A SCHEMATIC DESIGN OF DISC BRAKE AND ITS STATIC ANALYSIS USING ANSYS

MAHESH ADEPU
M. Tech Student, Dept of Mechanical-CAD/CAM, Brilliant grammar school educational institutions group of institutions integrated campus, T.S, India

Mr. K.SRINIVASA RAO
Associate Professor, Dept of Mechanical-CAD/CAM, Brilliant grammar school educational institutions group of institutions integrated campus, T.S, India

ABSTRACT

There is one of the most critical systems 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. A brake is a device for slowing or stopping the motion of a machine or vehicle, or alternatively a device to restrain it from starting to move again. In this project an attempt has been made to design of an sport bike disc brake, the main consideration of the product is to analyze the product design, working principal and selection of suitable material for selected product. The estimation of the motor cycle, to access the approximate design cost of this product.

In this experiment 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 and done the Thermal analysis and Modal analysis also calculate the deflection and Heat flux, Temperature of disc brake model. This is important to understand action force and friction force 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.

Keywords— *Disc Brake, Thermal Analysis, Modal Analysis, Ansys.*

1.0 INTRODUCTION

Brakes of some description are fitted to most wheeled vehicles, including automobiles of all kinds, trucks, trains, motorcycles, and bicycles. Baggage carts and shopping carts may have them for use on a moving ramp. Some airplanes are fitted with wheel brakes on the undercarriage. Some aircraft also Feature air brakes designed to slow them down in flight. Friction brakes on cars store the heat in the rotating part (drum brake or disc brake) during the brake application and release it to the air gradually. The kinetic energy lost by the moving part is usually translated to heat by friction. Alternatively, in regenerative braking, much of the energy is recovered and stored in a flywheel, capacitor or turned into alternating current by an alternator, then rectified and stored in a battery for later use. 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 callipers. The brake disc (or rotor in American English) is usually made of cast iron, but may in some cases be made of composites such as reinforced carbon–carbon or ceramic matrix composites. This is connected to the wheel and/or the axle.

Components of the Disc Brake Unit

Motorcycle uses the hydraulically operated foot brakes on the rear wheel. A layout of the proposed braking system is shown in Fig. The components of the system are listed below: Brake lever or pedal. (Pushes the master cylinder piston) Master cylinder. (Produces pressure in the brake system) Hydraulic lines. (Transfer hydraulic pressure from master cylinder to wheel cylinder) Disc or rotor, Calliper unit, Mechanical linkage. (To move the calliper unit in radial direction).Motorcycle uses the hydraulically operated foot brakes on the rear wheel. A layout of the proposed braking system. The components of the system are listed below:

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- Hydraulic lines. (transfer hydraulic pressure from master cylinder to wheel cylinder)
- Disc or rotor.
- Calliper unit.
- Mechanical linkage. (to move the calliper unit in radial direction)

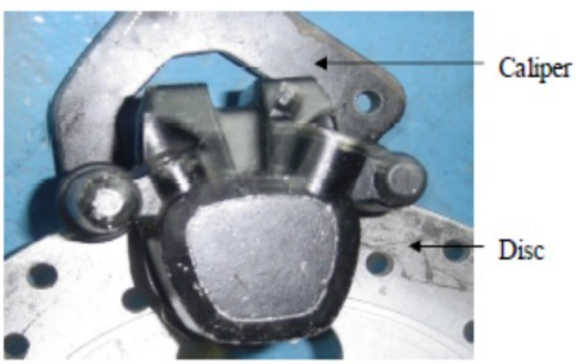


Figure 1.1 Single Piston Floating Type Calliper- sports motorcycle

Unlike a steel bar, however, fluid can be directed through many twists and turns on its way to its destination, arriving with the exact same motion and pressure that it started with. It is very important that the fluid is pure liquid and that there is no air bubbles in it. Air can compress which causes sponginess to the pedal and severely reduced braking efficiency. If air is suspected, then the system must be bled to remove the air. There are "bleeder screws" at each wheel cylinder and caliper for this purpose

