake. They are design to the safety purpose for care and trucks are brake. This model is created with the of help of design modeler for ANSYS 16.0 software. And thermal and structure stresses analysis are using ANSYS 16.0 workbench software.*

Keywords- Drum brake, ANSYS workbench, material, thermal stress, structure, FEA.

I. INTRODUCTION

mechanical on automobiles parts. Nowadays, over 100years after the first usage. Drum brake are still used on the rear wheels of most vehicles. Drum brake are still used on the rear wheels of the most vehicles. The drum brake are used extensively as the rear brake in automobile, light motor vehicles in particular. The term drum brake usually means a braking which shoes press on the inner surface of the drum. When shoes press on the outside of the drum, it is usually called a clasp brake. The brake drum historical background, the brake drum inogation was in 1902 by "Louiats Renault" though a less sophisticated drum brake has been used by may in year earlier. In the first drum brakes the shoes was mechanically operated with and rods or cables form the mid-1930s the shoes was operated with oil pressure in a small wheel cylinder and piston. the brake drum function are in the to stop the vehicle in shortest possible distance in case of emergency, to control the vehicle when it is travel along the hills, to keep the vehicle I desired position after bringing it in complete rest when there is no driver. The brake drum is generally made by a cast iron. It is positioned very close to the brake shoes without actually touching it, and rotates with the wheel and axle. As the lining is pushed against the inner surface of the drum, fraction heat can reach as high as 600 degrees F. many vehicles have drum brakes on the rear wheel sand disc brakes on the front. Drum brakes have more parts than disc brake and harder to serve, but they are less expensive to manufacture, and they easily incorporate an emergency brake mechanism. A brake drum unit consists of two brake shoes mounted on a stationary backing plate. When the brake pedal is pressed a hydraulically active 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.

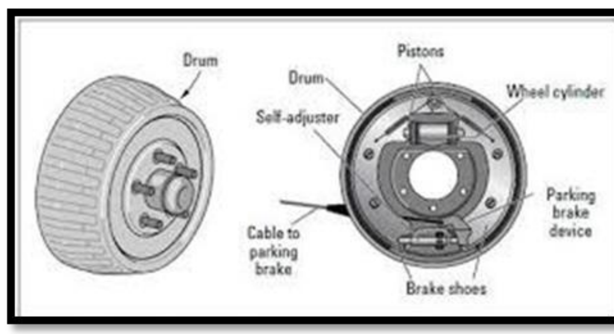

Figure-1

II. LITERATURE REVIEW

[1] PUTTI SRINIVAS RAO, D.V.G. PRASAD, D.D.S.P.R. RAJU, B.R. PHANINDRA, B.N.SURYA

In this paper object "development and Analysis of finned brake drum model for effective heat transfer". In this paper solve by problem, fin are connected to the outer surface of the brake drum. It is increases weight such as converting one fourth of the overall length thickness of the original model into extended surface and then analyzed in this paper. In this paper found to conclusion, the brake drum small stress or displacement show on the modify to design and indicates that the modify design stronger or rigit than original. The are using two material properties in made by brake drum ad provides a range of heat flow valve. The comparing two material properties with the apply two different application. And this paper conclusion by placing fin on the surface of the brake drum. The amount of heat flow are increases. When the criteria is maximum heat flow then it are better to go for a brake drum with rectangular cross- section annular fin and is of high conductive material use.

[2] UDAY PRATAP SIGNH, A.K. JAIN

In this paper object "finite element analysis of drum brake by using ansys". In this paper are decided how to solve problem you have to decided the analysis of the brake drum by taking the material gray cast iron, aluminum metal matrix1, aluminum metal matrix2 and the titanium alloy and find out the total deformation, maximum stress, heat flux and maximum temperature. In this paper found the conclusion, the brake drum conclude that beside general materials such as cast iron, aluminum metal materix1, aluminum metal materix2. But cast iron and aluminum metal matrix2 shown less valve of deformation as well as maximum von-mises stress under static structural analysis. Thermal analysis show adequate values of heat flux which validates the heat dissipation ability of material. In additional to that it have very less weight compared to cast iron and hence cast iron can be replace by aluminum metal matrix2.

