Design and Analytical Investigation of Disk Brake

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Abstract— **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 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.**

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 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 1

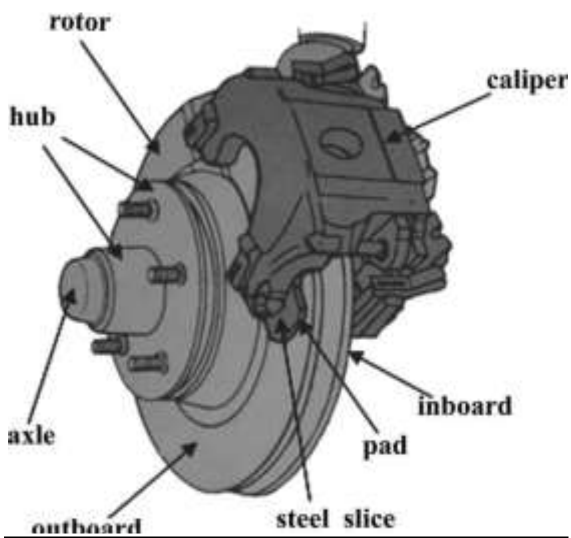

Fig 1 Disc Brake

DESIGN CALCULATIONS

In this type of brake two friction pads are pressed axially against a rotating disc to dissipate kinetic energy. The working principle is very similar to friction clutch. When the pads are new the pressure distribution at pad-disc interface is uniform, i.e.

p = constant .

If F is the total axial force applied then

p $=\frac{F}{A}$, where A is the area of the pad. The frictional torque is given by

$$T_{braking} = \frac{\mu F}{A} \oint_A r\, dA$$

where μ = coefficient of kinetic friction and r is the radial distance of an infinitesimal element of pad. After some time the pad gradually wears away. The wear becomes uniforms after sufficiently long time, when

pr = constant = (say)

1. Disc Brake

Standard Rotor disc dimension = 240 mm.

Rotor disc material = Carbon Ceramic Matrix Pad brake area = 2000 mm2

Pad brake material = Asbestos Coefficient of friction (Wet) = 0.07-0.13

Coefficient of friction (Dry) = 0.3-0.5

Maximum temperature = 350 ºC

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Maximum pressure = 1MPa
Tangential force between pad and rotor (Inner face), FTRI
FTRI = µ1.FRI
Where, FTRI = Normal force between pad brake And Rotor (Inner)
µ1 = Coefficient of friction = 0.5
FRI = P max / 2 × A pad brake area So,
FTRI = µ1.FRI
FTRI = (0.5)(0.5)(1×106 N/m2) (2000×106 m 2)
FTRI = 500 N
Tangential force between pad and rotor (outer face) , FTRO. In this FTRO equal FTRI because same normal force and same material

2. Brake Torque (TB) – With the assumption of equal coefficients of friction and normal forces FR on the inner and outer faces:
TB = FT.R
Where TB = Brake torque
µ = Coefficient of friction
FT = Total normal forces on disc brake,
= FTRI + FTRO
FT = 1000 N.
R = Radius of rotor disc. So,
TB = (1000) (120×1000)
TB = 120 N.m

3. Brake Distance (x) – We know that tangential braking force acting at the point of contact of the brake, and
Work done = FT. x (Equation A)
Where FT = FTRI + FTRO
X = Distance travelled (in meter) by the vehicle before it come to rest. We know kinetic energy of the vehicle.
Kinetic energy = (mV^2) / 2 (Equation B)
Where m = Mass of vehicle
v = Velocity of vehicle In order to bring the vehicle to rest, the work done against friction must be equal to kinetic energy of the vehicle.
Therefore equating (Equation A) and (Equation B) FT. x = ((mV^2)) / 2
Assumption v = 100 kg/h = 27.77 m/s M = 132 kg. (Dry weight of Vehicle)
So we get x = ((mV^2)) / 2 FT x
= (132×27.772) / (2×1000) m.
x = 50.89 mm

CONCLUSION

Discs are made up 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.

The machining process is performed in a brake lathe, which removes a very thin layer off the disc surface to clean off minor damage and restore uniform thickness. Machining the disc as necessary will maximize the mileage out of the current discs on the vehicle. Braking systems rely on friction to bring the vehicle to a halt – hydraulic pressure pushes brake pads against a cast iron disc or brake shoes against the inside of a cast iron drum. When a vehicle is decelerated, load is transferred to the front wheels – this means that the front brakes do most of the work in stopping the vehicle. Scarring can occur if brake pads are not changed promptly when they reach the end of their service life and are considered worn out.

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