DESIGN AND FABRICATION OF DISC BRAKE BYUSING ALUMINIUM METAL MATRIX COMPOSITES

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ABSTRACT: Disc brake is a device by means of which artificial frictional resistance is applied to rotating disc, in order to stop the motion of vehicle. During the braking phase, the frictional heat generated at the interface of the disc and pads can lead to high temperatures. The objective of the current study is to design a Disc, Brake pads, Piston and also Core and Cavity of Disc Brake Rotor by using Creo parametric 3.0 M070. To manufacturing of disc brake rotor using Aluminium Metal Matrix Composites by using stir casting method. AMMC is the combination of aluminium reinforced with fly ash along with small quantity of other material like magnesium, graphite which are added in precise quantity to enhance the chemical, mechanical, thermal strength of material and testing in real time application and to investigate and analyses the temperature distribution of rotor disc and to identify critical temperature during operation using FEA analysis.

Keywords: Disc brake, Core, Cavity

1. INTRODUCTION

The disc brake is of two type solid full and ventilated. The disc brake is a device for slowing or stopping the rotation of a wheel. A brake disc (or rotor) usually made of cast iron or ceramic composites (including carbon, Kevlar and silica), is connected to the wheel and/or the axle. To stop the wheel, friction material in the form of brake pads (mounted on a device called a brake caliper) is forced mechanically, hydraulically, pneumatically or electromagnetically against both sides of the disc. These brakes offer better stopping performance than comparable drum brakes, including resistance to "brake fade" caused by the overheating of brake components, and are able to recover quickly from immersion (wet brakes are less effective).Discs have now become the more common form in most passenger vehicles, although many (particularly light weight vehicles) use drum brakes on the rear wheels to keep costs and weight down as well as to simplify the provisions for a parking brake. As the front brakes perform most of the braking effort, this can be a reasonable compromise. Friction brakes act by generating frictional forces as two or more surfaces rub against each other. The stopping power or capacity of a friction brake depends on the area in contact and coefficient of friction of the working surfaces as well as on the actuation pressure applied. Wear occurs on the working surfaces, and the durability of a given brake (or service life between maintenance) depends on the type of friction material used for the replaceable surfaces of the brake. If drake disc are in solid body the Heat transfer rate is low. Time taken for cooling the disc is low. If brake disc are in solid body, the area of contact between Disc and Pads are more, so efficiency of brake is high. Brakes are most important safety parts in the vehicles. Brakes function to slow and stop the rotation of the wheel. To stop the wheel, braking pads are forced mechanically against the rotor disc on both surfaces. The increases in travelling speeds as well as the growing weights of cars have made these improvements essential. An effective braking system is needed to accomplish this task with challenging term where material need to be lighter than before and performance of the brakes must be improved. Today's cars often use a combination of disc brakes and drum brakes. However, the effectiveness of braking system depends on the design itself and also the right selection of material. System that follow with some improvements. In order to understand thebehaviours of braking system, there are three functions that must be complied for all the time

- ✓ The braking system must be decelerate a vehicle in a controlled and repeatable fashion and when appropriate cause the vehicle to stop.
- ✓ The braking should permit the vehicle to maintain a constant speed when traveling downhill.
- ✓ The braking system must hold the vehicle stationary when on the flat or on a gradient.