[3] K.GWOTHAMI, K.BALAJI

In this paper object "designing and analysis of drum brakes". in this paper found the conclusion, the brake drum uses the concept of friction for avulsion. During the brake operation, heat goes out, this many causes is damage to brake assembly. In this case drum brake material should possess high thermal conductivity, thermal efficiency and high power. thermal analysis of various materials like aluminum alloy, cast iron and stainless steel 304 will be carried out. The steady state condition are studies. A transient state analysis, for regular 30s, 90,120,210, temperature distribution and thermal flux is analyzed . A comparisons of all the three results is done and aluminum alloy material is proved better than other materials.

[4] SIMON GEORGE, ARUN LR, GURU PRASAD BS

In this paper object "analysis of composite drum brake using FEA approach". In this paper are using hybrid material such as the composite material. And mechanical and physical properties are improve the brake drum application. These researcher are using design modeling catia software. The way from engineering to explore the possibility of substitute material which can perform efficiently and effectively than conventional material. Most of material are using the automobile engineering cast iron and aluminum alloy but these are replace by the material are using lightweight aluminum hybrid composite material. This paper conclusion the radial deformation induced in brake drum is found to be less for sic-fiyash composite material by 0.1695mm. hence it exhibits sic fly ash composites have better wear resistance compare to base metal.

[5] MEENAKSHI KUSHAL, SUMAN SHARAM

In this paper object "optimization of design of brake drum of two wheeler through approach of reverse engineering by using ansys software" in this paper problem found by the replacing by the material. And this paper aim of to optimize of hero Honda passion brake drum and it also increases the braking performance. These design by the model CAD (computer aided design) software. And analysis by the model ansys workbench14.5. in this paper conclusion that the controlled expansion alloy for brake drum have less weight, less deformation, minimum temperature at the brake drum surface. Hence the controlled expansion alloys can be a better condition material for the brake drum application of the light commercial vehicles.

[6] P VENKATARAMANA

In this paper object "design of a brake drum using finite element method". In this paper working on the TATA INDICA car under the load certain condition. The size is required of the brake drum to used in newly introduced TATA NANO car, the help of finite element analysis. The tested under the different load of the brake drum. The result shown that the size of the brake drum required for NANO car is smaller than the size that being used in INDICA car with lesser brake than the later one. This paper conclusion results are the obtained stresses I the brake drum are lower the allowable stresses of the brake drum material. Our design will be acceptable.

[7] Bako Sunday, Usman Aminu, Paul O. Yahaya, Mohammed B. Ndaliman

In this thesis object "development and analysis of finned brake drum model using solid works simulation. In this paper research brake drum development and analysis. These research work on the two model. Brake drum without fin and brake drum with fin, And compare to the both model of the ansys. These are indicated by the added to the fin have brake drum so more circumferential strength. And the circumferential increased the resistance of the brake drum to motion of the shoes force. And this help of reduce the hoop stress or circumferential stress motion at the inner wall thickness of brake drum. And the result of the this indicate by the fin has improved by the rate of heat dissipation and conductivity for the inner face to the outer face of the modified brake drum. And the research paper conclusion are show on the brake drum are prone to structural and thermal failure due to hard braking force. If the detail design and material properties are not correctly specified. These paper analysis to automotive engineering to model design a more effective and reliable brake drum.

[8] A.Belhocine, M. Bouchetara

In this paper "temperature and thermal stresses of vehicle grey cast brake". The main purpose of the study is to analyze the thermomechanical behavior of the dry contact between the brake disc and pads during the braking phase. The simulation strategy is based on computer code ANSYS11. We demonstrated that the ventilation system plays an important role in cooling the disc and provides a good high temperature resistance. The analysis results showing that, temperature and stress field in the processes of braking phase were fully coupled. The temperature Von mises stress, and the total deformations of the disc and contact pressure of thepads increased because the thermal stresses are additional to mechanical stress which caused the crack propagation and fracture of the bowl and wears off the disc and pads.

