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Design, Analysis, Optimization and Manufacturing of Disc Brake

Mr. Amol Garad[1] and Prof. R. R. kulkarni[2]
PG Student, Dept. of Mechanical Engineering[1]
Asst. Professor, Dept. of Mechanical Engineering[2]
Siddhant College of Engineering, Pune, Maharashtra, India

Abstract: *Braking system is one of the very critical system in automobile. Braking System should say the safety and comfort of the passage, Driver and other Road user. The Brake must be strong enough to stop the vehicle during Emergency within shortest distance. This is possible if there is no Skidding and driver has proper control over vehicle. In this project we minimize the break fail to avoid the accident. Recently, disc brake are most wildly used. Its operation is simple. It also requires low maintenance. It is our new idea & new concept those we present in model form. Hence there are many advantages by introducing this machine. While manufacturing vehicle at competition level, many problems may arise while selecting brake rotor. The size of rotor according to our design calculations may not be vailablein the market. In case, we select any available disc, it may be the case of overdesign. Also due to fix shape of the disc, we may have to compromise with various other design parameters. With modification in size shape and material, disc can be effectively used in vehicle of same transmit motion and power. This will provides same braking effect without any overdesign and altering any of the design parameters. Also due to fix shape of the disc, we may have to compromise with various other design parameters. With modification in size shape and material, disc can be effectively used in vehicle of same transmit motion and power. This will provides same braking effect without any overdesign and altering any of the design parameters.*

Keywords: Braking system

I. INTRODUCTION

As we all know, an excellent **braking system** is the most important safety feature of any land vehicle. Competition regulations require at least two separate hydraulic braking systems, so that in the event of a failure of one, the other will continue to provide adequate braking power to the wheels. The main requirement of the vehicle's braking system is that it must be capable of locking all four wheels on a dry surface. Ease of manufacturability, performance and simplicity are a few important criteria considered for the selection of the braking system.

A brake is a device by means of which artificial frictional resistance is appliedto moving machine member, in order to stop the motion of a machine. In the process of performing this function, the brakes absorb either kinetic energy of the moving member or the potential energy given up by objects being lowered by hoists, elevators etc. The energy absorbed by brakes is dissipated in the form of heat. This heat is dissipated in the surrounding atmosphere to stop the vehicle, sothe brake system should have following requirements:

- The brakes must be strong enough to stop the vehicle with in a minimumdistance in an emergency.
- The driver must have proper control over the vehicle during braking andvehicle must not skid.
- The brakes must have well anti fade characteristics i.e. their effectivenessshould not decrease with constant prolonged application.

II. OBJECTIVE

1. Thermal analysis of the disc brake with different materials
2. Structural analysis of disc brake with different material.
3. Automate the design procedure and reduce time of modeling

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III. LITERATURE REVIEW

G. Ranjith Kumar, S. Thriveni, M. Rajasekhar Reddy, Dr. G. Harinath Gowd[1]
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.

Tanuj Joshi, Sharang Kaul[2] For Torsional strength simulation the maximum values of the Von Mises Stress in perimetric disc is quite comparable to that in the conventional brake-disc and is much lower than the yield stress of the material, indicating that yielding is unlikely to occur during hard braking of the motorcycle. For Lateral strength simulation maximum value of Von Mises Stress is about 50% lower in the perimetric brake-disc as compared to conventional disc. Again, the maximum stresses are much lower than the yield stress of the material, indicating that bending or yielding is unlikely to occur in the perimetric brake-disc during lateral loading. For the perimetric brake-disc, it is noted that the maximum Residual stress value due to temperature distribution is less than the yield stress value. Also the values of both perimetric and conventional are quite comparable to each other. Hence the design is safe.

Prof. Mit Patel, Mansi Raval, Jenish Patel[3] As brakes have to undergo through continuous use, many issues surround their heating characteristics when it comes to their development, including contact region properties, material choice, development of hot spots, associated physical geometry, and deformations. The main purpose of this study is to analysis the thermo-mechanical behaviour 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 to enhance performance of the rotor disc. A comparison between analytical and results obtained from FEA is done and all the values obtained from the analysis are less than their allowable values. Hence best suitable design, will be suggested based on the performance, strength and rigidity criteria.

Sunkara Sreedhar, Parosh.G[4] concluded that using CATIA V5 R20 software design and modeling become easier. Only few steps are needed to make drawing in three dimensions, some can be imported to Ansys for analysis. Disc brake made of four different materials mild steel, all alloy, cast iron and composite material (e-glass) are analysed. Max pressure is found at the centre of disc brake. This is equal for all materials. The disc brake is done on both static structural and modal analysis (with and without pre stresses). Depending upon on frequency and pressure values, the max frequency and pressure is found at Al alloy, and minimum frequency and pressure is found at composite material. mild steel frequency and pressure will varies but the mild steel has good corrosive resistanceand the aluminimum values also increasing slightly but it has good thermal conductivity and the cast iron has good strength.From the four materials e-glass has good properties and it has less frequency and less deformation.

IV. DIMENSION OF DISC BRAKE:

Inner diameter = 80 mm
Outer diameter= 160 mm
Thickness = 4 mm
Disc is made up of Stainless steel 420.

