THERMAL ANALYSIS OF TWO WHEELER DISC BRAKE VARYING DISC GEOMETRY

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***Abstract*: The application of disc brake with growing automotive world is considered as a major automotive performance factor to be considered while designing any automobile class and variants. Disc brake system provides instant and efficient braking, although it is tough to design disc brake. The impact braking effect may affect disc plate due to thermal action as due to impact loading enormous heat is produced at action surface which may results in distortion or deformation of plate. In this present work, the disc brake is of grey cast iron with four different geometrical variations are considered as a problem. The software simulation is performed with the aim of thermal analysis. It is found that disc with optimized geometry can perform better in terms of thermal action performance, the heat generation can be controlled and greater heat dissipation can be achieved, it also helps to improve life and durability of disc brake.**

***Keywords*: Thermal Analysis, Solid Works, Heat Flux, Temperature, Brake, Disc Brake.**

Introduction

Brakes are mechanical or sometimes electrical devices or components that help to decelerate the vehicle and eventually stop the vehicle in a certain time and certain distance called the stopping distance or the braking distance. The automotive brake is basically a mechanical device which inhibits motion, slowing or stopping a moving object, here, the automobile, and thereby preventing its motion. Brakes are one of the most significant safety systems in any automobile. Functioning of brakes is based on the conservation of energy. Most commonly used brakes are frictional brakes, where the friction produced between two objects convert the kinetic energy of the moving vehicle into heat energy.

Literature Review

A.Belhocine et. al., The work uses the finite element analysis techniques to predict the temperature distribution on the full and ventilated brake discs and to identify the critical temperature of the rotor. The analysis also gives the heat flux distribution for the two discs.

Ahmad Islahi et, al., The aim of the work is to investigate the rise of the temperature of the disk brake under severe braking conditions and the stresses generated from it. The investigation will be done using ANSYS software. ANSYS is a powerful FE package used to determine stress, strain and heat transfer in complicated problems.

Ali Belhocine And Mostefa Bouchetara, The numerical simulation for the coupled transient thermal field and stress field is carried out by sequentially thermal-structural coupled method based on ANSYS to evaluate the stress fields and of deformations which are established in the disc and the contact pressure on the pads. The results obtained by the simulation are satisfactory compared with those of the specialized literature.

B.Subbarayudu and Ginjala Kishore, The current study essentially deals with the modeling and analyzing ventilated disc brake by solid works and ANSYS. Finite element (FE) models of the brake-disc are shaped with solid works and simulated using ANSYS which is based on the finite element method (FEM). This study Thermal analysis is done so as to get the strength of the disc brake. The design is found and in thermal analysis, heat flow rates, and heat fluxes are considered by varying the dissimilar cross sections and materials of the disc brake rotor.

Deekshith Ch et. al., Present work deals with structural and thermal analysis of disc brake rotor of a vehicle. Heat generation and dissipation of disc brake rotor is analyzed. The objective of this work is to compare temperature distribution and heat flux of disc brake rotor of two different materials. After obtaining the analyzed results the manufacturing of the rotor for the best results is carried out using CNC machine.

Gongyu Pan and Rongyu Cai, The results of the simulated temperature field are compared with the results of the complete thermodynamic coupling method, the sequential coupling method based on fixed heat source and dyno test.)e comparison shows that the new method combines the advantages of the first two methods and has a better engineering value.

Ishwar Gupta, et. al., This paper deals with thermal analysis through finite element analysis of rotor disc of disc brake of BAJA SAE 2013 Car. The objective of thermal analysis of rotor disc is to study the temperature distribution & related thermal quantities such as thermal fluxes & thermal gradients & to evaluate the performance under severe conditions. In this present work, an attempt has been made to suggest best combination of parameters of rotor disc like Material composition, Flange Width & Wall Thickness. PRO/E wildfire 4.0 & ANSYS 13.0 software is being used for modeling & analysis of rotor disc. The Dimensions of an existing Maruti 800 car's disc rotor of disc brake are taken.

Jaenudin et. al., This thermal analysis on brake discs is aimed to evaluate the performance of an electric car in the braking process. The aim of this study is to analyze the thermal behavior of the brake discs using the Finite Element Method (FEM) through examining the heat distribution on the brake disc using 3-D modeling. Results obtained from the FEM reflect the effects of high

heat due to the friction between the disc pad with the disc rotor. Results of the simulation study are used to identify the effect of the heat distribution that occurred during the braking process.

M. Saran Theja et. al., The aim of the project is to design, model a disc brake. Modeling is done using Pro/Engineer. Structural and Thermal analysis is to be done on the disc brakes using two materials Stainless Steel and Carbon Steel. Structural analysis is done on the disc brake to validate the strength of the disc brake and thermal analysis is done to analyze the thermal properties. Comparison can be done for displacement, stresses, thermal gradient etc. for the two materials to check which material is best.

Rakesh Jaiswal et. al., The objective of this paper is to model and analyse stress concentration, structural deformation and thermal gradient of disc brake. Here the disc brake is designed by using Solidworks and analysis is done by ANSYS.

