Design Optimization of Disc Brake By Using Finite Element Analysis

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Abstract- *A brake is a mechanical device which simulated frictional safety is connected to moving machine part, to stop the movement of a machine. At present performing this function, the brakes take in either kinetic energy of the moving part or the potential energy surrendered by items being brought down by lifts and so forth. The energy absorbed by the brakes is scattered as heat. Disc brake is a recognizable car application where they are utilized broadly for car and bike wheels. The disc is sandwiched between two pads activated by cylinders backed in a caliper mounted on the stud shaft. At the point when the brake lever is pressed using pressurized hydraulic pressurized fluid is constrained into the chambers pushing the contradicting cylinders and brake pads into frictional contact with the disc.*

Keywords- Disc Brake, Static Analysis, Thermal Analysis, Finite Element Method

I. INTRODUCTION

In today's growing automobile market competition for better performance of vehicle is growing drastically. Disc brakes are very important devices to decelerate the vehicle. The main Object of the literature work is to understand cooling system of brake, thermo-fluid mechanism, structural rigidity, low stress. Brake is Device which uses to stop motion of machine by transferring the Kinetic Energy of the vehicle into Thermal Energy by Mutual Slipping of contacting components of brake system. Usually brakes made of Cast Iron or Ceramic Composites which include Aluminum ,Kevlar and Silica. Brake pads also called as Friction Materials are made to engage both sides of disc to decelerate the system.

When pad is pressed Normal to the Disc, the disc absorbs Kinetic Energy of vehicle and it will transfer into heat energy which is 90% heat energy absorbed by disc and remain absorb by pads and calliper . When temperature exceeds the critical value of material, it will cause to Brake Failure, Thermal Crack, Wear and Fade of Disc . frictional heat produced amid braking application can result in various negative impacts on the brake assembly, for example, brake blur, untimely wear, thermal splits and disc thickness variation (DTV). Previously, surface roughness and wear at the pad interface have infrequently been considered in investigations of thermal analysis of a disc brake finite element method.

The main purpose of this project is to Optimization of Automotive Brake Disc and analysis the steady state thermal behavior of the dry contact between the brake disc and pads during the braking phase. The thermal-structural analysis to determine the deformation and the Von Misses stresses established in the disc. The objective of the project is the design, analysis and optimization of solid and ventilated disc brake using Solid works,Hyper mesh and Ansys. The ventilated brake disc assembly is built by a 3D model in Solid Works and imported to ANSYS to evaluate the stress fields and of deformations which are established in the disc with the pressure on the pads and in the conditions of tightening of the disc.

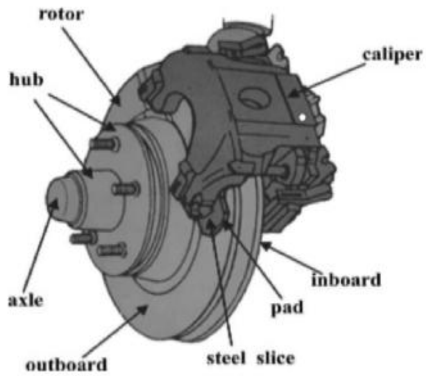


Figure 1. Disc Brake Components

II. PROBLEM STATEMENT

Discs are made up mainly gray cast iron, so discs are damaged in one of three ways: scarring, cracking, warping or excessive rusting. Service shops will sometimes respond to any disc problem by changing out the discs entirely. This is done mainly where the cost of a new disc may actually be lower than the cost of workers to resurface the original disc. Mechanically this is unnecessary unless the discs have reached manufacturer's minimum recommended thickness, which would make it unsafe to use them, or vane rusting. severe (ventilated discs only). Most leading vehicle manufacturers recommend brake disc skimming (US: turning) as a solution for lateral run-out, vibration issues and brake noises.