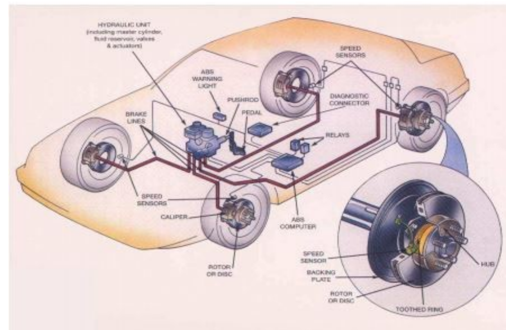


Figure 1.2 Four Wheel Disc Brake View

1.3 PROBLEM OCCURRED IN DISC BRAKE

Discs are made up of 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.

1.4 LOCATION OF CALIPER AND THE MECHANICAL LINKAGE

The main phase of this design is the construction and the assembly of the linkage to move the calliper in the radial direction. The layout of the linkage is shown in Figure

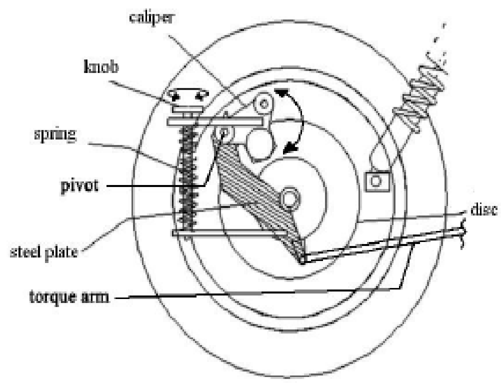


Figure 1.3 Calliper position without pillion rider on the motorcycle

Braking Requirements

1. Brakes should be a good anti wear resistant.
2. While braking the driver should have good control over the vehicle i.e. the vehicle should not skid.
3. Brakes of a vehicle should be strong so that it can stop a vehicle in minimum time.
4. Brakes should have good anti fade characteristics.

Classification of brakes

1. Hydraulic brakes
2. Electric brakes
3. Mechanical brakes
    - Radial Brakes
    - Axial Brakes

2.0 LITERATURE REVIEW

[1] I have studied on a stress analysis of ventilated brake discs using the finite Element method. In this study, three different ventilated brake discs, the cross drilled disc, the cross-slotted disc, and the cross-slotted with a side groove disc, were manufactured, and their braking force performances were investigated experimentally together with a solid disc. Stress analyses were subsequently performed by the finite element method. Analyses results showed that the maximum stress generations were formed on the ventilated discs in comparison to the solid disc. However, these comparisons indicate that the application of varying force distributions along brake pads reduces the stresses on ventilated discs by 8.8% to 19.1%.

[2]The studied Investigation of thermo-structural behaviors of different ventilation applications on brake discs. In this study, the thermal behaviors of ventilated brake discs using three different configurations were investigated at continuous brake conditions in terms of heat generation and thermal stresses with finite element analysis. The results were compared with a solid disc. Heat generation on solid brake discs reduced to a maximum of 24% with ventilation applications. The experimental study indicated finite element temperature analysis results in the range between 1.13% and 10.87%. However, thermal stress formations were higher with ventilated brake discs in comparison to those with solid discs.

[3]Ali Belhocine and MostefaBouchetaraetal have studied Thermal analysis of a solid brake disc. The objective of this study is to analyze the thermal behavior of the full and ventilated brake discs of the vehicles using computing code ANSYS. The modeling of the temperature distribution in the disc brake is used to identify all the factors and the entering parameters concerned at the time of the braking operation such as the type of braking, the geometric design of the disc and the used material. The results obtained by the simulation are satisfactory compared with those of the specialized literature.