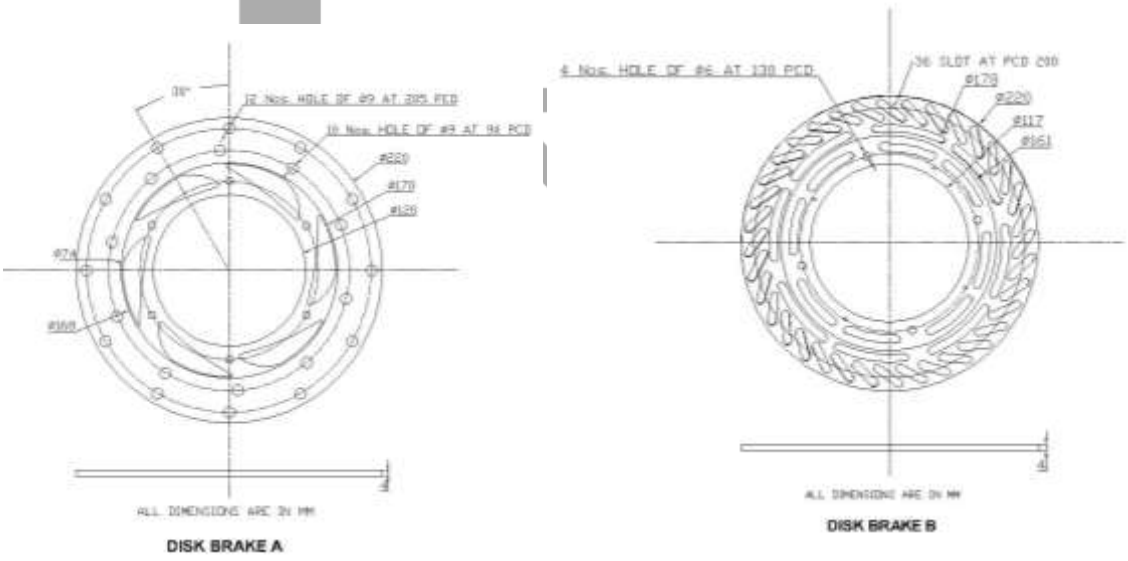
Sumeet Satope and Akshaykumar Bote, The design of brake rotor is done on solid works 15 and analysis is done with the help of Ansys. It was observed that the maximum temperature rise for cast iron is much less as compared to stainless steel and thus on the basic of thermal analysis, cast iron is the best preferable material for manufacturing disc brake. However cast iron disc brake suffers a drawback of getting corroded when it comes in contact with moisture and hence it cannot be used in two wheeler and thus we prefer stainless steel.

Problem Formulation

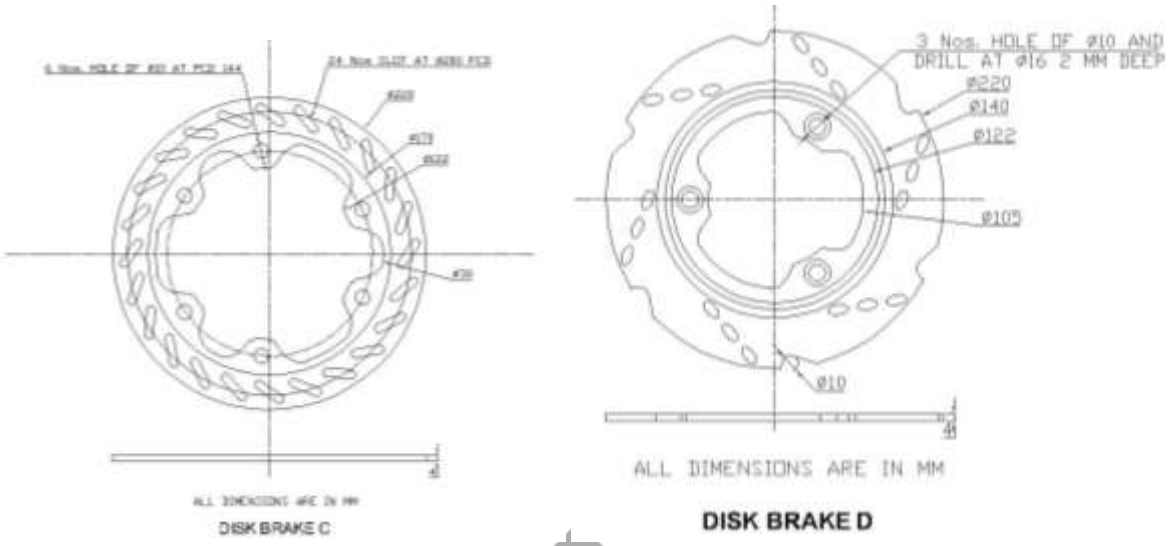
The objective/specification of the present work is to design and analyze brake disc made of gray cast iron. Cast Iron materials are used to design the disc. The disc will be then be optimized with its geometry based on some parameters to get the best possible design. The rotor was created and analyzed in Solid Works. Many materials are widely available in the market like ceramic components, carbon-carbon composites, stainless steels and cast iron components; gray cast iron is best material because of its strength and thermal properties, high temperature resistance and availability.

