Analysis of Vented Disc Brake Using Ansys. (A Review Paper)

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Abstract- *In Today's automobile sector there is change in technology from transmission system to braking system. The braking system is one of the most important safety point of view as well as better performance. Kinetic energy is gets converted into amount of heat generation brakes applied when vehicle in motion. The thermal stresses are reduced in disc brake due to excessive temperature generation. The disc brake has ability of inherent co-efficient of friction on disc since there is no fading phenomenon of brake. Advantage of disc brake is friction material is in contact with small part of disc. Disc has dissipates heat to the atmosphere because of large surface area. Specifically by the mode of forced convection which is dissipates heat to atmosphere. The main aim of work to select best material and profile there is maximum heat dissipate surrounding to it.*

Keywords- Disc brake, Material, Heat Flux, Ansys

I. INTRODUCTION

A break is a device in order to stop the motion of vehicle or moving machine member which is artificial frictional resistance. In this heat energy dissipated by brake.
The heat generated between the brake pad & disc has to be dissipated by passing air over them. This heat transfer takes place by conduction, convection and somewhat by radiation. To achieve proper cooling of the disc and the pad by convection, study of the heat transport phenomenon between disc, pad and the air medium is necessary. Then it is important to analyze the thermal performance of the disc brake system to predict the increase in temperature during braking. Convective heat transfer model has been developed to analyze the cooling performance. Brake discs are provided with cuts to increase the area coming in contact with air and improve heat transfer from disc. This is because large area is exposed to air which makes more heat transfer through conduction and convection. But increase in number and size of cuts decreases the strength of disc.

A disc brake is a type of brake that uses calipers to squeeze pairs of pads against a disc in order to create friction that retards the rotation of a shaft, such as a vehicle axle, either to reduce its rotational speed or to hold it stationary. The energy of motion is converted into waste heat which must be dispersed. Hydraulic disc brakes are the most commonly used form of brake for motor vehicles but the principles of a disc brake are applicable to almost any rotating shaft.

The brake disc (or Rotorin American English) is usually made of cast iron but may in some cases be made of composites such as reinforced ceramic matrix composites. This is connected to the wheel and/or the axle. To retard the wheel, friction material in the form of brake pad mounted on the brake caliper, is forced mechanically, hydraulically, pneumatically, or electromagnetically against both sides of the disc. Friction causes the disc and attached wheel to slow or stop.

II. LITERATURE REVIEW

1] Thilak V.M.M. et al.(2012), presented work on Transient Analysis of Rotor Disc of Disc Brake Using Ansys. In presented work an attempt has made to investigate suitable hybrid composite material which is lighter than cast iron and has good young's modulus [1].Yield strength and density properties. They conducted study on Aluminium base metal matrix composites and high strength glass fibre composites have a promising friction and wear behaviour as a disc brake rotor. The transient thermo elastic analysis of disc brake in repeated brake application has been performed and results were compared. The suitable material for the braking operation is S2 glass fibre and all the value obtained from the analysis are less than their allowable value. This investigation is done using ANSYS software.

2]Khaled R. M. Mahmoud etal (2017),They presented work on Dynamic Behaviour of a Wedge Disc Brake. In this work the friction coefficient has significant role in the brake system dynamic especially, self energized. They have been conducted experimental set up to formulate mathematical equations relating the frictional coefficient, normal force and sliding speed [2]. They investigated that the effect of main operational parameter of a wedge disc brake such as normal force, sliding speed and wedge angle on dynamic behaviour and their

comparisons with conventional disc brake system was investigated. They concluded that the normal force has relatively little effect on wedge disc brake dynamic and has negligible effect on classical disc brake dynamic.

3]Aleksander Yevtushenko, Michal Kuciejetal , They presented work on Influence of Thermal Sensitivity of the Material on Temperature and Thermal Stresses of the Brake disc with Thermal Barrier Coating. In this work to determine the temperature field in coating and disc in a one dimensional friction heat problem during braking was formulated. Depending upon the thermal properties of material from temperature [3].

4]QifeiJian , Yan Shui , They presented work on Numerical and Experimental Analysis of Transient Temperature Field of Ventilated Disc Brake Under the Condition of Hard Braking. They work on ventilated disc brake of vehicles objective of this study which was built on 3D modelling technology. In this paper temperature curves of brake disc in radial and circumferential direction were obtained [4].The rationality of the selected finite element analysis was attributed which provide better theoretical basis experimental analysis.