III. DESIGN METHODOLOGY

1. This model are design by the ansys workbench16. Design modeler.
2. structural analysis of the model brake drum is using ansys workbench 16. Software.
3. Thermal analysis of the model brake drum is using ansys workbench 16. Software.

Scope of present work

In the research paper of the scope in the system, and brake drum will be study in future thermal structural analyses on different materials. The research of the work of the material cast iron and aluminum alloy. This research work on the thermal analysis of aluminum metal matrix

The objective od this study are:

1. Model are designing by the ansys workbench 16. Design modular.
2. To study the behavior of difference material on brake drum thermal structure analysis.
3. To calculated by the heat flux, stresses, the total deformation .
4. To compare all for the result in the best material for the geometry.

Brake drum modeling

This model is first step made by the ansys design modular. These software with the help create by the 3d model of the brake drum as per measurement data of the model. And the analysis by the ansys workbench16.

Specification of brake drum design data

Table-1

Outer diameter	460mm
Inner diameter	280mm
Width	10mm
Bolt hole diameter	20mm
Drum height	210mm
Thickness of drum brake	10mm
Number of hole	6mm

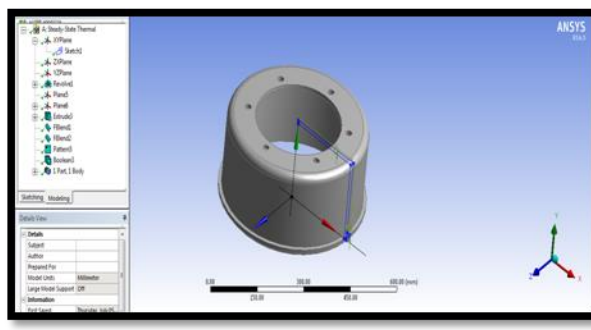

Figure-1 Sketch of drum brake

IV. STRUCTURAL ANALYSIS

Structure analysis is probably the most common application of the finite element method. The term structural implies not only civil engineering structural such as bridges and building, but also naval, aeronautical and mechanical structural such as ship hull, aircraft bodies and machine housing, as well as mechanical component such as pistons, machine parts and tools. [8]

The amount of friction developed between the two surface in contact is independent of the area of the surface in contact. However the magnitude of the force of friction or retarding force exerted on the shoes by the retarding mechanism and the coefficient for the two materials. For the purpose of the thesis, a retarding force of 150N was considered to be acting between the brake lining and the brake drum.

Brake drum thermal structure analysis

In acceleration, heat energy of the fuel is converted by the engine into kinetic energy to move the vehicle. In braking, the kinetic energy is converted into heat by means of friction produced between the two mating surface of the brake drum. The amount of friction developed between the two surfaces in contact is independent of the area of the surface in contact. However the magnitude of the force of friction or retarding force created between the brake lining and brake drum depends upon the pressure or force exerted on the shoes by the retarding mechanism and the coefficient for the two materials. For the purpose of this paper, a retarding force of 150N was considered to be acting between the brake lining and the brake drum[1].

During the simulation the exterior and the interior temperature of the brake drum were assigned to be 30^0C and 120^0C respectively. The following specification properties of the brake drum material gray cast iron and aluminum alloy. And these are properties are taking the model.

Brake drum material properties

S.NO.	PROPERTIES	GAEY CAST IRON	ALUMINIUM ALLOY
1	Young's modulus (E) GPa	110	71
2	Poisson ratio	0.28	0.33
3	Bulk modulus, K MPa	83	69.6
4	Shear modulus, G Mpa	42.9	26.6
5	Density kg/m^3	7200	277
6	Thermal expansion ^{0}C	$11*10^{-6}$	$23*10^{-6}$
7	Specific heat J kg^{-1} C^{-1}	420	896
8	Thermal conductivity	53.3	185

Table-2

Static structure analysis by using ansys workbench16.

The thermal structure analysis is a technique used to obtain the temperature, rate of heat flow and the temperature variation of the brake drum using gray cast iron and aluminum alloy material.

