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Optimization Parameters of Disc Brake

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Abstract: ***In recent time due to high performance of electronic component the heat generation is increasing drastically. Due to this scenario heat dissipation becomes a major issue in efficiency promation and stable operation.***
Silicon based microchannel heat sink fabricated using semiconductor production technique plays important role in cooling devices. The effect of the thermophysical properties of working fluids on the performance of microchannel is tested or we can say investigated. For this purpose the different working fluids are selected. water, hepthane, ammonia, methanol, and ethanol.
The disc brake is a device for slowing or stopping the rotation of a wheel. Repetitive braking of the vehicle leads to heat generation during each braking event. Transient Thermal and Structural
Analysis of the Rotor Disc of Disk Brake is aimed at evaluating the performance of disc brake rotor of a car under severe braking conditions and there by assist in disc rotor design and analysis. Disc brake model and analysis is done using ANSYS workbench 14.5. The main purpose of this study is to analysis the thermo mechanical behavior of the dry contact of the brake disc during the braking phase. The coupled thermal-structural analysis is used to determine the deformation and the Von Mises stress established in the disc for the both solid and ventilated disc with two different materials to enhance performance of the rotor disc. A comparison between analytical and results obtained from FEM is done and all the values obtained from the analysis are less than their allowable values. Hence best suitable design, material and rotor disc is suggested based on the performance, strength and rigidity criteria.

Keywords- disc break, thermal analysis, structure analysis.

I. INTRODUCTION

In today's growing automotive market, the competition for better performance vehicle is growing enormously. The disc brake is a device for slowing or stopping the rotation of a wheel. A brake disc usually made of cast iron or ceramic composites includes carbon, Kevlar and silica, is connected to the wheel and the axle, to stop the wheel. A friction material in the form of brake pads is forced mechanically, hydraulically, pneumatically or electromagnetically against both sides of the disc. This friction causes the disc and attached wheel to slow or stop. Generally, the methodologies like regenerative braking and friction braking system are used in a vehicle. A friction brake generates frictional forces as two or more surfaces rub against each other, to reduce movement. Based on the design configurations, vehicle friction brakes can be grouped into drum and disc brakes. If brake disc is in solid body the heat transfer rate is low. Time taken for cooling the disc is low. If brake disc is in solid body, the area of contact between disc and pads are more. In disc brake system a ventilated disc is widely used in automobile braking system for improved cooling during braking in which the area of contact between disc and pads remains same.

A disc brake is a type of brake that uses calipers to squeeze pairs of pads against a disc or &quo rotor &quo; to create friction. This action 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.

II. LITERATURE REVIEW.

Dr suresh PM et all stated that the The disc brake is a device used for slowing or stopping the rotation of a wheel. Repetitived braking of the vehicle leads to heat generation during each braking event. Transient Thermal and Structural Analysis of the Rotor Disc of Disk Brake is aimed at evaluating the performance of disc brake rotor of a car under severe braking conditions and thus by assist in disc rotor design and analysis. Disc brake model and analysis is done using ANSYS workbench 14.5. The main purpose of this study is to analysis the thermomechanical behavior of the dry contact of the brake disc during the braking phase. The coupled thermalstructural analysis is used to determine the deformation and the Von Mises stress established in the disc for the both solid and ventilated disc with two different materials to enhance performance of the rotor disc. A comparison between analytical and results obtained from FEM is done and all the values obtained from the analysis are less than their allowable values. Hence best suitable design, material and rotor disc is suggested based on the perfornce, strength and rigidity criteria. [1]

A.Belhoneia, and M noubyc et all stated that, In automotive engineering, the safety aspect has been considered as a number one priority in development of a new vehicle.