Input Parameters and Material Properties

Elastic Modulus	6.62E+10	N/m^2
Poisson's Ratio	0.27	Unit Less
Shear Modulus	5.00E+10	N/m^2
Mass Density	7200	kg/m^3
Tensile Strength	151658000	N/m^2
Compressive Strength	572165000	N/m^2
Thermal Expansion Coefficient	1.20E-05	Per Kelvin
Thermal Conductivity	45	W/(m·K)
Specific Heat	510	J/(kg·K)



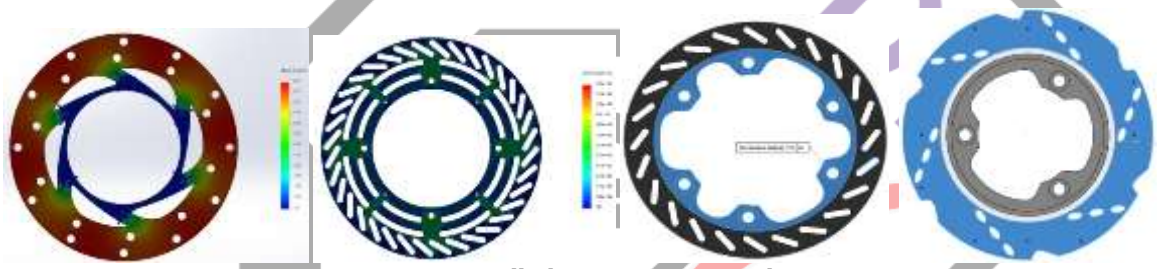
Model ‘A’ and ‘B’ Geometry



Model 'C' and 'D' Geometry

Methodology

- Survey of existing research is performed. It helps to understand the domain of the field.
- The problem then is to be identified from research survey. Case is generated as disc brake analysis with varying geometry and specifications Next step is to create a models for all cases of disc brake.
- Boundary conditions are then applied for all cases and meshing is performed. Thermal analysis type is required to select as analysis method. The analysis part is performed with SolidWorks.
- Initial temperature, heat flux and material is defined as initial boundary conditions.



All Plate Geometries Analysis Images

Results

Table: Result Table

Model No.	TEMP C	DISTRIBUTED HEAT FLUX
A	627	3350000
B	590	1290000
C	99.4	309000
D	360	1340000

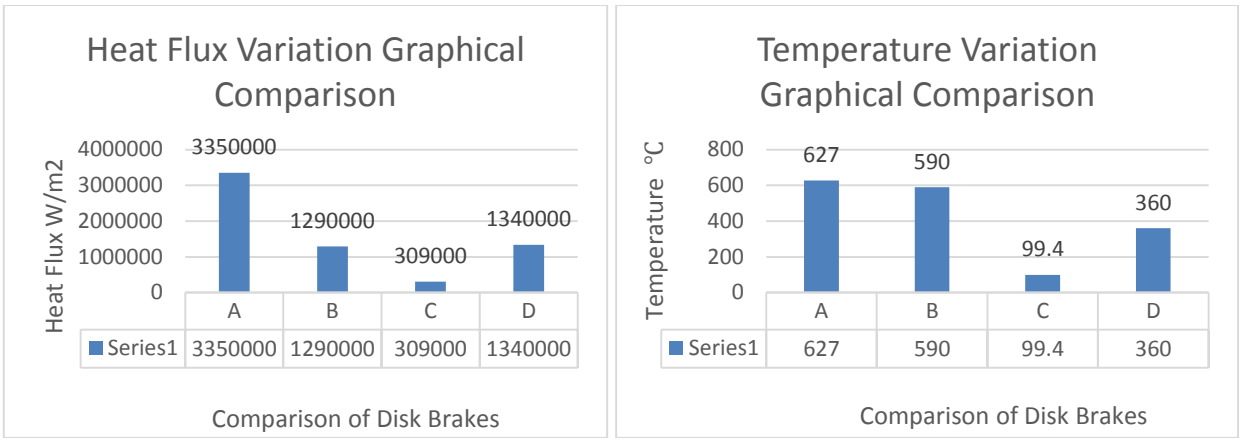


Figure: Result Comparison Graphs

Conclusion

Four types of models were taken for disc analysis and material selected is Grey Cast Iron. The speed considered for all four models is also considered same. The brake power is considered same for all models. Heat flux is then calculated for all models. The values of respective heat flux is considered for analysis of model and thermal analysis is performed for all models, say A, B, C and D.The results are in term of temperature and distributed heat flux. It can be concluded that maximum temperature and distributed heat flux result values are generated in model 'A' and distributed heat flux result values are in model 'C, it shows that geometry 'C' is best geometry in compare to other all considered geometry.

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