1. **Gray cast iron-** total deformation of brake drum

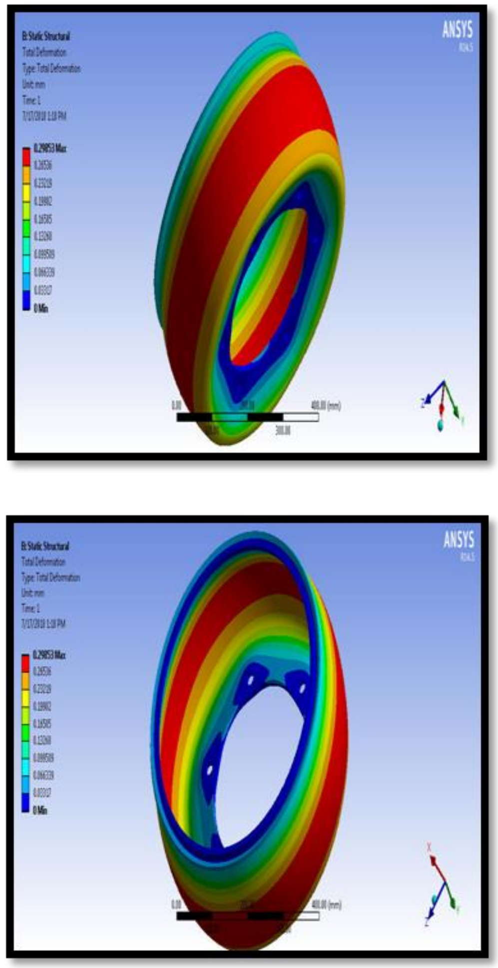

Figure-1 Total deformation

2. **Aluminum alloy–** total deformation of brake drum.

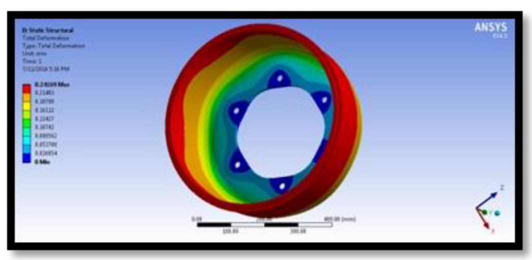

Figure-2 total deformation of aluminum alloy

3. **Grey cast iron-** maximum and minimum equivalent stress

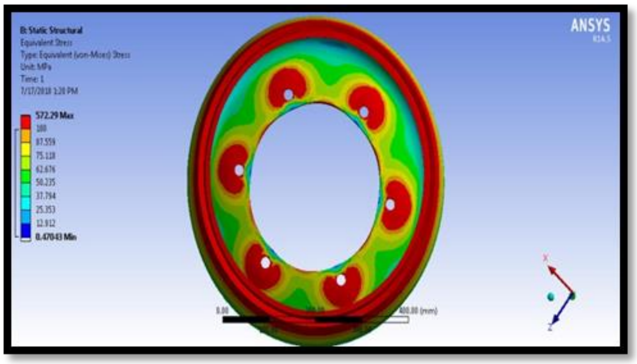

Figure-3 equivalent stress grey cast iron.

4. **Aluminum alloy-** maximum and minimum equivalent stress.

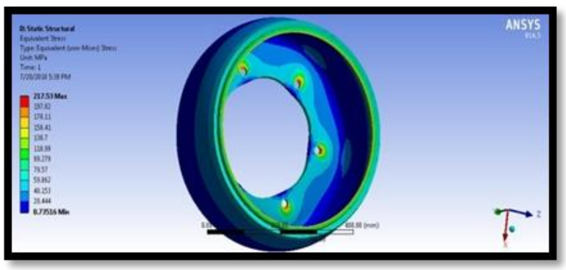

Figure-4 equivalent stress aluminum alloy

5. **Grey cast iron-** maximum and minimum total heat flux grey cast iron.

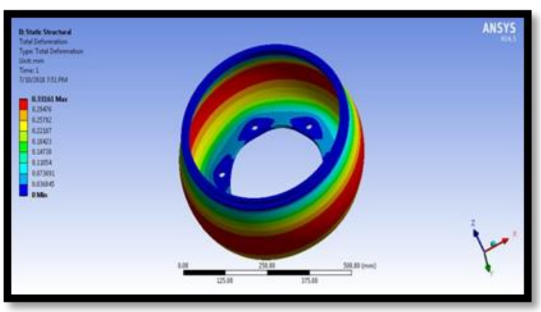

Figure-5 total heat flux grey cast iron.