The machining process is performed in a brake lathe, which removes a very thin layer off the disc surface to clean off minor damage and restore uniform thickness. Machining the disc as necessary will maximize the mileage out of the current discs on the vehicle. Braking systems rely on friction to bring the vehicle to a halt – hydraulic pressure pushes brake pads against a cast iron disc or brake shoes against the inside of a cast iron drum. When a vehicle is decelerated, load is transferred to the front wheels – this means that the front brakes do most of the work in stopping the vehicle. Scarring can occur if brake pads are not changed promptly when they reach the end of their service life and are considered worn out.

III. METHODOLOGY

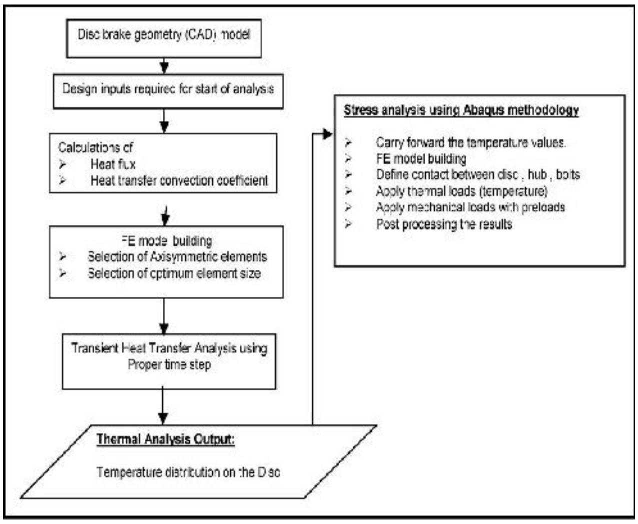


Figure 2. Methodology Chart

Thickness variation has many causes, but there are three primary mechanisms which contribute to the propagation of disc thickness variations. The first is improper selection of brake pads. Pads which are effective at low temperatures, such as when braking for the first time in cold weather, often are made of materials which decompose unevenly at higher temperatures. This uneven decomposition results in uneven deposition of material onto the brake disc. Another cause of uneven material transfer is improper break-in of a pad/disc combination. For proper break-in, the disc surface should be refreshed (either by machining the contact surface or by replacing the disc) every time the pads are changed. Once this is done, the brakes are heavily applied multiple times in succession. This creates a smooth, even interface between the pad and the disc. When this is not done properly the brake pads will see an uneven distribution of stress and heat, resulting in an uneven, seemingly random, deposition of pad material. The third primary mechanism of uneven pad material transfer is "pad imprinting." This occurs when the brake pads are heated to the point that the material begins to break-down and transfer to the disc. In a properly broken-in brake system (with properly selected pads), this transfer is natural and actually is a major contributor to the braking force generated by the brake pads. However, if the vehicle comes to a stop and the driver continues to apply the brakes, the pads will deposit a layer of material in the shape of the brake pad. This small thickness variation can begin the cycle of uneven pad transfer.