[4]Jaeyoung Kang etal has studied Squeal analysis of gyroscopic disc brake system based on finite element method. In this paper, the dynamic instability of a car brake system with a rotating disc in contact with two stationary pads is studied. For actual geometric approximation, the disc is modeled as a hat-disc shape structure by the finite element method. From a coordinate transformation between the reference and moving coordinate systems, the contact kinematics between the disc and pads is described. The corresponding gyroscopic matrix of the disc is constructed by introducing the uniform planar-mesh method. The dynamic instability of a gyroscopic non conservative brake system is numerically predicted with respect to system parameters. The results show that the squeal propensity for rotation speed depends on the vibration modes participating in squeal modes. Moreover, it is highlighted that the negative slope of friction coefficient takes an important role in generating squeal in the in-plane torsion mode of the disc.

3.0 METHODOLAGY:

DESIGN

CATIA offers a solution to shape design, styling, surfacing workflow and visualization to create, modify, and validate complex innovative shapes from industrial design to Class-A surfacing with the ICEM surfacing technologies. CATIA supports multiple stages of product design whether started from scratch or from 2D sketches. CATIA is able to read and produce STEP format files for reverse engineering and surface reuse

3.2 DISC BRAKE PADS

The existing area of contact of the pad is increased for maintaining enough area of contact with the disc, when the calliper moves in the radial direction for loaded conditions. When the pillion load is increased, the calliper is moved outwards from the disc centre with respect to pivot. In that position, brake pads do not have enough area to have contact with the disc since the disc size (outer diameter) is small when it is compared with the centre of brake pad that is located more than disc size (diameter). The calliper piston centre is more than the brake disc outer radius with respect to disc centre. So the size of the brake pad is increased.

Figure 3.1 Pads

3.3 FLUID SYSTEMS

CATIA offers a solution to facilitate the design and manufacturing of routed systems including tubing, piping, Heating, Ventilating & Air Conditioning (HVAC). Capabilities include requirements capture, 2D diagrams for defining hydraulic, pneumatic and HVAC systems, as well as Piping and Instrumentation Diagram (P&ID). Powerful capabilities are provided that enables these 2D diagrams to be used to drive the interactive 3D routing and placing of system components, in the context of the digital mockup of the complete product or process plant, through to the delivery of manufacturing information including reports and piping isometric drawings.

3.4 CAD MODEL OF THE DISC ROTOR

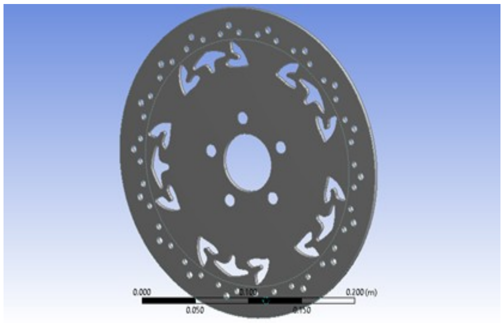


FIGURE 3.2 CAD LAYOUT O THE DISC ROTOR

LOCATION OF THE MASTER CYLINDER

The location of the master cylinder is very important for the build up of the right amount of brake pressure. The master cylinder maybe placed at a higher level than that of the brake pedal. It has been found out that the suitable place for locating master cylinder is the place of tool box. Hence the tool box is removed and the master cylinder is located in that place. Then the master cylinder is screwed to metal strips that are welded to the chassis frame of the motorcycle as shown in the Figure It gives rigid support to the master cylinder which is located at a height of 187 mm from the brake pedal. It is not mandatory to locate the master cylinder at the place of the tool box. Actually, a space is needed near the brake pedal to ease the operation of the master cylinder linkage. Since the tool box is originally fitted nearer to brake pedal, that place where the tool box fitted, is selected to fix the master cylinder.

3.5 WHEEL HUB DESIGN

Figure 3.3 Rear wheel hubs

The gap between the disc and the hub is 15mm as shown in Figure But the linear movement of calliper requires at least 35 mm to accommodate calliper LH part travel between the hub and the disc. To make this possible the following modifications are required in the existing wheel hub

- Wheel hub/ rim – facing
- Additional spacer
- New Axle bush

WHEEL HUB MODIFICATION

The wheel hub before and after modification work, is shown in Figure about 20 mm facing operation was performed on wheel hub.