6. **Aluminum alloy-** maximum and minimum total heat flux of aluminum alloy.

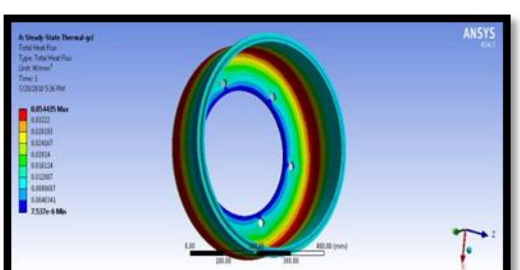

Figure-7 total heat flux aluminum alloy

7. **Grey cast iron-** maximum and minimum temperature of grey cast iron.

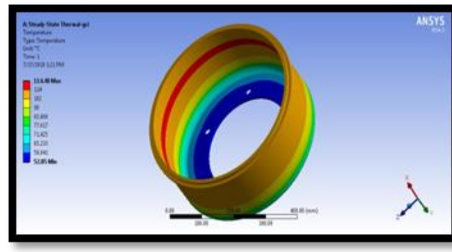

Figure-8 temperature grey cast iron.

8. **Aluminum alloy-** maximum and minimum temperature of aluminum alloy.

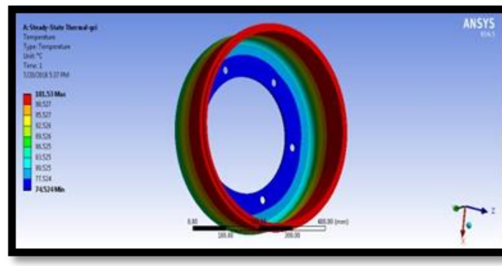

Figure-9 temperature aluminum alloy.

