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"FOUR WHEELER BRAKE ROTOR THERMAL TRANSIENT ANALYSIS WITH DIFFERENT GEOMETRY"

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ABSTRACT

The disc brake rotor is a rotating device. Braking is a process which converts the kinetic energy of the vehicle into mechanical energy which must be dissipated in the form of heat. This paper presents the analysis of the contact pressure distributions at the disc interfaces using a detailed 3-dimensional finite element model of a real car disc brake rotor . Finite element (FE) models of the brake-disc rotor are created using Solidwork 2021 and simulated using ANSYS 19.2 which is based on the finite element method (FEM). It is also investigates different levels in modeling a disc brake rotor system and simulating contact pressure distributions . It covers Finite Element Method approaches in the automotive industry the contact analysis and thermal analysis. The effect of the angular velocity and the contact pressure distribution on disc brake rotor are investigated. Here we can clearly observed that drilled & slotted rotor geometry has very high value of heat flux compare to other rotor geometries.

***Keyword**: Gray Cast Iron , ANSYS, solidwork, Disc brake rotor, drilled & slotted rotor.*

I. INTRODUCTION

The brakes designed for the purpose of racing need to have very high braking efficiency. The wear and tear of the pads or the cost is not of great concern to the manufacturer of the racing car brakes. Initially the automobiles employed drum brakes in the cars. The main focus of this thesis is not for the passenger car technology but it concentrates on the automotive racing industry, NASCAR, the Nation Association of Stock Car Racing. NASCAR is a racing league similar to other racing leagues like Formula 1. The words "Stock Car" are complete purpose built race cars whose only similarity to the production vehicles replicate in exterior side profile. Major vehicle systems are designed for their specific racing purposes [2]. The chassis used by the racing car is full tube frame while that used on commercial vehicles is made of single body frame. Another difference is the drive train; race versions have eight cylinder engines with rear wheel drive whereas commercial vehicles are four or six cylinder engines with front wheel drive

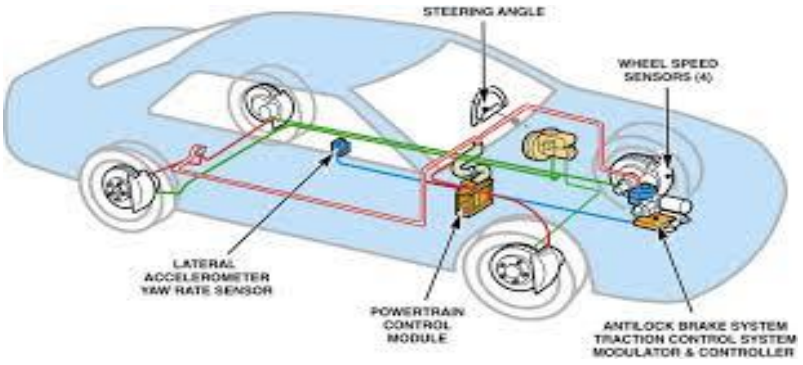

Figure 1.1 Vehicle Brake System

1.1 How do disk brakes work?

- Disk brakes convert kinetic energy from the car into thermal energy by friction

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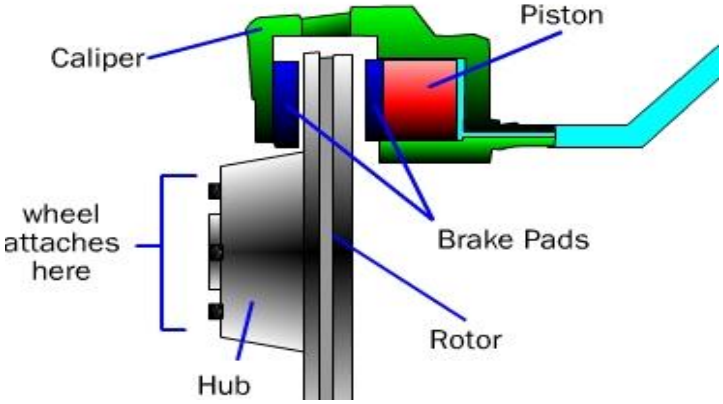

Figure 1.2 Disc brake systems

1.2 Brake Caliper

The brake fluid compresses the piston inside the brake caliper applying pressure to the brake pads.