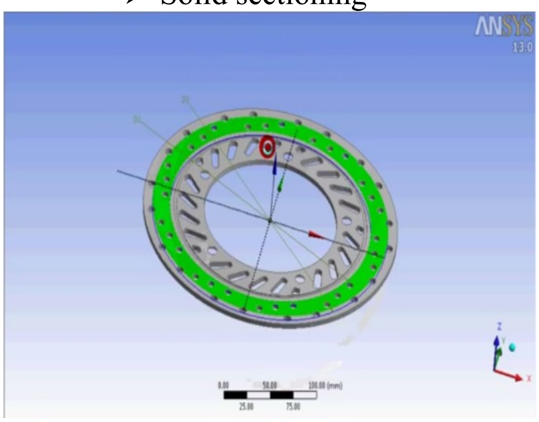
Figure 3.4Wheel hub modifications

After modification, the hub face is drilled and tapped for the same pitch circle diameter (PCD-125mm) to provide mounting for the spacer. The original wheel hub setup is retained after the facing operation.

4.0 RESULTS

It is a powerful user-friendly post-processing program using interactive color graphics. It has extensive plotting features for displaying the results obtained from the finite element analysis. One picture of the analysis results can often reveal in seconds what would take an engineer hour to asses from a numerical output, say in tabular form. Contours of stresses, displacements, temperatures, etc.

- Deform geometric plots
- Animated deformed shapes
- Time-history plots
- Solid sectioning