Fig 1. Cad model of disc

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The optimization of the disc is done using Design Study in Solidworks. After selecting definite pattern of the disc. After selecting pattern for the disc, it is needed to decide the dimension of the slot present on the disc. Solidworks Design Study is function which can give us optimum result fromvarious adequate designs. For getting optimum design we went on varying lengthof the slot from 30mm to 40 mm making sure that slot does not touch the edges.

V. ANALYSIS

The optimization of the disc is done using Design Study in Solidworks. After selecting definite pattern of the disc. After selecting pattern for the disc, it is needed to decide the dimension of the slot present on the disc. Solidworks Design Study is function which can give us optimum result fromvarious adequate designs. For getting optimum design we went on varying lengthof the slot from 30mm to 40 mm making sure that slot does not touch the edges.This involves three phases:

1. Pre-processor phase.
2. Solution phase.
3. Post-processor phase

The ANSYS Workbench, together with the Workbench projects and tabs, provides a unified working environment for developing and managing a variety of CAE information and makes it easier for set up and work with data at a high level. Workbench includes the following modules “ANSYS Design Space” is referred to as Simulation “ANSYS AGP” is referred to as Design Modeler and ”ANSYS Design explorer” referred to as Design explorer.

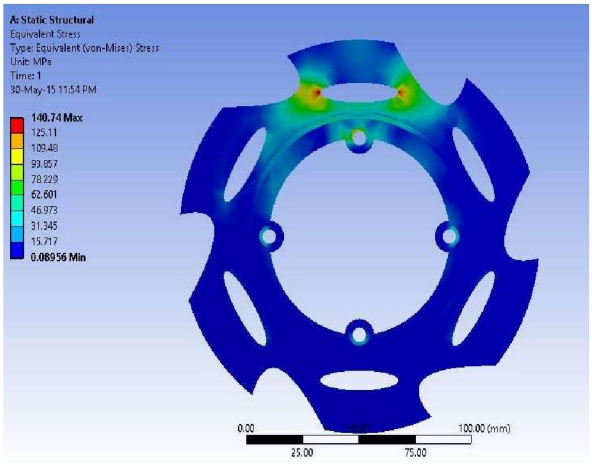

Fig 2. Solution for Stress developed

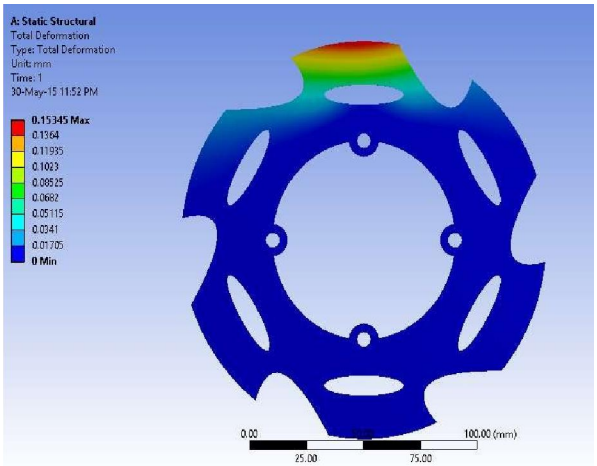

Fig 3. Solution for Deformation

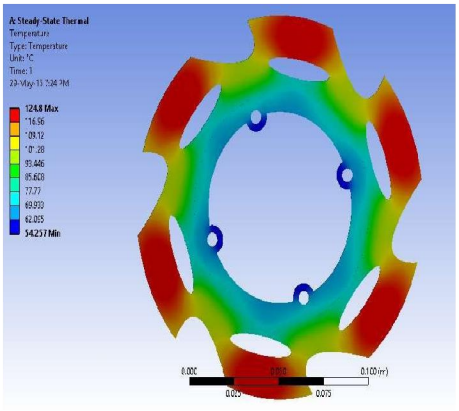

Fig 4. Temperature

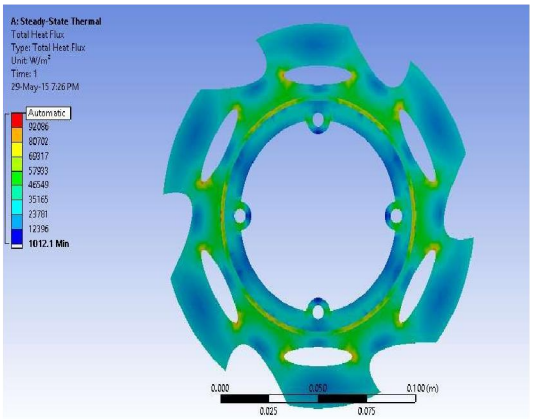

Fig 5. Heat Flux

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VI. RESULT AND DISCUSSION

Sr. No.	Parameter	Pattern1	Pattern 2	Pattern 3
1	Mass	449.20	410.24	436.82
2	Max Temp	194.41	156.41	192.43
3	Heat Flux	1.47 x 10^5	1.56 x 10^5	1.73 x 10^5
3	Max stress	267.49	140.74	257.9
4	Max Deformation	0.28074	0.15345	0.30412

Table. Optimum Pattern

After Deciding pattern shown in shape 2, dimension of the slots are decided by using Design study function in Solidworks. It is discussed in detail in next section.

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