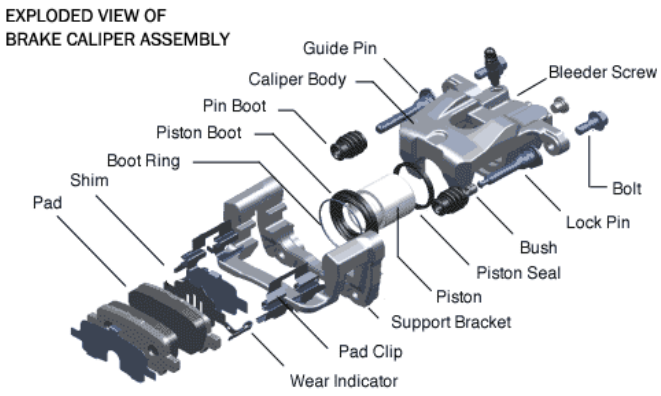

Figure 1.3 Brake Caliper Assembly Systems

1.3 Brake Rotors

- ✓ Connected to the axel – rotating at the same speed as the wheel
- ✓ Generally made out of steel
- ✓ Commonly slotted or drilled for extra heat dissipation

Figure 1.4 Brake Rotors

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1.4 Brake Pads

- Fixed in the brake caliper
- Various compounds of materials are used
- Wear over time and must be replaced

Figure 1.5 Brake Pads

1.5 Brake Pad Materials

- Asbestos
- Semi-Metallic
- Non-Asbestos Organics
- Low Steel
- Carbon
- Exact composition of each manufacturer's pads is a closely guarded secret

II. Problem in Brake Rotors

On studying the background of brakes the main purpose of conducting this research work was finalized. The main objective was to propose a conceptual design for a disc brake rotor using exiting material Aluminium Alloy, Titanium, Gray Cast iron Alloy and New materials Carbon fiber, called a modular brake caliper. The efficient working of brake system depends on how the brake behaves at high temperatures. Thus the aim of the research work will be to reduce the thermal deformation in the modular brake rotor. Since Gray Cast iron hard to machine, modular caliper will be developed as an assembly instead of single block design..

III. Objectives

Disc brake noise and vibration generation during braking has been one of the most important issues and definitely worrying problem to automotive manufacturers. Despite brake noise is not a safety issue and has little impact on braking performance, it gives customers the impression of underlying quality problems of the vehicle. In addition, the customers view that the noise emitted from the brake system is indicator of malfunctioning condition and consequently lose confidence on the quality of the vehicles.

IV. Materials

4.1 Material Selection

Material selection plays a very important role in machine design. Three metals are considered for the analysis of scissor lift is epoxy e glass fiber structural steel and stainless steel.

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Table- 1 Gray Cast Iron Alloy Mechanical properties

Material Field Variable	Value	Units
Density	7200	Kg/m^3
Young's modulus	1.1E+11	Mpa
Poisson Ratio	0.28	
Shear modulus	4.2969E+10	Mpa
Bulk Modulus	8.3333E+10	Mpa
Tensile Strength	240	Mpa
Compressive Strength	820	Mpa
Material Field Variable	Value	Units
Density	7200	Kg/m^3