4.1 Applying the values

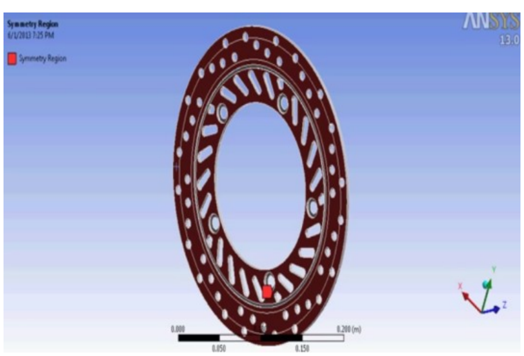


Figure 4.2 Deformation-1 of object

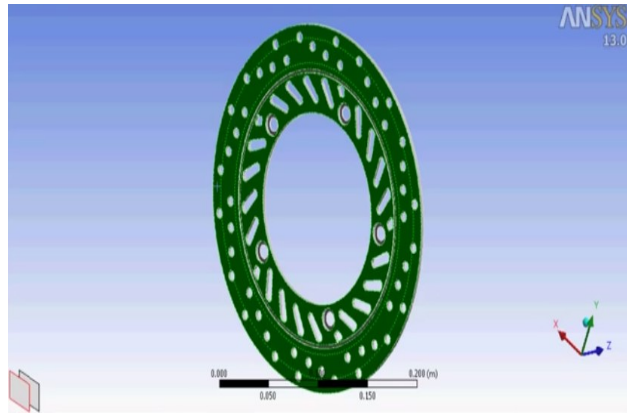


Figure 4.3 Deformation-2 of object

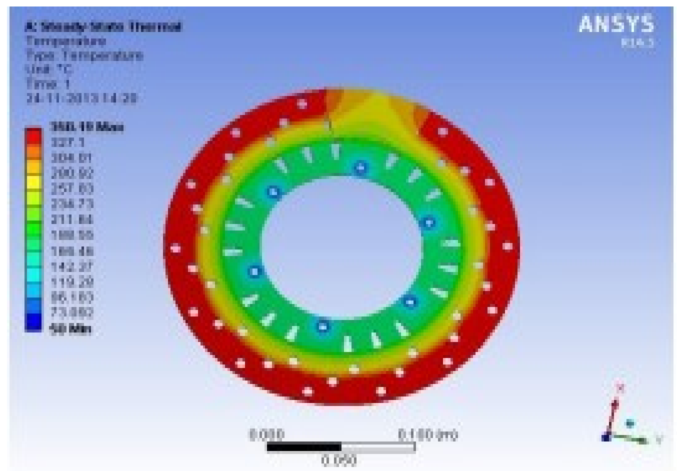


Figure 4.4 Temperature Distribution

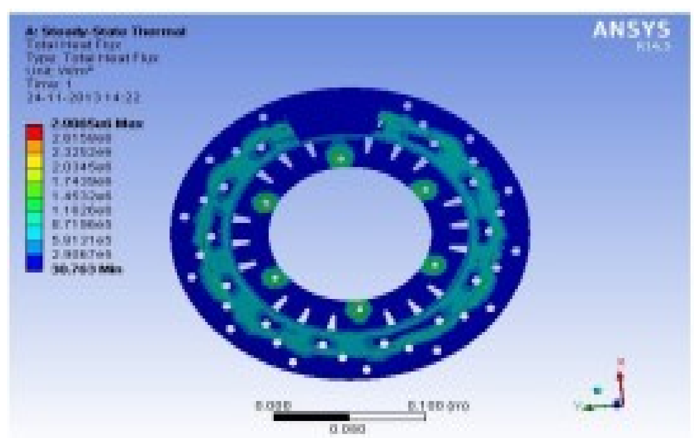


Figure 4.5: Total Heat Flux

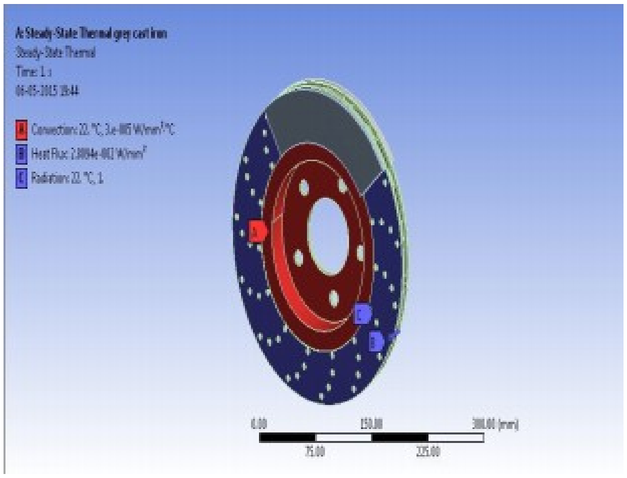


Figure 4.6: Steady state thermal analysis boundary condition for grey cast iron

5. CONCLUSIONS

A complete disc rotor designer must have a thorough knowledge of the principles of the working of the various parts of the motor bikes depends on the techniques adopted for its manufacturer. Case studies of the various designs same kind have been conducted prior to the design process. Proper evaluation of the previous designs were performed and created something even better instead of simply keeping to what was done previously. The various demands of the customer were considered while designing of the tool. The final design is prepared after the part design has been specified and all requirements affecting the design of the motor cycle have been clarified.

Using carbon ceramic matrix disc brake material 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, done the Thermal and Modal Analysis calculate the deflection, total heat flux, Frequency and temperature of disc brake model. This is important to understand action force and friction force on the disc brake new material, which use disc brake works more efficiently, which can help to reduce the accident that may happen in each day.

2 FUTURE SCOPE:

The reliable intelligent driver assistance systems and safety warning systems is still a long way to go. However, as computing power, sensing capacity, and wireless connectivity for vehicles rapidly increase, the concept of assisted driving and proactive safety warning is speeding towards reality. As technology improves, a vehicle will become just a computer with tires. Driving on roads will be just like surfing the Web: there will be traffic congestion but no injuries or fatalities. Advanced driver assistant systems and new sensing technologies can be highly beneficial, along with large body of Work on automated vehicles. These findings suggest that the research into autonomous vehicles within the ITS field is a short term reality and a promising research area and these results constitute the starting point for future developments. Some of the suggestions towards extension and/or future related works are identified and are summarized below:

- New sensory systems and sensory fusion is to be explored to plug additional information to the control system.
- This work can be extended to include different makeovers to make the driving system capable of dealing with all driving environments.
- Future issues may also include an algorithm for autonomous formation of the cooperative driving.
- Thus, with the current and growing awareness of the importance of security, trustworthy vehicle autonomous systems can be deployed in few years.

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