Each single system has been studied and developed in order to meet safety requirements. Instead of having air bags, good suspension systems, good handling and safe cornering, one of the most critical systems in a vehicle is the brake system. The objective of this worked is to investigate and analyzed the temperature distribution of rotor disc during braking operation using ANSYS Multiphysics. 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 us the heat flux distribution for the two discs. [2]

Anurag Dey et all stated that, The brake system is inarguabled as one of the most critical aspect of a vehicle safety. It has always been the major concern for design engineers to developed a system that gives a steady performance with respect to time. In order to achieve that feat, one of the most common problems that arises in maintaining a brake is the problem of brake fluid vaporization. The race cars of the Formula SAE team at the University of Texas of Arlington face this challenge on a regular basis because of repetitive braking on curved tracks. In order to ensure safety of the vehicles, a study had been proposed in this report that deals with the problem of repetitive braking under extreme (hard) braking conditions and the temperature dependence of the brake fluid on it. The study was concentrated on finding the heat partition towards the brake disk and brake pads when brakes are applied. The theoreticaled results of the simulation conducted in MATLAB were later verified by the experimental ones performed on a Formula SAE vehicle of the University of Texas Arlington.[3]

Viraj Parab, Kunal Naik et all stated that , Disc (Rotor) brakes are exposed to large thermal stresses during routine braking and extraordinary thermal stresses during hard braking. The aim of the project is to design, model a disc. Modeling is done using catia. Structural and Thermal analysis is to be done on the disc brakes using three materials Stainless Steel and Cast iron & carbon carbon composite. 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 deformation, stresses, temperature etc. form the three materials to check which material is best. Catia is a 3d modelling software widely used in the design process. ANSYS is general-purposed finite element analysis (FEA) software package. Finite Element Analysis is a numerical method of deconstructing a complex system into very small pieces (of user-designated size) called elements. [4]

Debayan das, Pawan Mishra et all stated that the Braking system represents one of the most fundamental safety critical components in modern vehicles. Brake absorbed kinetic energy of the rotating parts (Wheels) and the energy is dissipated in the form of heat energy to the surrounding atmosphere. It decelerates or stops the vehicle. When brake is applied to the disc brake it is subjected to high stress, thus it may suffer structural and wear issues. Hence for the better performance, structural, stress and the thermal analysis is preferred to choose low stress material.

The objective of this paper is to modeled and analysed stress concentration, structural deformation and thermal gradient of disc brake. Here the disc brake is designed by using Solid works and analysis is done by ANSYS workbench R 14.5.[5]

III. METHODOLOGY.

A. We started the work of this project with literature survey. We gathered many research papers which are relevant to this topic. After going through these papers we learnt about Disc Brake Optimization.

B. After that the components which are required for our project are decided.

C. After deciding the components, the 3D Model and drafting will be done with the help of CATIA software.

D. The Analysis of the components will be done with the help of ANSYS using FEA.

E. Comparative analysis of Reaction forces will be made between simulation results and then Results and conclusions will be drawn.

IV. ANALYSIS OF DISC BREAK.

The finite element method (FEM), is a numerical method for solving problems of engineering and mathematical physics. Typical problem areas of interest include structural analysis, heat transfer, fluid flow, mass transport, and electromagnetic potential. The analytical solution of these problems generally require the solution to boundary value problems for partial differential equations. The finite element method formulation of the problem results in a system of algebraic equations. The method yields approximate values of the unknowns at discrete number of points over the domain. To solve the problem, it subdivides a large problem into smaller, simpler parts that are called finite elements. The simple equations that model these finite elements are then assembled into a larger system of equations that models the entire problem. FEM then uses variational methods from the calculus of variations to approximate a solution by minimizing an associated error function.

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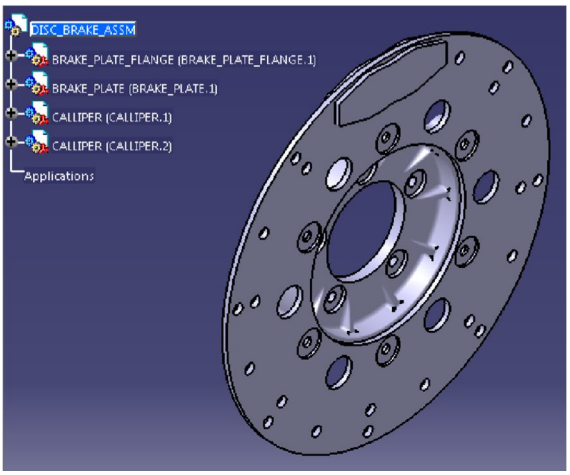

