Design and Analysis of Disc Plate of an All Terrain Vehicle

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***Abstract*: The present Paper work aims to design of a disc for the braking system of the ATV Car. The disc of grey cast iron is modelled in Autodesk Inventor and Analysis of same was done in the FEA module of the Autodesk Inventor. Structural analysis of disc is carried out to study stress distribution, strain, deformation, etc for real world implementation. It is designed in a manner that the disc will support different loading condition without failure. Basic approach is to reduce the mass of disc which directly leads to reduce unsprang mass of the vehicle. As the friction between the disc pads and disc causes wheel to slow or stop where kinetic energy is converted to heat energy. In order to dissipate maximum heat, several vents are designed in the disc which may leads in reduction of mass of the disc. At the same time there should be enough strength to sustain under the dynamic conditions.**

I. **Introduction: -** A brake is a device which is used to retard or to stop the motion of vehicle. The purpose of the brakes is to stop the car safely and effectively without skidding in minimum possible time. In order to achieve maximum performance from the braking system, the brakes have been designed to lock up all four wheels. A 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. To stop the wheel, friction material in the form of brake pads, mounted on a device called a brake caliper, on which the force is applied mechanically, hydraulically, pneumatically or electromagnetic ally against both sides of the disc.

Friction causes the disc and attached wheel to slow or stop. After the removal of force from disc pads, the pads retain its original position and the wheel can rotate freely again. Disc brakes have proven to be the most reliable and stable working, so they are widely used in modern automobiles. In a hydraulically actuated system, master cylinder and brake lines are used for transferring the motion of driver's pedal. The fluid filled in lines. The brake pedal linkage operates a piston in a master cylinder to pressurize the fluid inside the lines. Fluid pressure in each wheel cylinder or caliper forces the friction material against the drum or rotor. Hydraulic brakes work on the principle of pascal law.

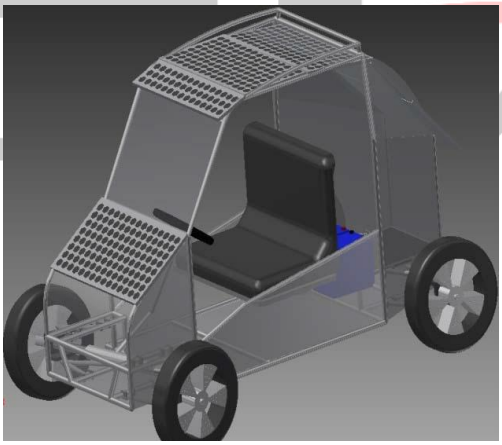

Fig. 1. 3D model of ATV Car

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. To stop the wheel, friction material in the form of brake pads, mounted on a device called a brake calliper, is forced mechanically, hydraulically, pneumatically or electromagnetically against both sides of the disc. Friction causes the disc and attached wheel to slow or stop. Brakes convert motion to heat, and if the brakes get too hot, they become less effective, a phenomenon known as brake fade.

Disc-style brakes development and use began in England in the 1890s. The first calliper-type automobile disc brake was patented by Frederick William Lanchester in his Birmingham, UK factory in 1902 and used successfully on Lanchester cars. Compared to drum brakes, disc brakes offer better stopping performance, because the disc is more readily cooled. 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 as 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. The passages are also connected to another one for bleeding. Each cylinder contains rubber-sealing ring between the cylinder and piston. A schematic diagram is shown in the figure 2.

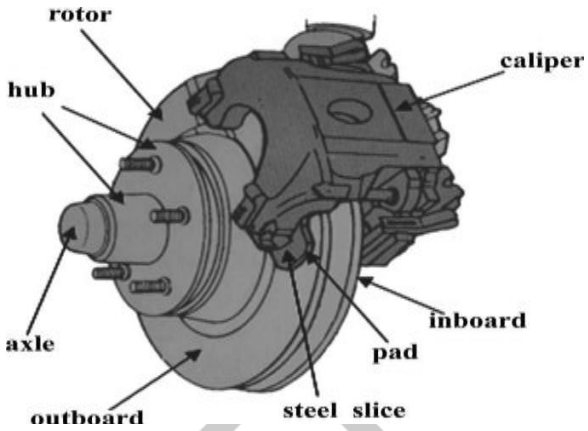

Fig. 2. Disc Brake

II. Design

Gross Weight of Vehicle, W = 3500 N
Weight on Front axle with no braking, W1 = 1400 N
Weight on rear axle with no braking, W2 = 2100 N
Height of cg, h= 547 mm
Wheel base, l= 1550 mm
Coefficient of friction b/w road & tyre, μ =0.6
Tire radius= 240 mm
Dynamic weight transfer On front wheels =2254 N
On rear wheels = 1246 N
Brake force Front wheel, f =1352.4 N
Rear wheels, f =747.6 N
Braking torque required
For front wheels = 162.288 Nm
For rear wheels = 89.712 Nm
Brake line pressure = 1.403 MPa
Clamping force = 971 N on each face
Brake Torque Actual =100 Nm
Stopping distance = 5.75 m
Braking efficiency = 80 %

