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Performance analysis of drum brake using finite element method

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ABSTRACT

The main objective behind undertaking the project "Analysis of Brake Drum Rotor" is to study and evaluate the performance of Brake Drum under severe braking conditions and thereby assisting in Brake Drum rotor design and analysis.

ANSYS 11.0 is a dedicated general purpose Finite Element package used for determining the temperature, stress and strains. ANSYS11.0 is a flexible and cost effective tool. ANSYS11.0 is used in industries in order to solve several mechanical problems.

In this project, an Axis-Symmetric Brake Drum rotor is considered for analysis. Flange width of 8mm, 10mm and 12mm made of Cast Iron, Aluminum and Aluminum composite are considered. A Coupled Field Analysis (Transient Thermal Analysis and Structural Analysis) is performed to obtain the Temperature Distribution and Von Mises Stress. After the Coupled field analysis is Performed, a graph is plotted between the distance and temperature. An attempt is Made to suggest the best combination of material and flange Width for Brake Drum rotor, which yields a low temperature variation across the rotor disc and minimum von mises stress possible.

INTRODUCTION

A brake is an instrument or equipment that makes use of artificial frictional resistance to stop the motion of a moving member. While performing this function, the brakes imbibe potential energy or kinetic energy of the moving member. The energy that is absorbed by the brakes is dissipated in the form of heat. The dissipated heat is in turn liberated into the surrounding atmosphere.

LITERATURE REVIEW

Rittner (2009) have presented the applications of metal matrix composites in defense, aerospace and light vehicles. She has concluded that the scope for MMC in all the above areas were optimistic and suggested further improvement in processes, selection of alloy, selection of reinforcement and selection of components to reduce the cost of end product.

Robert (2010) has presented various forms of aluminium alloys and their applications. Based on his survey on the growth of aluminium alloys, he concluded that 32.2% of the aluminum was consumed in transport industry in different forms. Foltz et al (2010) have presented various matrix alloys, reinforcements and their applications in space, defense, automotive and electronic packaging. They also presented the possible applications oMMCs in making automotive components like pistons, cylinder sleeve, connecting rod and brake discs. Many Researchers (Subra Suresh 2010, Kevorkijan 1999; Rohatgi 2010; Nakanishi 2010) have presented the applications of MMCs for the automotive components and the feasibility of manufacturing these materials. Surappa (2014) has presented an overview of aluminium matrix

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composite material systems on aspects relating to processing, microstructure, properties and applications.

The challenges of using the MMCs like producing high quality and low cost reinforcements, developing simple economical and portable non-destructive kits to quantify undesirable defects, developing less expensive tools for machining and cutting and developing re-cycling technology have been explored.

METHODOLOGY

Solid works mechanical design automation software is a feature-based, parametric solid modeling design tool which advantage of the easy to learn windows TM graphical user interface. We can create fully associate 3-D solid models with or without while utilizing automatic or user defined relations to capture design intent.

Parameters refer to constraints whose values determine the shape or geometry of the model or assembly. Parameters can be either numeric parameters, such as line lengths or circle diameters, or geometric parameters, such as tangent, parallel, concentric, horizontal or vertical, etc. Numeric parameters can be associated with each other through the use of relations, which allow them to capture design intent A Solid Works model consists of parts, assemblies, and drawings, Typically, we begin with a sketch, create a base feature, and then add more features to the model. (One can also begin with an imported surface or solid geometry). We are free to refine our design by adding, changing, or reordering features.

Specifications of Brake Drum

Mass of the vehicle unladen = 4540 kg Mass of the vehicle laden = 8300 kg Rolling radius of tyre = 389 mm Coefficient of friction (μ) = 0.36. Shoe contact angle = 95.5° Shoe width =120 mm

Brake drum internal diameter = 416 mm Brake drum external diameter = 470 mm Brake drum width = 178 mm

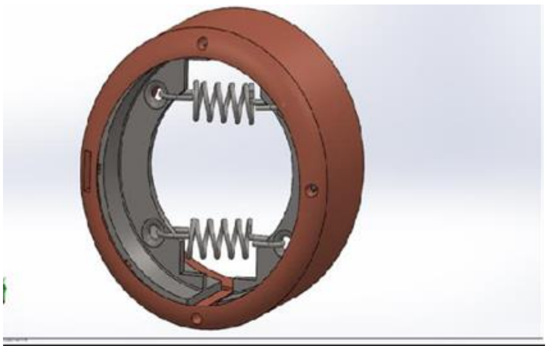

Fig no; 2.4 3D medalling View

- Convection film coefficient = 0.001W/mm °C2 Thermal expansion coefficient = 9×10- 6 /°C Density = 7.822×10 Kg
- /mm 6 3 Specific heat = 410 Joules Thermal conductivity (k) = 0.0544 W/mm°C
- In thermal analysis, three different flange widths of 8mm, 10mm, 12mm and three different materials such as Cast Iron, Aluminum, and Aluminum composite are considered respectively.
- An axis-symmetric model of disc brake rotor is created with flange width of 8mm.
- In order to create the disc brake, lines are created as shown in the Figure 3.
- The created model should obtain four sides in order to generate areas in.