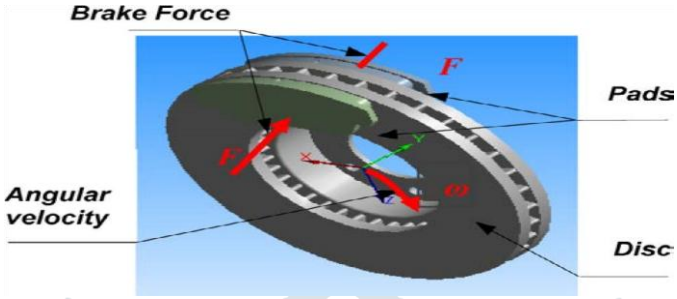
The Disc Brake discs are commonly manufactured out of grey cast iron. The SAE maintains a specification for the manufacture of grey cast iron for various applications. For Normal car and light truck applications the SAE specification is J431 G3000 (superseded to G10). This specification dictates the correct range of hardness, chemical composition, tensile strength and other properties necessary for the intended use. Some racing cars and airplanes use brakes with carbon fibre discs and carbon fibre pads to reduce weight. Wear rates tend to be high and braking may be poor until the brake is hot. It is investigated that the temperature distribution, the thermal deformation and the thermal stress of automotive discs have quiet close relations with car safety; therefore, much research in this field has been performed.Talati and Ziad:(2009), presented a paper on an investigation of disc brake rotor by Finite element analysis. In this paper, the author has conducted a study on ventilated disc brake rotor of normal passenger vehicle with full load of capacity. The study is more likely concern of heat and temperature distribution on disc brake rotor. Modelling is done in CATIA & ABAQUS/CAE has been used as finite elements software to perform the thermal analysis on transient response. Material used is Grey cast iron, with maximum permissible temperature 550 C. For load analysis 10 cycles of breaking and 10 cycles without breaking (idle) operation is considered total of 350 seconds. Result provided during 1st , 5th and during 10th cycle. Thus, this sure study provide better understanding on the thermal characteristic of disc brake rotor and assist the automotive industry in developing optimum and effective disc brake rotor.Ali Belchocine & Mostefa Bouchetara:(2012), presented C. paper on thermal analysis of a solid brake disc . The objective of this study is to analysethethermal behaviour of the full and ventilated brake discs of the vehicles using computing code ANSYS. In this analysis approach is to create the model CFD which contains the fields to be studied in Ansys Workbench. Three different grade of cast iron is chosen (FG 25 AL, FG20, and FG15). The numerical simulation shows that radial ventilation plays a very significant role in cooling of the disc in the braking phase. The variation in temperature between a full and ventilated

disc having same material is about 60 degree at the moment1.8839 s from application of brake The obtained results are very useful for the study of the thermo mechanical behaviour of the disc brake (stress, deformations, efficiency and wear).

2. METHODLOGY OF DISC PLATE

2.1 DISC BRAKE SECTION

A disc brake consists of a cast iron disc bolted to the wheel hub and a stationary housing called calliper. The calliper is connected to some stationary part of the vehicle, like the axle casing or the stub axle and is cast in two parts, each part containing a piston. In between each piston and the disc, there is a friction pad held in position by retaining pins, spring plates, etc., passages are drilled in the calliper for the fluid to enter or leave each housing. These passages are also connected to another one for bleeding. Each cylinder contains rubber-sealing ring between the cylinder and piston.



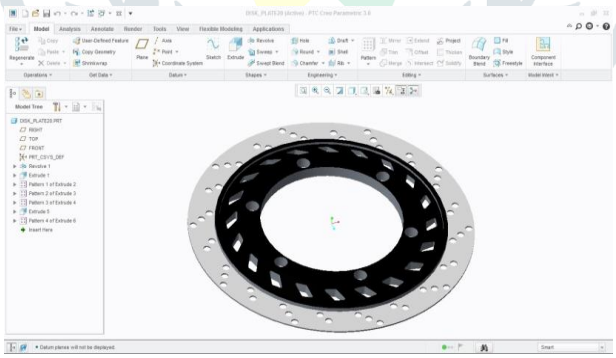
2.2 MODELING OF DISC BRAKE

It is very difficult to exactly model the brake disk, in which there are still There always a need of some assumptions to model any complex geometry. These assumptions are made, keeping in mind the difficulties involved in the theoretical calculation and the importance of the parameters that are taken and those which are ignored. In modelling we always ignore the things that are of less importance and have little impact on the analysis. The assumptions are always made depending upon the details and accuracy required in modelling. The assumptions which are made while modelling the process are given below:

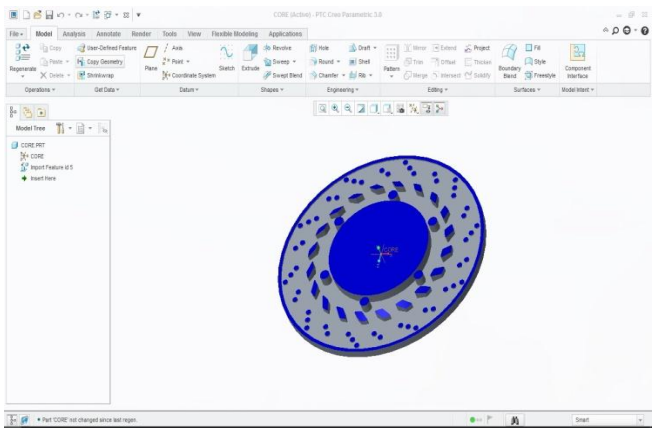
- ✓ The disk material is considered as homogeneous and isotropic.
- ✓ The domain is considered as axis-symmetric.
- ✓ Inertia and body force effects are negligible during the analysis.
- ✓ The disk is stress free before the application of brake
- ✓ Brakes are applied on the entire four wheels.
- ✓ The analysis does not determine the life of the disk brake.
- ✓ The disk brake model used is of solid type and it is not ventilated type.