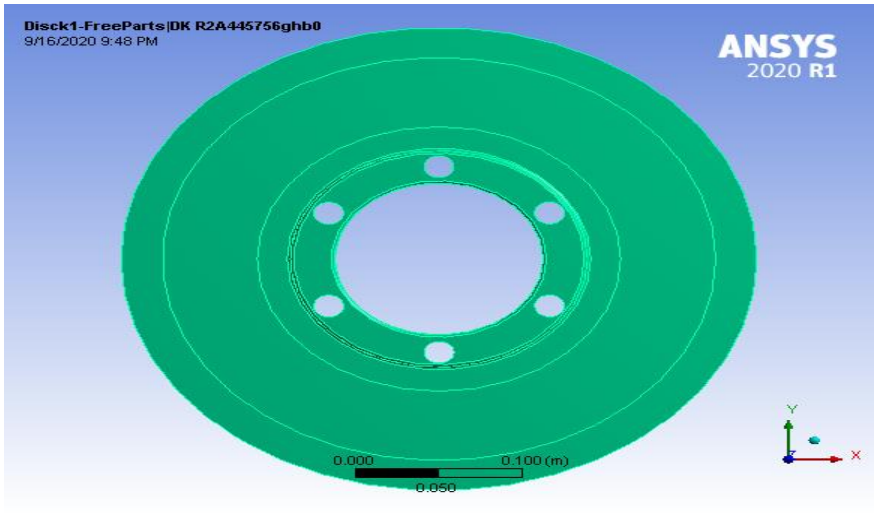

Fig. 4.1 Imported Geometry in ANSYS

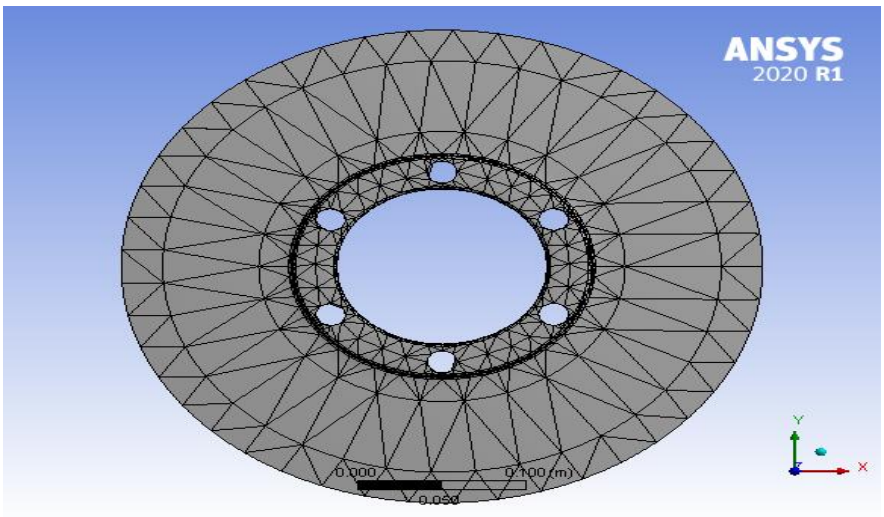

Fig. 4.2 Meshing solid rotor

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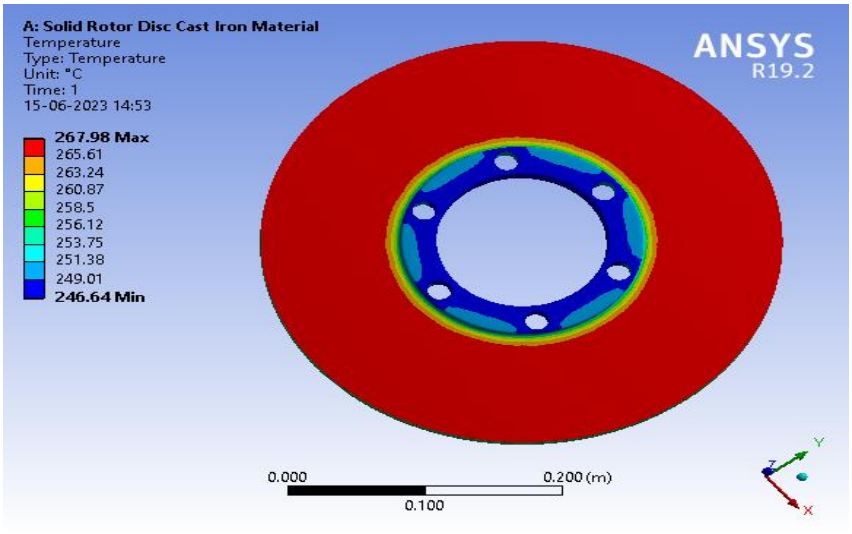