Material

The material should have enough strength to withstand all the loads acting on it in dynamic conditions. The material selection also depends on number of factors such as material properties, availability and the most important parameter is the cost. Grey Cast Iron is selected for the material of disc. Properties of Grey Cast Iron are as under:

Table.1: Properties of material for the Disc

1. Mass Density 7.15 g/cm^3
2. Yield Strength 758 MPa
3. Ultimate Tensile
Strength 884 MPa
4. Young's Modulus 120.5 GPa
5. Poisson's Ratio 0.3 ul
6. Shear Modulus 46.3462
7. Coefficient of Thermal Expansion (m/°C) 46 W/m-K

Modelling

Ansys is one of the useful software for design analysis in mechanical engineering. This software is based on the Finite Element Method (FEM) to simulate the working conditions of your designs and predict their behaviour. FEM requires the solution of larges systems of equations. Powered by fast solvers, Ansys makes it possible for designers to quickly check the integrity of their designs and search for the optimum solution.

A product development cycle typically includes the following steps:

• Build your model in the Pro-Engineer system.
• Prototype the design.
• Test the prototype in the field.
• Evaluate the results of the field tests.
Modify the design based on the field test results.

The assumptions which are made while modeling the process are given below.

- The disc material is considered as homogenous and isotropic.
- The problem domain is considered as axis- symmetric.
- Inertia & body force effects are negligible during the analysis.

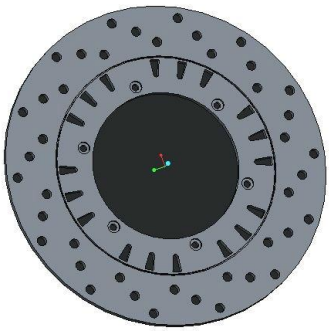

Fig. 3 Model Of Disc Plate

Thermal Analysis of Disc Brake:

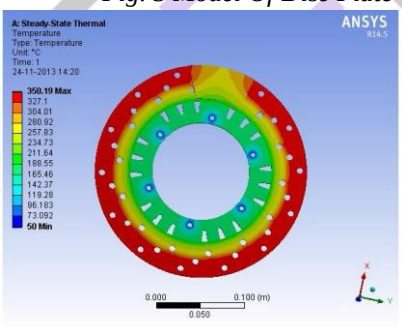

Fig 4 Temperature Distribution

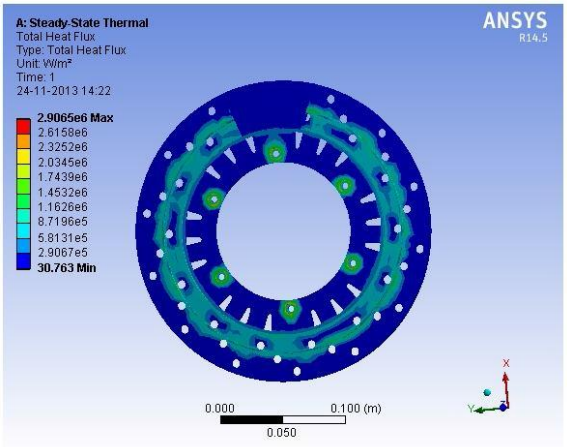

Fig 5 Total Heat Flux

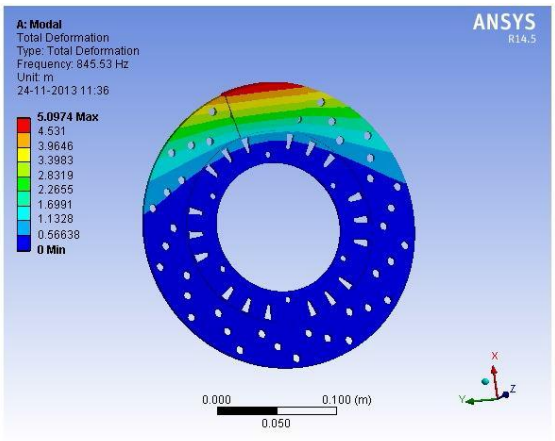

Fig 6 Frequency and Total Deformation of Disc Brake

III. CONCLUSIONS

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.

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