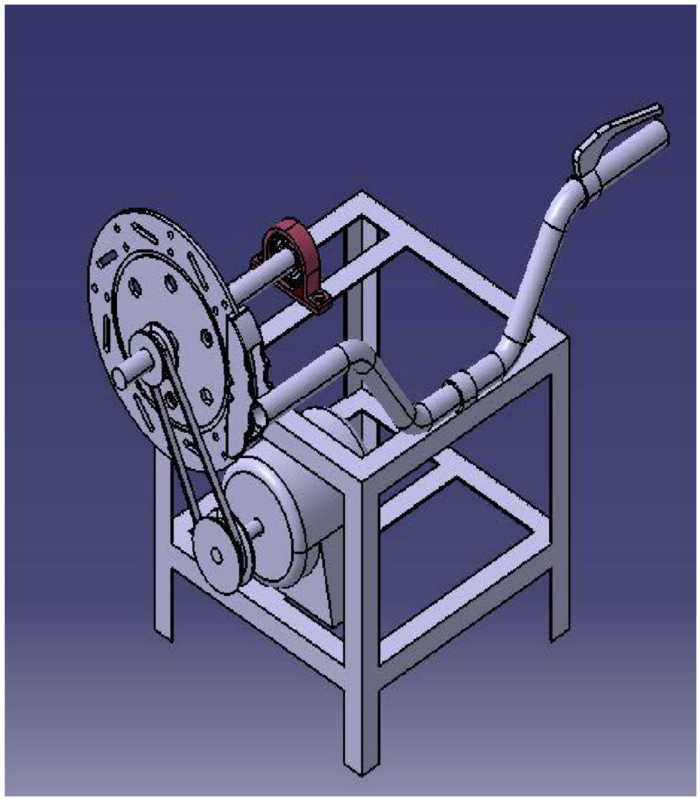

Fig: CATIA Model.

A. MESH

ANSYS Meshing is a general-purpose, intelligent, automated high-performance product. It produces the most appropriate mesh for accurate, efficient Multiphysics solution.

Creating the most appropriate mesh is the foundation of engineering simulations. ANSYS Meshing is aware of the type of solutions that will be used in the project and has the appropriate criteria to create the best suited mesh. ANSYS Meshing is automatically integrated with each solver within the ANSYS Workbench environment. For a quick analysis or for the new and infrequent user, a usable mesh can be created with one click of the mouse. ANSYS Meshing chooses the most appropriate options based on the analysis type and the geometry of the model

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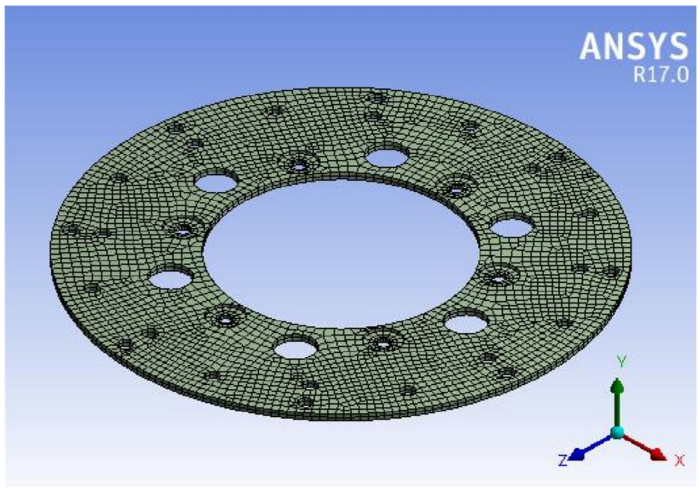


Fig: Meshing of disk break.

B. Boundary Condition

A boundary condition for the model is the setting of a known value for a displacement or an associated load. For a particular node you can set either the load or the displacement but not both. The main types of loading available in FEA include force, pressure and temperature. These can be applied to points, surfaces, edges, nodes and elements or remotely offset from a feature. The way that the model is constrained can significantly affect the results and requires special consideration. Over or under constrained models can give stress that is so inaccurate that it is worthless to the engineer. In an ideal world we could have massive assemblies of components all connected to each other with contact elements but this is beyond the budget and resource of most people. We can however, use the computing hardware we have available to its full potential and this means understanding how to apply realistic boundary conditions.