Fig. 4.3 Solid rotor temperature results

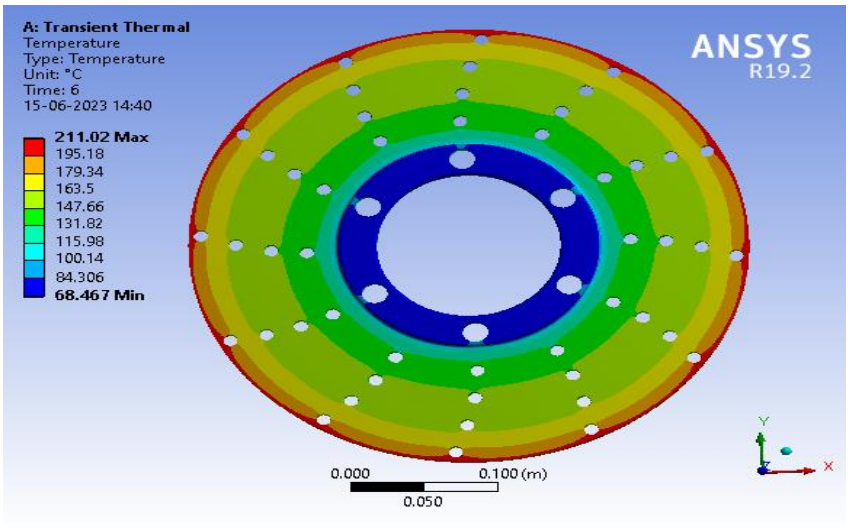

Fig. 4.4 Solid drilled rotor temperature results

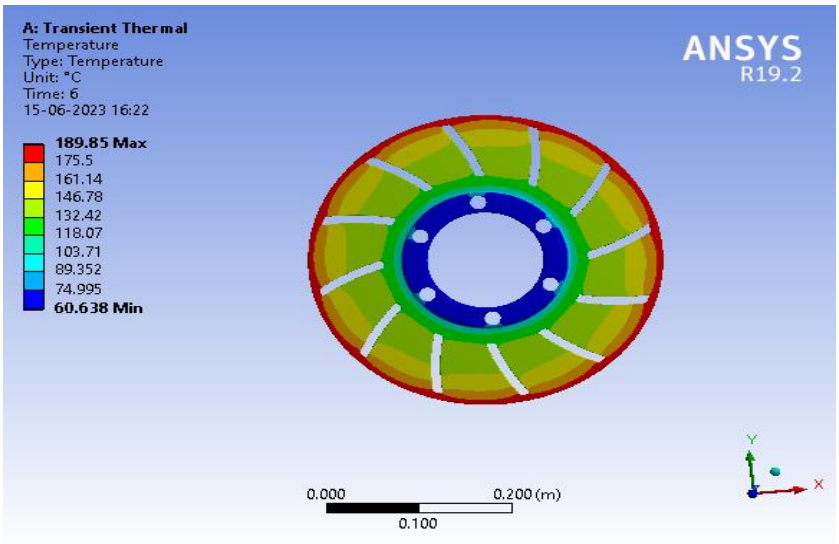

Fig. 4.5 slotted rotor temperature results

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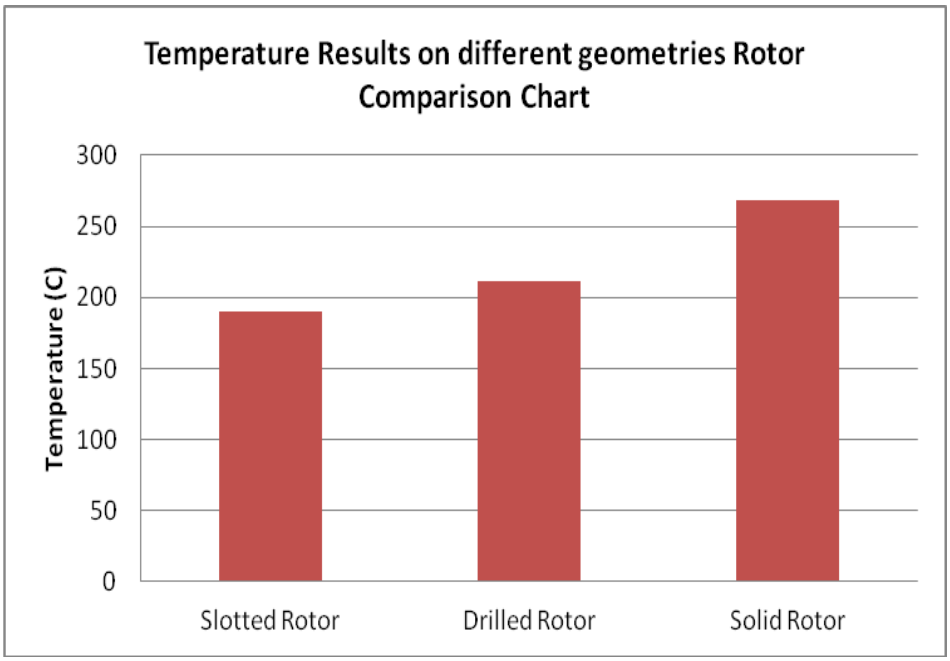

Fig.4.6 Temperature comparison Charts

V. RESULT & DISCUSSION

We take cast iron alloy material and observe that the maximum temperature values for all three geometries - Solid rotor, Drilled rotor, and Drilled & Slotted rotor respectively are 267.9°C, 211°C, and 189.8°C. We can clearly see that the Drilled & Slotted rotor has a much lower temperature than the other rotors, making it a safe choice for future design.

Furthermore, we also see that the maximum heat flux values of these three geometries are 2.7W/m2, 4.9 W/m2 and 5.5 W/m2 respectively; Here again we can observe that the highest value of heat flux is present in the drilled & slotted rotor which makes it an optimal choice for Low budget car's brake rotors in the future design scenarios.

VI. CONCLUSION

- Determination of the braking force is the most crucial aspect to be considered while designing any braking system. The generated braking force should always be greater than the required braking force.
- The calculation of required clamping force helps us to decide the diameter and the number of pistons to be used. Space and assembly constraints are also an important factor while designing the caliper body.

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