2.3 DISC BRAKE ROTOR 3D VIEW

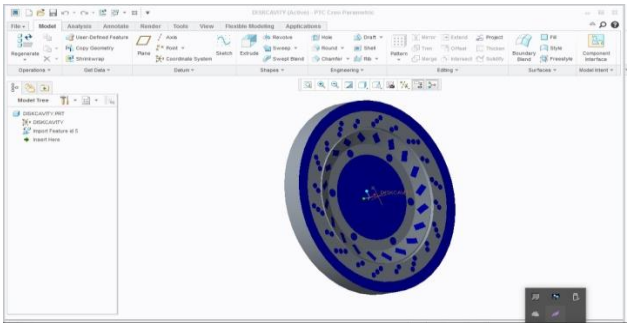
The proposed three dimensional modelling entirely on the basis of standards adopted for tool design. The extruded sketch follows strong dimensional parameters on its each segment. The rendered view of the 3D model.



2.4 DESIGNING OF CORE



2.5 DESIGNING OF CAVITY



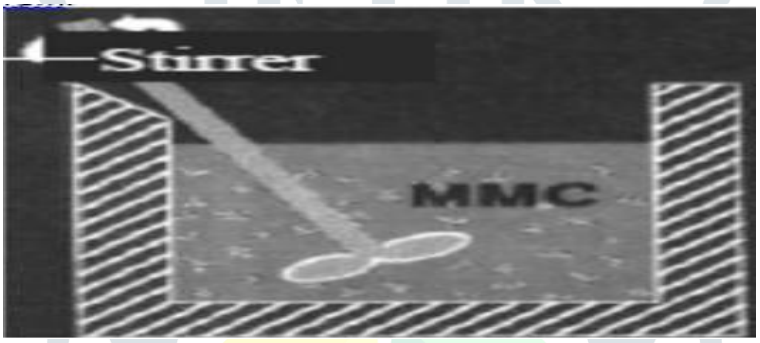
3. FABRICATION OF DISC BRAKE ROTOR BY USING AMMC

3.1 STIR CASTING METHOD

Stir casting is a process in which uniformly mixed very fine powder of additives are mixed with a molten matrix metal by means of mechanical stirring. Stir casting is the simplest and the most cost effective method of liquid state fabrication. The liquid composite material is then cast by conventional casting methods and may also be processed by conventional Metal forming technologies.

3.2 STIRRER

It is very important parameter in stir casting process which is required for vortex formation. The blade angle and number of blades decides the flow pattern of the liquid metal. The stirrer is immersed till two third depth of molten metal. All these are required for uniform distribution of reinforcement in liquid metal, perfect interface bonding and to avoid clustering. Stirring speed decides formation of vortex which is responsible for dispersion of particulates in liquid metal. In our project stirring speed is 300 rpm.



