DESIGN AND ANALYSIS OF DISC BRAKE

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***Abstract*: The disc brakes failed repeatedly during extreme braking conditions that ultimately reduced the efficiency and performance of the rotor. This may be due to excessive temperatures acting on a location on the disc that deforms the disc. The material used in these disc brakes is not very rigid and, therefore, vehicles are prone to accidents. Therefore, the main objective of this article is to mitigate the failure by using a material that overcomes the disadvantages of all materials currently used in disc brakes. Static analysis is performed on the disk rotor to validate the ductility and thermal analysis is performed to determine the heat flow acting on the disk. The distribution of the temperature around the disk rotor is also analyzed. Three existing materials, namely stainless steel, cast iron and carbon-carbon composite, are compared with vanadium steel to verify maximum deformation, tension and temperature. The disk brake is modeled using Creo Parametric 3.0 and the analysis is performed in ANSYS Workbench 15.0. Upon completion of the analysis, Vanadium Steel has been shown to have better resistance and temperature distribution factors than the other three materials.**

***Keywords*: Brake, Thermal Analysis, Rotor, Disc, Heat, Thermal.**

I.INTRODUCTION

The disc brake is a wheel brake that slows the rotation of the wheel by the friction caused by the thrust of the brake pads against a Brake disc with a set of stirrups. The brake disc (or rotor in American English) is usually cast iron, but may In some cases, they consist of compounds such as reinforced carbon. Composites with carbon or ceramic matrix. This is connected to the Wheel and / or axis. To stop the wheel, the friction material in the shape of brake pads, mounted on a device called brake. Clamp, is forced mechanically, hydraulically, pneumatically or electromagnetically against both sides of the disk. Friction causes the disk and the fixed wheel to slow down or stop. The breaks turn the movement into heat, and if the brakes get too hot, they become less effective, a phenomenon known as braking the brakes. The development and use of disc brakes began in England. in the 1890s. The first automotive caliper disc brake was patented by Frederick William Lanchester in his Birmingham, British factory in 1902 and successfully used in Lanchester automobiles. Compared to drum brakes, disc brakes provide better braking Performance because the disc cools more easily. A disc the brake consists of a cast iron disk screwed to the axle of the wheel and a fixed housing called stirrup. The stirrup is connected to a fixed part of the vehicle, such as the axle box or Rocket, since it is launched in two parts, each contains a piston. Between each piston and the disc, a friction pad is maintained in place retaining pins, spring plates, etc. the passages are perforated in the stirrup so that the fluid enters or leaves each living place. The passages are also connected to another one for bleeding each cylinder contains a rubber ring between the cylinder and the piston.

III. PROBLEM OCCURRED IN DISC BRAKE

The discs consist mainly of gray cast iron, so the discs are damaged in three ways: scars, cracks, deformities or excessive rust. The service workshops will sometimes respond to any disk problem by completely changing the disks. Is mainly when the cost of a new disc can really be lower than the cost of workers to redo the surface of the original disc. Mechanically, this is not necessary unless the discs it reaches the minimum thickness recommended by the manufacturer. What would make it dangerous to use them, or the rust on the platform. Serious (only ventilated discs).Most visible vehicle Manufacturers recommend scraping the brake discs (US: turn) as a solution to the problems of lateral sailing, vibration and braking. Noises the machining process is done in a brake revolution that removes a very thin layer from the surface of the disc to clean it Minor damage and restore uniform thickness. Machining the disk as necessary will maximize the mileage of the Discs in progress in the vehicle. Braking systems depend on friction. To stop the vehicle - the hydraulic pressure pushes the brake Pads against a cast iron disk or brake pads against the inside. A cast iron drum. When a vehicle slows down, the load is transferred to the front wheels - this means that the front the brakes do most of the work when stopping the vehicle. Scars It can happen if the brake pads are not changed quickly They reach the end of their useful life and are considered worn. Cracking is mainly limited to perforated discs, which can develop small cracks around the holes of the holes drilled near the edge of the disk due to uneven disk expansion rate difficult work environments.

IV. CALCULATION OF DISC BRAKE

Disc Brake Standard
Rotor disc dimension = 240 mm. (240×10-3 m)
Rotor disc material = Carbon Ceramic Matrix
Pad brake area = 2000 mm2 (2000×10-6 m)
Pad brake material = Asbestos
Coefficient of friction (Wet) = 0.07-0.13

Coefficient of friction (Dry) = 0.3-0.5
Maximum temperature = 350 ºC
Maximum pressure = 1MPa (106 Pa)

4.1 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 m2)
FTRI = 500 N.

