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Thermal Analysis of FSAE Brake Disc

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Abstract - *Since Brake is a mechanical device which is used for slowing or stopping of motion. This paper presents the method to design disc brakes for car and thermal analysis of rotor. The objective is to find out dimensions of rotor for given requirement and analyzing the results on* ***ANSYS workbench****. In this temperature distribution on rotor during working condition is observed. Each single system has been studied and developed in order to meet safety requirement. Instead of having air bag, good suspension systems, good handling and safe cornering, there is one most critical system in the vehicle which is brake systems. Without brake system in the vehicle will put a passenger in unsafe position. Therefore, it is must for all vehicles to have proper brake system. In this paper carbon ceramic matrix disc brake material use for calculating normal force, shear force and piston force. And also calculating the brake distance of disc brake. The standard disc brake two wheelers model using in* ***ANSYS****.* ***Thermal analysis and Model analysis*** *also calculate the deflection and Heat flux, Temperature of disc brake model. This is important to understand action force and friction on the disc brake new material, how disc brake works more efficiently, which can help to reduce the accident that may happen in each day.*

Key Words**: *ANSYS, Thermal analysis, Model analysis***

1. INTRODUCTION

The disc brake is a wheel brake which slows rotation of the wheel by the friction caused by pushing brake pads against a brake disc with a set of calipers. The brake disc is usually made of cast iron, but in some cases be made of composites such as reinforced carbon, Grey cast iron carbon ceramic matrix composites. Friction causes the disc and attached wheel to slow or stop. Brakes convert motion to heat, and if the brakes get too heated, they become less effective, a phenomenon known as brake fade. Disc-style brakes development and use began in England in the 1890s.

In this paper Grey cast iron disc brake material is used for calculating normal force, shear force and piston force. Thermal analysis and Modal analysis are done to calculate the deflection and Heat flux, Temperature of disc brake model.

If we see, there are 3 main functions of a brake system, i.e., to control a vehicle's speed when driving downhill, to minimize a vehicle's speed when necessary and to keep a vehicle stationary when in parking. If we consider at present scenario, most passenger vehicles are fitted with disc braking systems. The elements/parts disc brake system are a caliper, two pads, two guide pins, a disc, a piston, a carrier bracket. The major requirements of the caliper are to press Pads against the disc and it should achieve an interface pressure as possible. It is known that gradually wearing of pads, brake temperature, and friction coefficient could play vital role in braking action. In addition to this, it also reduces the life of the braking pads.

This will cause the customers dissatisfaction and they often required to go to the garage more frequently to replace these brake pads. As the brake disc, usually made up of cast iron or ceramic composites is connected to the wheel or the axle. To stop the rotation of wheel, friction material in the form of brake pads is forced hydrolytically, mechanically, pneumatically or electromagnetically against both sides of the disc. The friction causes the disc and attached wheel to slow or stop. As soon as the brake applied friction which leads to convert into frictional heat. When large amount of heat is generated brakes can't perform adequate work.

1.1 Material Used

1. ROTOR

Gray Cast Iron is a type of cast iron that has a graphitic microstructure. It is named after the gray color of the fracture it forms, which is due to the presence of graphite. It is the most common cast iron and the most widely used cast material based on weight. A typical chemical composition to obtain a graphitic microstructure is 2.5 to 4.0% carbon and 1 to 3% silicon. The main advantages of Gray are that Grey cast iron are easy to mold and acquire any desired shape. It has High compressive strength and damping capacity, resists corrosion after application of protective coating, it acts as a tool lubricant due to the presence of graphite, and it has relatively low prices compared to all other materials.

Gray cast iron (Grade)	Single specimen tensile strength σb≥/Mpa
HT 350	350

Material	K W/mK	E Gpa	μ	Specific heat J/ kgK	ρ Kg/ m^3	Ultimate Strength Mpa
Gray cast iron	54	125	0.25	586	7100	2400

2. BRAKE PADS

Semi – sintered brake pads are chosen and material will be asbestos. Semi-sintered brake pads are a nice alternative to traditional sintered brake pads, because they have organic linings for enhanced durability with the excellent features of sintered linings. Semi-sintered brake pads are a nice hybrid that provides low rotor wear and tear and the high-tech organic feel.