IV. DESIGN

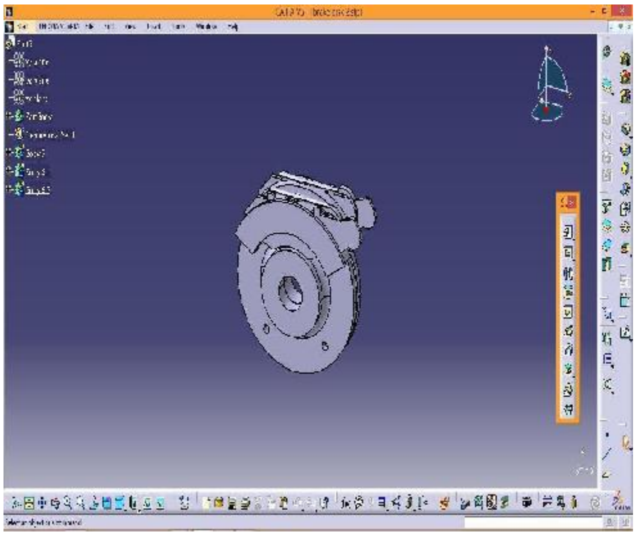


Figure 3. Disc Brake

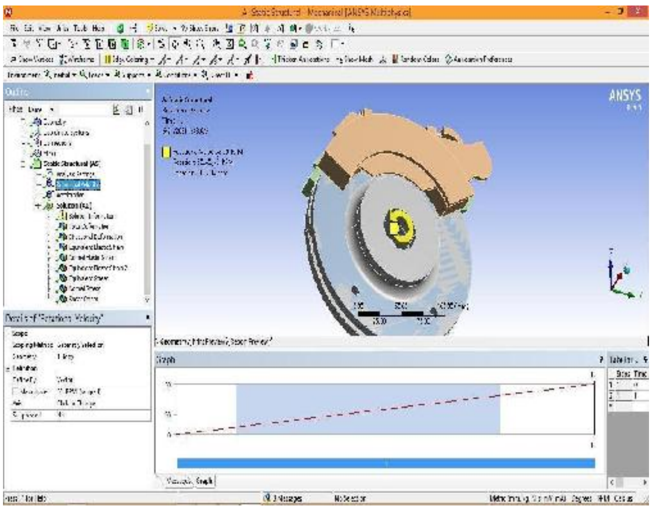


Figure 3.1 Boundary Condition

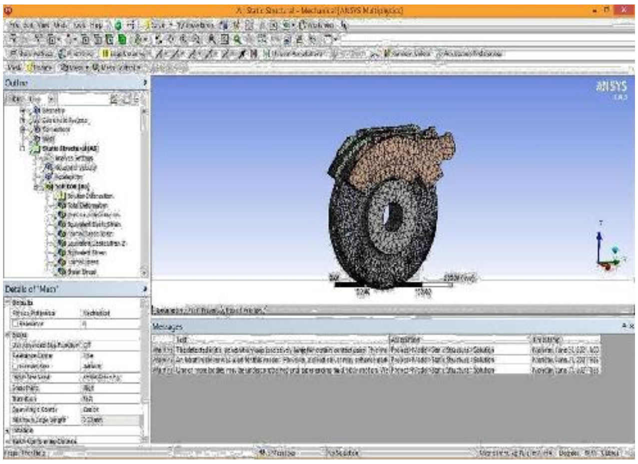
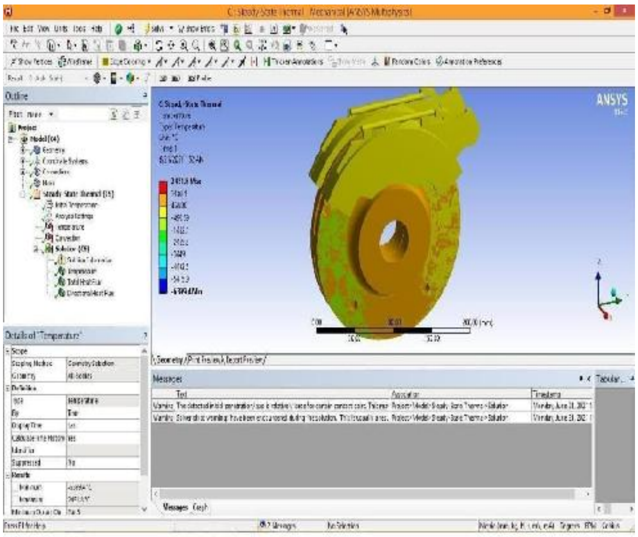