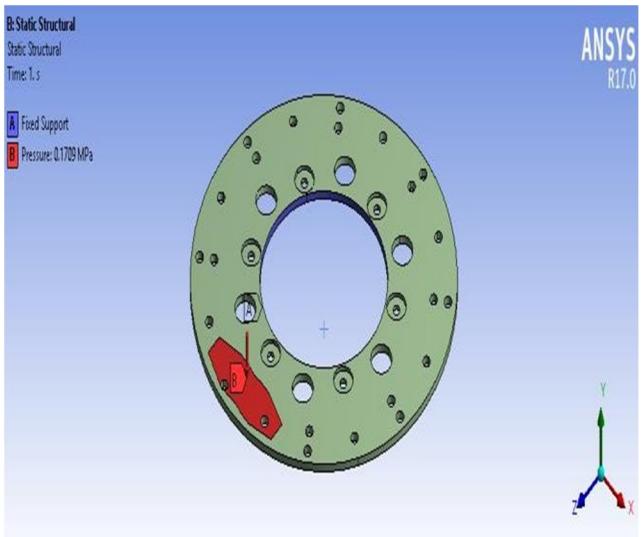


Fig : Stress Formation

C. Equivalent Stress

Structural and thermal stresses are founded on the disc plate portion because of braking action and also heat generation due to friction between brake pad and disc plate portion.

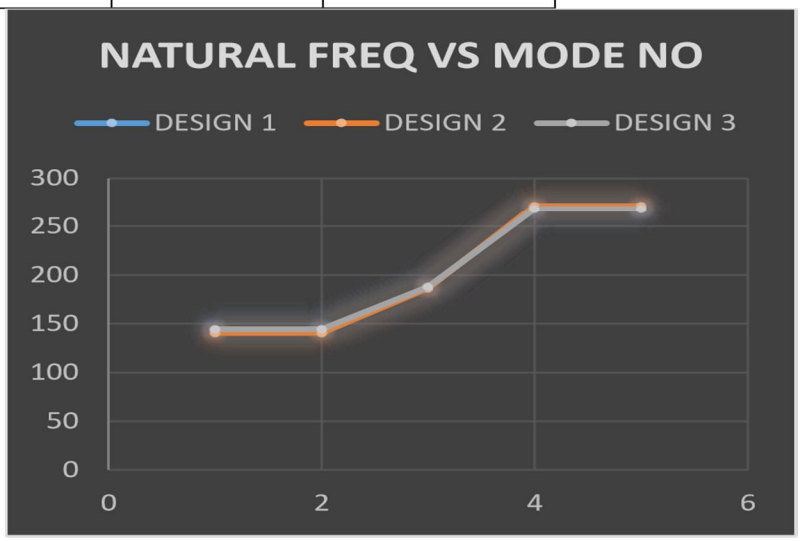
D. Deformation

Due to sudden braking action the static and thermal stresses are induced on disc plate portion. Due to this stresses the deformation of disc plate happen. Gaps on the disc plate are expand in dimensions due to heat generation. Heat affects the properties of the disc plate material and deformation happen due to heat.

V. RESULT & DISCUSSION.

Following are the values of Total deformation (mm), Von mises stress (Mpa), Temperature (celsius) between Original model and Optimized model. Graph shows that Natural frequency Vs. mode no. We found that the optimized model is best in use over original model because its overall deformation , stress values and temperature values are lower than original model. So it is colcluded that optimized model is suitable for use.

SR.NO.	CHARACTERISTICS	ORIGINAL MODEL 1	OPTIMIZED MODEL 2
1.	Total Deformation (mm)	0.03543	41.186
2.	Von-mises Stress (MPa)	148.38	75.046
3.	Temperature (0C)	58.13	41.186



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VI. CONCLUSION

A. By studying all the process we can say that the stainless steel can provide better break performance than the other form of deformation point of view. Because it is having the good properties like the good thermal conductivity, low noise, low weight etc.