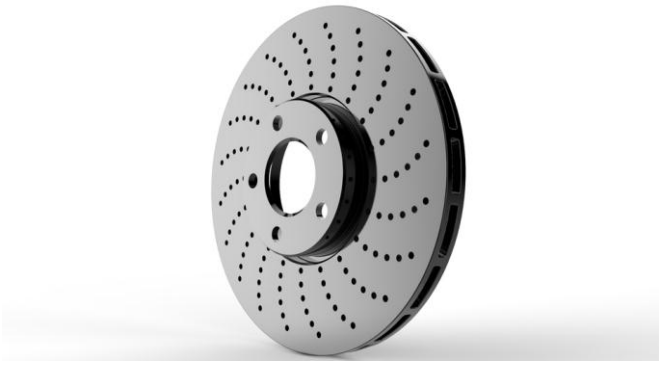
Asbestos was once considered the best material to build all sorts of brake pads and shoes. Cars, trucks, and buses weren't the only vehicles with asbestos brake pads. Every sort of motion device required braking power. Asbestos seemed to make good sense for friction control and withstanding high heats associated with stopping moving parts. Asbestos had excellent wear properties, was widely available and proved economical.

1.2 Software's

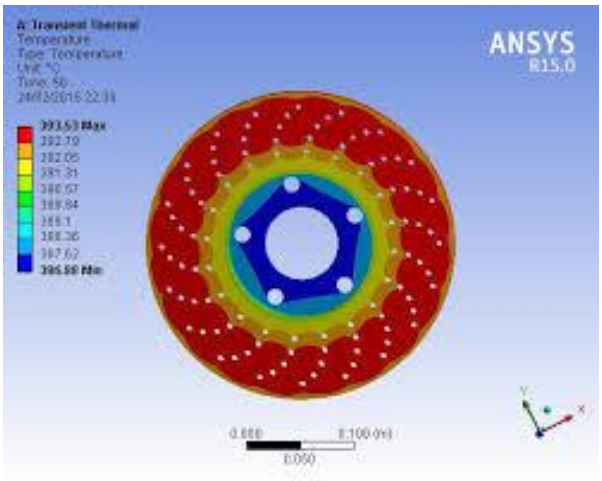
Modelling – SOLIDWORKS PREMIUM S18

Thermal Analysis– ANSYS S20 STUDENT VERSION

Modelling - SolidWorks is a solid modeler, and utilizes a parametric feature-based approach which was initially developed by PTC (Creo/Pro-Engineer) to create models and assemblies.



Thermal Analysis - Thermal analysis is used to determine the temperature distribution, thermal gradient, heat flow, and other such other properties of the material on ANSYS WORKBENCH or SOLIDWORKS.



2. DESIGN: Ventilated disc (Drilled +slotted)

Ventilated disc brake is a very stable and efficient mechanism. For better cooling, the front discs are usually ventilated. Ventilated disc brakes are easy to apply, guarantee a safe reduction of speed and can thus avoid accidents or reduce the consequences of accidents. Even after many braking cycles, effectiveness is ensured by the internal ventilation. Compared to a standard disc, from the initial braking phase, drilled discs ensure greater grip and more responsive and efficient performance of the braking system. Because of the holes, the friction coefficient between disc and pad is greater. Slotted rotors do improve heat transfer by air cooling. The slots can improve brake output by removing gas and dust that is trapped between the pad and rotor. Given the choice between drill holes and slots, the drill holes will give you better braking power over slots for normal city/highway driving.

3. CONCLUSIONS

With this project we achieved a safe, durable and viable design for a rotor component in a disc brake system taking in consideration the forces exerted for all the components in the brake system.

With this we demonstrate that disc brakes do not fracture. That is because the force exerted in the disc is a compressive force.

That's why the materials used for the manufacturing of brake disc are brittle. Thus we conclude that the material selected will be GREY CAST IRON, and the final layout of the brake rotor will be ventilated along with slotted and drilled design.

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