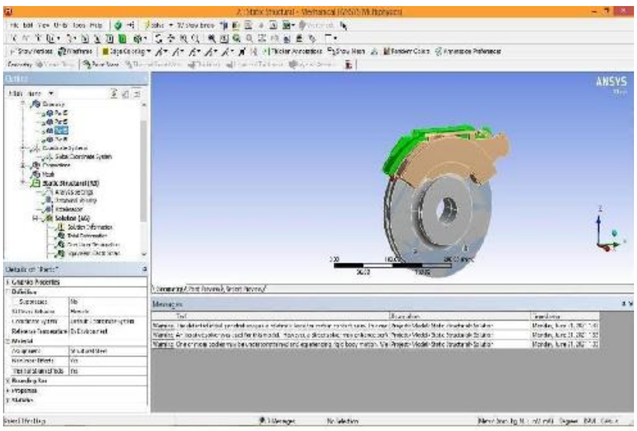
Figure 3.2 Boundary condition

V. ANALYSIS

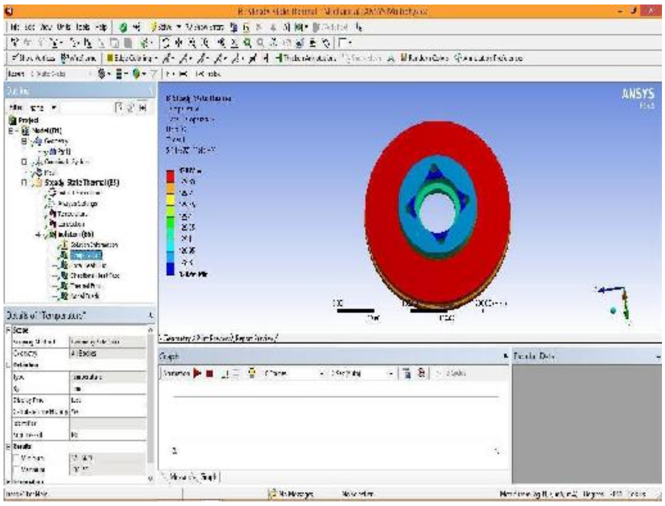
STEADY THERMAL ANALYSIS:



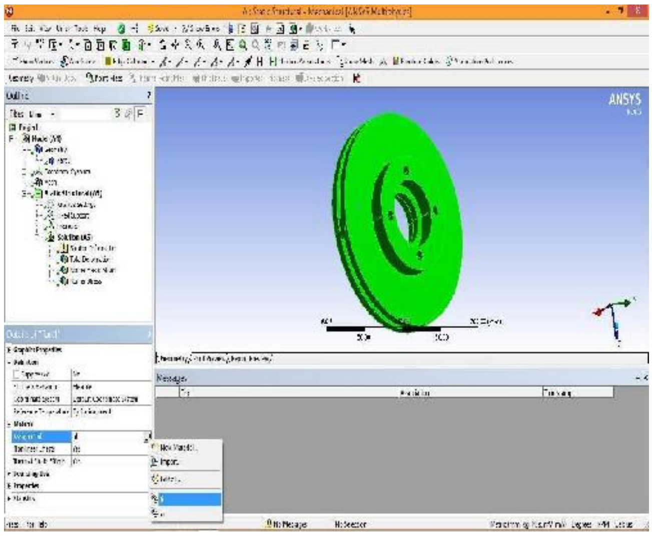
BOUNDARY CONDITION:



THERMAL ANALYSIS:



PROPOSED MATERIAL – AL(Aluminum):



VI. RESULT TABULATION

S. N O	PARTICALS	AL(Aluminum)	TI(Titanium)	ZR(Zirconium)	STEEL
1	Total Deformation	9.1669*E-10	9.43*E-10	9.7281*E10	10.1*E-10
2	Normal Elastic Strain	1.8118*E-12	1.86*E-12	0.19228*E-12	-
3	Normal Stress	6.52*E-6	6.52*E-6	6.528*E-6	-
4	Temperature	129.85	129.85	129.87	129.81
5	Total Heat Flux	0.004006	0.0040063	0.0040103	0.003998
6	Directional Heat Flux	0.0020742	0.0020742	0.0020743	0.0020741
7	Thermal Error	84.855	84.855	75.008	105.66

VII. CONCLUSION

This paper explains about the design of a straight & vented brake discs in Solid Works. It also includes the deck preparation in hyper mesh, i.e., meshed part with applying the temperatures. Finally both the brake discs are been analyzed in Ansys for the Steady Static Thermal analysis. In these results, we get that, by changing the straight vents to curved vents in the brake disc the vanishes stresses & displacement vector sum & mass of the brakes disc has been reduced. And also curved vented brake disc is generated a high thermal flux than a straight vented brake disc.

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