B. Cast iron provides better performance from stress point of view.

C. The study of this can gives useful design tool and improves the break performance of disc break system.

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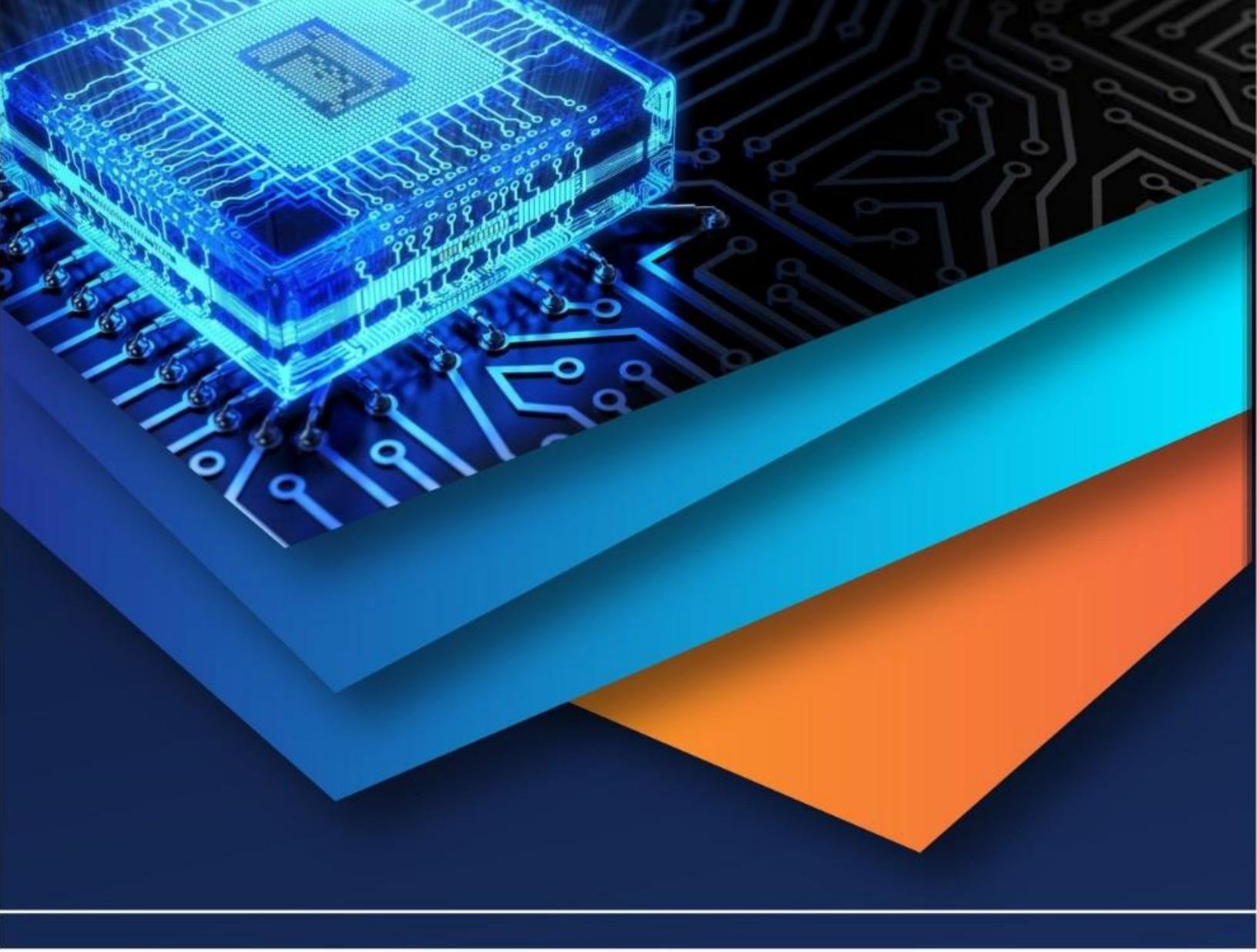

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