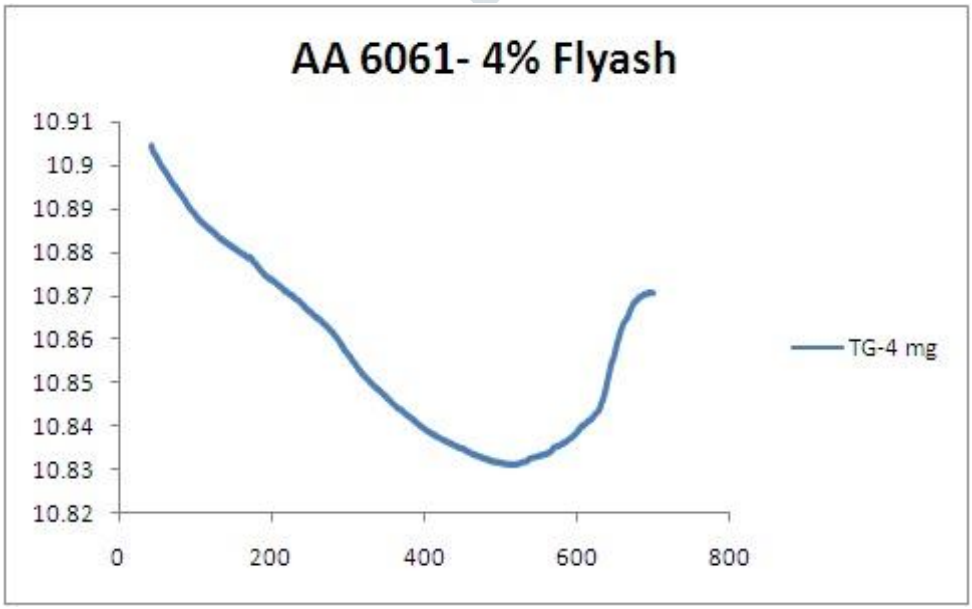
3.3 PRE-HEATING REINFORCEMENTS

Casting process is very difficult if Reinforcement particles are wet also it results in non-uniform distribution and poor mechanical property. To avoid this problem reinforcement are pre-heated at 500°C for 40 minutes.

3.4 PRE-HEATING OF MOULD

Porosity is the major problem in casting. In order to avoid porosity preheating of mould is good solution. It helps in removing the entrapped gases from the slurry to go into the mould. It also enhances the mechanical properties of the cast AMC. Mould is heated to 500°C for one hour.

4. THERMOGRAVIMETRIC ANALYSIS

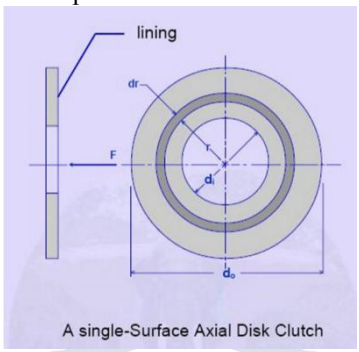


4.1 METHOD OF ANALYSIS

The torque that can be transmitted by a clutch is a function of its geometry and the magnitude of the actuating force applied as well the condition of contact prevailing between the members. The applied force can keep the members together with a uniform pressure all over its contact area and the consequent analysis is based on uniform pressure condition. condition may no longer prevail. Hence the analysis here is based on uniform wear condition.

Elementary Analysis

Assuming uniform pressure and considering an elemental area dA = 2Π.r dr
The normal force on this elemental area is dN=2. π.r.dr.p
The frictional force dF on this area is therefore dF=f.2.π.r.dr.p



A single-Surface Axial Disk Clutch

Now the torque that can be transmitted by this elemental are is equal to the frictional force times the moment arm about the axis that is the radius 'r' i.e.
T = dF. r = f.dN. r = f.p.A.r = f.p.2.π.r. dr .r
The total torque that could be transmitted is obtained by integrating this equation between the limits of inner radius ri

$$F_a = \int_{r_i}^{r_o} 2\pi p r dr$$

$$F_a = \pi\left(r_o^2 - r_i^2\right).p$$

$$T = \int_{r}^{o} 2\pi p f r^2 dr = \frac{2}{3}\pi p f (r_o^3 - r_i^3)$$

$$T = fF_a.\frac{2}{3}\frac{(r_o^3 - r_i^3)}{(r_o^2 - r_i^2)}$$

to the outer radius ro Integrating the normal force between the same limits we get the actuating force that need to be applied to transmit this torque. Equation 1 and 2 can be combined together to give equation for the torque.

4.2 STRUCTURAL ANALYSIS

	Displacement (mm)	Stress (MPA)	Strain
ALUMINIUM 6061-4% Fly ash	0.099028	20 .9257	0.212e-03

4.3 DYNAMIC ANALYSIS

	Time (Sec)	Displacement (mm)	Stress (MPA)	Strain
ALUMINIUM 6061-4% Fly ash	10	0.102203	22.5171	0.251E-03
	20	0.115792	32.2951	0.284E-03
	30	0.126927	30.4494	0.312E-03

5. CONCLUSION

In this, a single plate clutch is modelled in 3D modelling software Creo 3.0. Present used material for clutch is Cast Iron. In this research work, it is replaced with, Aluminium metal matrix composite. The advantage of using aluminium alloys is their lightweight. The advantage of using composite material is their strength to weight ratio. Byobserving the static analysis results, the analysed stress values are less than the respective yield stress values of, aluminium MMC 6061 with 4%fly ash composite. Theoretical calculations are also done to determine stresses for all the materials. By observing the results, the stress values are less than the respective allowable stress values for all materials. By observing the AA6061-4%fly ash composite results, the stress value is less. So it can be concluded that by analytical and theoretical results, AA6061-4%fly ash composite is better.

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