5] Adam Adamowicz , PiotrGrzes ,(2011) They presented work on Influence of convective on a Disc Brake Temperature Distribution During Repetitive Braking. In this paper they evaluated an impact of convective mode of heat transfer on the thermal behaviour of disc system during repetitive braking process with the constant velocity using fully three dimensional finite element model [5].To determine temperature distribution on the contact surface of disc brake has been performed. They concluded that repetitive brake application with constant velocity occurred.

6]Dae - Jin Kim, Young –Min Lee, Jae-Sil Park etal (2008) They presented work on that Thermal Stress Analysis for a Disc Brake of Railway Vehicles with Consideration of the Pressure Distribution on a frictional Surface. They performed ventilated disc brake with three dimensional model for two cases whether the pressure distribution on contact surface is uniform or not. They were obtained result from pressure distribution analyses and they performed thermal stress analyses for each case [6]. They concluded that region of maximum von-Misses stress in thermal stress analysis coincides with the region where actual cracks are located on frictional plate in case with variable pressure distribution. As the thermal analysis of the disc brake, applying a variable pressure on a contact surface is more reliable than applying a uniform pressure.

7]HashalNikam , Prem Mishra &SayaliBharambe ,(2014) They presented work on Design And Analysis of Brake Rotor with Parameter Optimization. In this paper they studied that rotor was analysed for mechanical forces acting on it and heat generated due to friction between calliper pad and rotor surface [7]. Rotor under study was modelled, analysed and optimized in Ansys workbench14.0 software package. They concluded that in structural analysis stress value on rotor on left and deformation on right side. The temperature distribution over the rotor surface obtained from transient thermal analysis of rotor. Also factor of safety and temperature graph varying with rotor thickness.

8]Ganesh P, Naresh C and Syed AltafHussain, (2014) They presented work on Finite Element Analysis of Normal and Vented Disc Brake Rotor. In this paper the mechanical brake are classified according to acting force, i.e. radial brake and axial brake. In Radial brakes forced acting on the brake drum in the radial direction. Whereas axial force acting on the brake drum in the axial direction that is disk brakes. In the present work actual disc brake rotor has no holes ; designed is changed by giving holes in the disc brake rotor for more heat dissipation[8].Modelling is to be done on cad software (solid work) and Analysis is to be done in Ansys 13.0 They concluded that value obtained from the analysis are less than their allowable values. Hence brake disc rotor design is safe based on the strength and rigidity criteria. They also concluded that disc brake rotor with vents with hexagonal profile and material aluminium metal matrix composites is the best possible combination for the present application.

III. METHOD OF APPROACH

1] Initially the model will be created in Creo Parametric 2.0.and the analysis will be performed in Ansys15.0.
2] The mode of analysis will be selected for steady state Thermal.
3] The model will be imported in the steady state thermal Analysis.
4] First of all the model will be subjected to the symmetry region i.e. both sides of the disc to be similar.
5] After defining the symmetry region, the model will be subjected to the Meshing. In meshing, the discretization of the model into small element is done which are called as nodes.
6] After completion of meshing, the disc contact surface will be defined for the convection and radiation phenomenon of heat dissipation.
7] After defining the heat transfer phenomenon, the disc surface will be subjected to heat flux.
8] All the result of temperature, total heat flux will be evaluated by generating solution.

Formula of Mathematical Modelling for the Temperature

The Mathematical Formula for calculation of temperature is given by,

$$T_i = (0.527*q*\text{Sqrt of t}) / \text{sqrt}(\rho*Cp*k).$$

Where,

ρ- Density of material.
Cp- Specific heat of material in $j/Kg^0 C$.
t- Time for braking in seconds.
q - Input Heat Flux.
The temperature at final stage is given by,

$$T = T_{Ambient} + T_i$$

IV. SUMMARY & DISCUSSION

From above literature survey we can say that the heat dissipation in the disc is affected by no. of holes, shape of hole material use for manufacturing. We can suggest best material &profile which can dissipates maximum amount of heat to the atmosphere and heat flux also. Result obtained from Ansys will be observed and validate by analytical method. The best material from C.I. and S.S. will be selected for future manufacturing of disc.

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