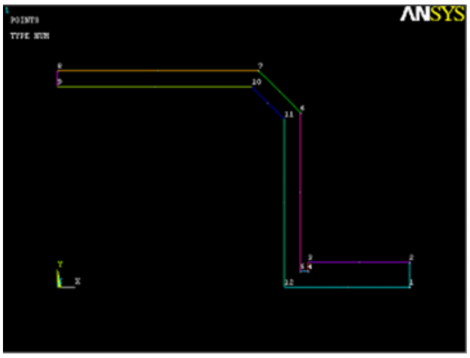

Figure 3 Creation of Lines of Disc Brake Rotor

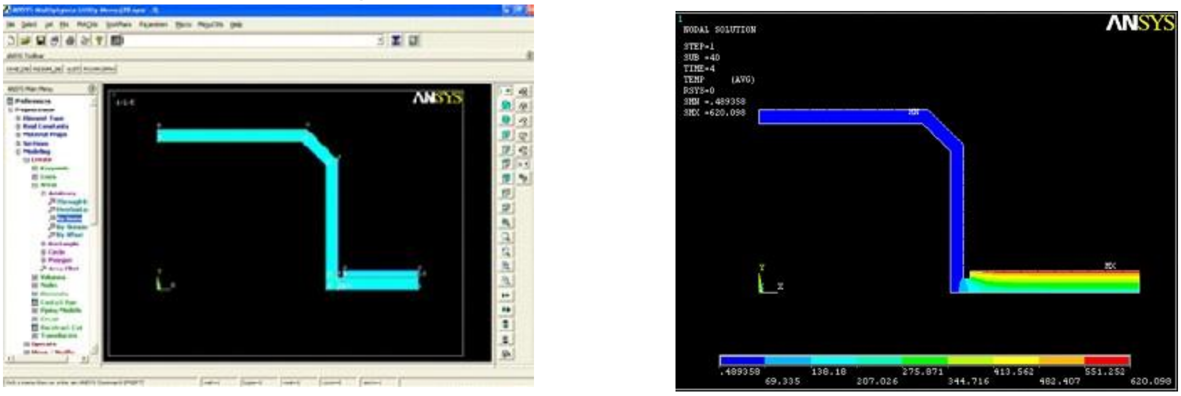

Figure 4 Creation of Areas through Lines

In order to mesh the model, the element type Considered for thermal analysis is Plane 55. After the creation of the areas and allocation of element types, the model is meshed with a line division of 10 on all the sides as shown in Figure

RESULTS & DISCURESS

The results discussed below are of 8mm, 10mm and 12mm flange width made of Cast Iron, Aluminum and Aluminum composite. These results are obtained after the thermal and structural boundary conditions are applied to the model and the analysis is performed. The minimum and maximum temperature and stress are interpreted in the form of colors such as blue being the minimum, green being the intermediate temperature and red being the maximum.

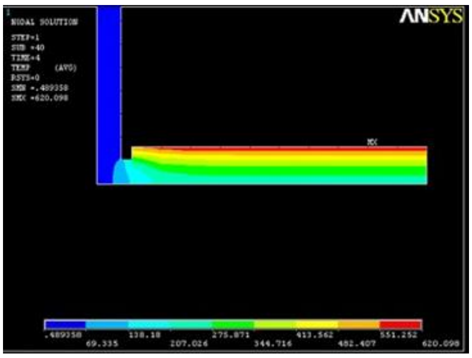

Figure 8 Screenshot of Nodal Temperature for 8mm flange width made of cast iron

The Figures 8 and 9 displays the temperature for 8mm flange width made of cast iron. As it is evident from the screenshot, the minimum temperature represented in blue color, is .489 K and the maximum temperature that is in red color is 620.090 K. It is also clearly visible from the screenshot that the temperature distribution is evenly distributed along the length of the flange and mainly it is towards the surface of the flange.

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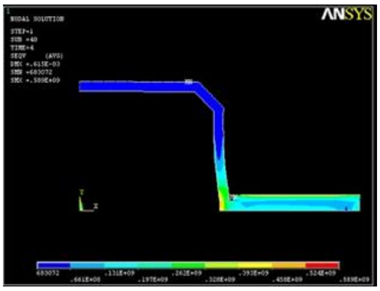

Figure 9 Close view of Nodal Temperature for 8mm flange width made of Cast Iron

CONCLUSION & DISCUSSION

The following conclusions are drawn from the present work:

1. An Axis-symmetric analysis of disc brake has been carried out using **Plane**
2. Different materials such as cast iron, aluminum and aluminum composite.
3. A transient thermal analysis is carried out using the **direct time integration technique** for the application of braking force due to friction for time duration of
4. **4 seconds** for different widths and different materials.
5. A steady state structural analysis coupled with thermal analysis is carried out for various widths and various materials.
6. The obtained results are compared and analyzed.
7. The minimum temperature distribution obtained on the disc brake rotor at the contact surface is observed to be 1. Figure 10 Screenshot of Von Mises Stress for 8mm flange width made of Cast **55** and **Plane 42** through **ANSYS11.0** software. A coupled field analysis is performed on disc brake rotor with different flange widths of 8mm, 10mm, 12mm and **413.183 °K** for 12mm flange width made of cast iron.
8. Static structural analysis is carried out by coupling the thermal solution with the structural analysis. The minimum Von Mises stress is observed to be **$415*10^6$ MPa** for 12mm flange width made of cast iron.
9. Comparing the different results obtained from the analysis, it can be concluded that the disc brake rotor with 12mm flange width and Cast Iron material is the best possible combination.

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