COMPARISON BASED MATERIALS GRAPH

Heat flux graph

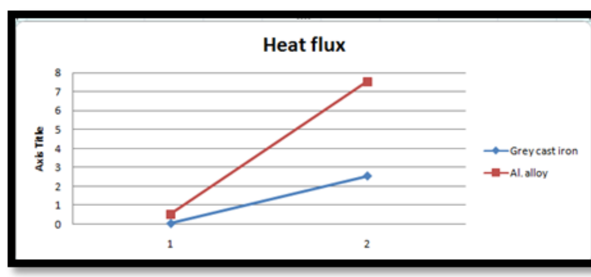

Figure-10

Equivalent stress graph

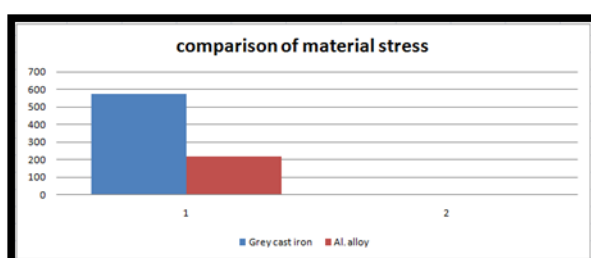

Figure -11

Equivalent strain graph

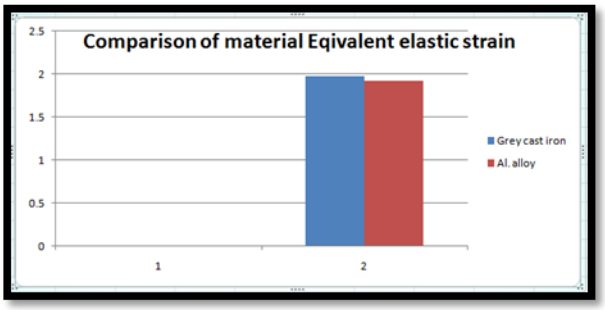

Figure- 12

Tempareture variation graph

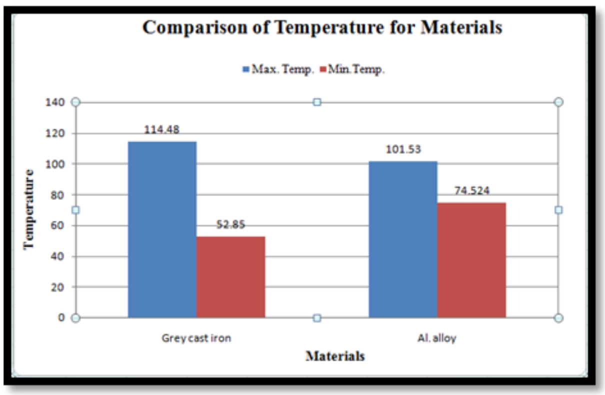

Figure-13

Total deformation graph

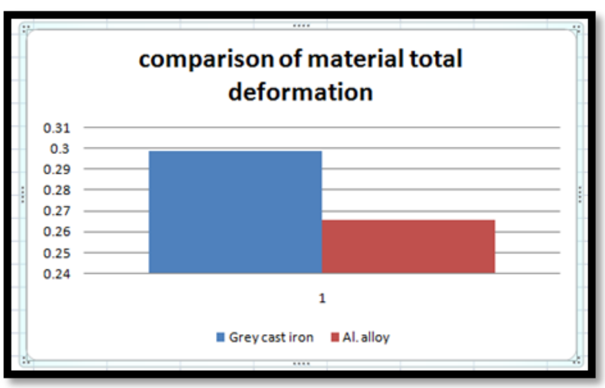

Figure-14

V. RESULTS

Static Structure Analysis material comparison
Table-3

Parameters metal	Total deformation	Equivalent stress	Equivalent strain
Grey cast iron	0.29853	0.47147	0.0028736
Aluminum alloy	0.26559	0.73516	0.0029242
Total difference	**-0.03294**	**0.26369**	**0.00506**

Thermal analysis material comparison
Table-4

Parameters metal	Max. temperature	Min. temperature	Total heat flux
Grey cast iron	114.48	52.85	0.33161
Aluminum alloy	101.53	74.524	0.054435
Total difference	**-12.95**	**21.674**	**0.277175**

VI. CONCLUSION

Form above result we can conclude the beside general material such as grey cast iron and aluminum alloy show the result of valve of deformation as well as maximum von- mises stress under static structural analysis. Thermal analysis shows adequate valve of heat flux which validates the heat dissipation ability of material. In addition to that it has very less weight compared to grey cast iron and hence grey cast iron can be replace by aluminum alloy. Because aluminum in vehicles reduces dead- weight and energy consumption while increasing load capacity.

REFERENCES

[1] Putti srinivas rao, D.V.G. Prasad, D.D.S.P.R. Raju , B.R.Phanindra , B.N. surya, Development and analysis of finned brake drum model effective heat transfer, International journal of scientific engineering and applied science (IJSEAS)- Volume-2 issue, September-2016, ISSN: 2395-3470.

[2] Uday Pratap singh, A.K. Jain, finite element analysis of drum brake by using ansys.

[3] K.Gowthami, K. balaji, Designing and analsys of brake drum, International journal for research in applied science & engineering technology (IJRASET), volume-2

[4] Siomn George, Arun LR, Guru Prasad BS, Analysis of composite drum brake using FEA approach, International journal of engineering trends and technology (IJETT), Volume-4, issue 8- august 2013.

[5] Meenakshi khusal, suman sharam, 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, issue- jul.-aug.-2015, pp- 70-75.

[6] P Venkataramana, design of a brake drum using finite element method, international journal of mechanical and robotics research, Volume-2, issue- 2-april-2013, ISSN: 2278-0149.

[7] Bako Sunday, Usman Aminu, Paul O. Yahaya, Mohammed B. Ndaliman, development and analysis of finned brake drum model using soildworks simulation, International journal of innovative research in science, engineering and technology, Volume-4, issue 5-may-2015, ISSN(Online): 2319-8753, ISSN(Print): 2347-6710.

[8] A.Belhocine , M. Bouvhetara, temperature and thermal stresses of vehicles Gray cast brake, Journal of applied research and technology