Tangential force between pad and rotor (outer face) , FTRO. In this FTRO equal FTRI because same normal force and same material

4.2 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) (120×10-3)
TB = 120 N.m

4.3 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 vehiclebefore it come to rest.
We know kinetic energy of the vehicle.
Kinetic energy = (mv2) / 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 = (mv2) / 2

Assumption v = 100 kg/h = 27.77 m/s
M = 132 kg. (Dry weight of
Vehicle)

So we get x = (mv2) / 2 FT
x = (132×27.772) / (2×1000) m.
x = 50.89 m

Heat Generated (Q) = M .Cp. ΔT J/S
Flux (q) = Q/A W/m² Thermal Gradient (K) = q / k K / m

4.4 Carbon Ceramic Matrix

Heat generated Q= m*cp*ΔT
Mass of disc = 0.5 kg
Specific Heat Capacity = 800 J/kg 0 c
Time taken Stopping the Vehicle = 5sec
Developed Temperature difference = 15 0 c
Q = 0.5 * 800 * 15= 6000 J
Area of Disc = Π * (R2 – r2) = Π * (0.120 2 – 0.055 2)
= 0.03573 m 2
Heat Flux = Heat Generated /Second /area = 6000 /5 /
0.0357 = 33.585 kw/m 2
Thermal Gradient = Heat Flux / Thermal Conductivity
= 33.582*10 3 / 40
= 839.63 k/m

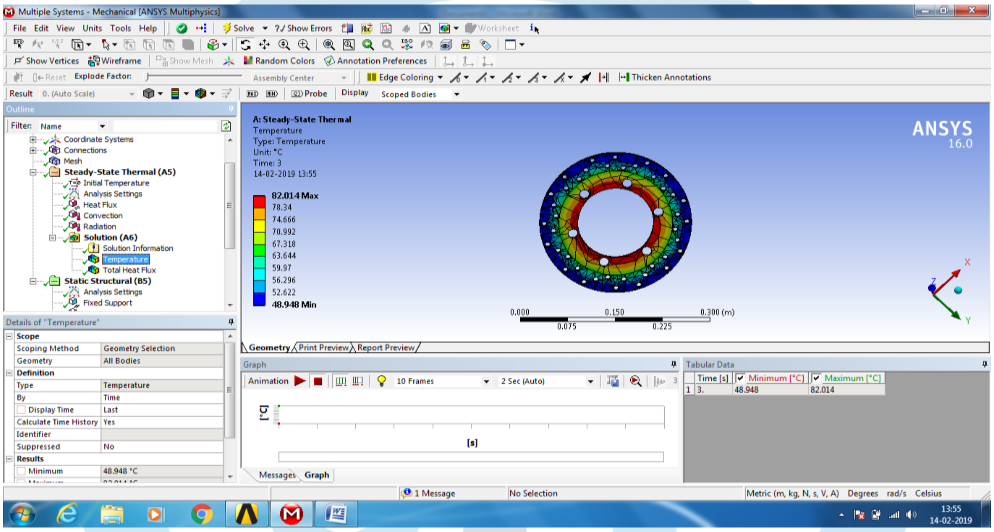
V.FEM USING ANSYS

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:

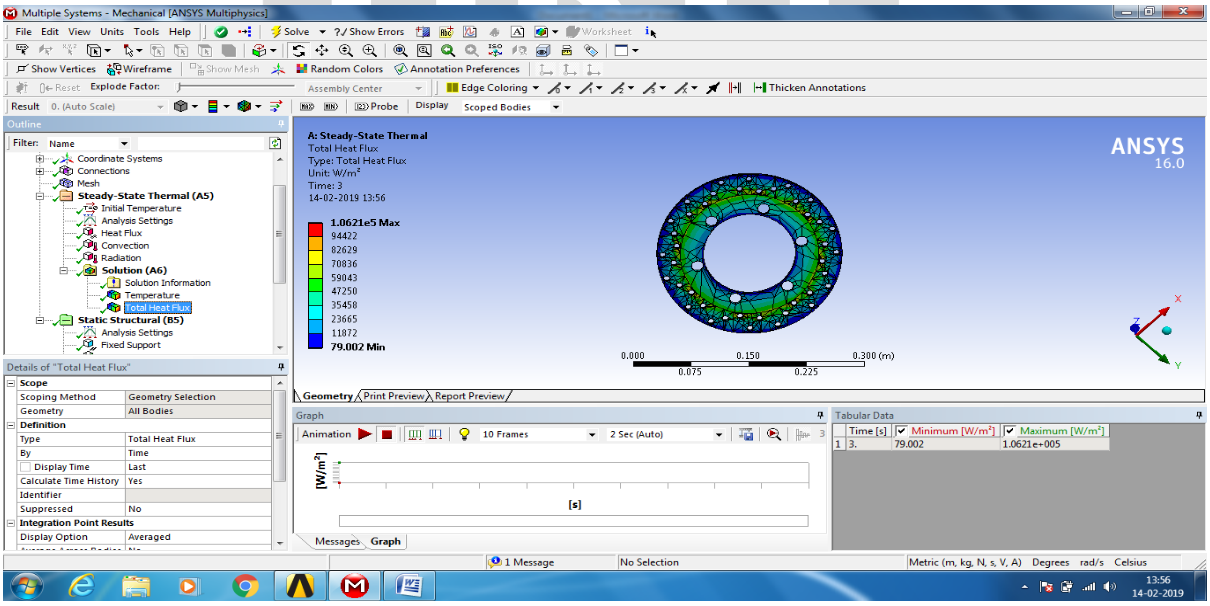
- Build your model in the Pro-Engineer system.
- Prototype the design.
- Test the prototype in the field.
- Evaluate the results of the field tests.
- Modify the design based on the field test results.

5.1 Model of Disc Brake



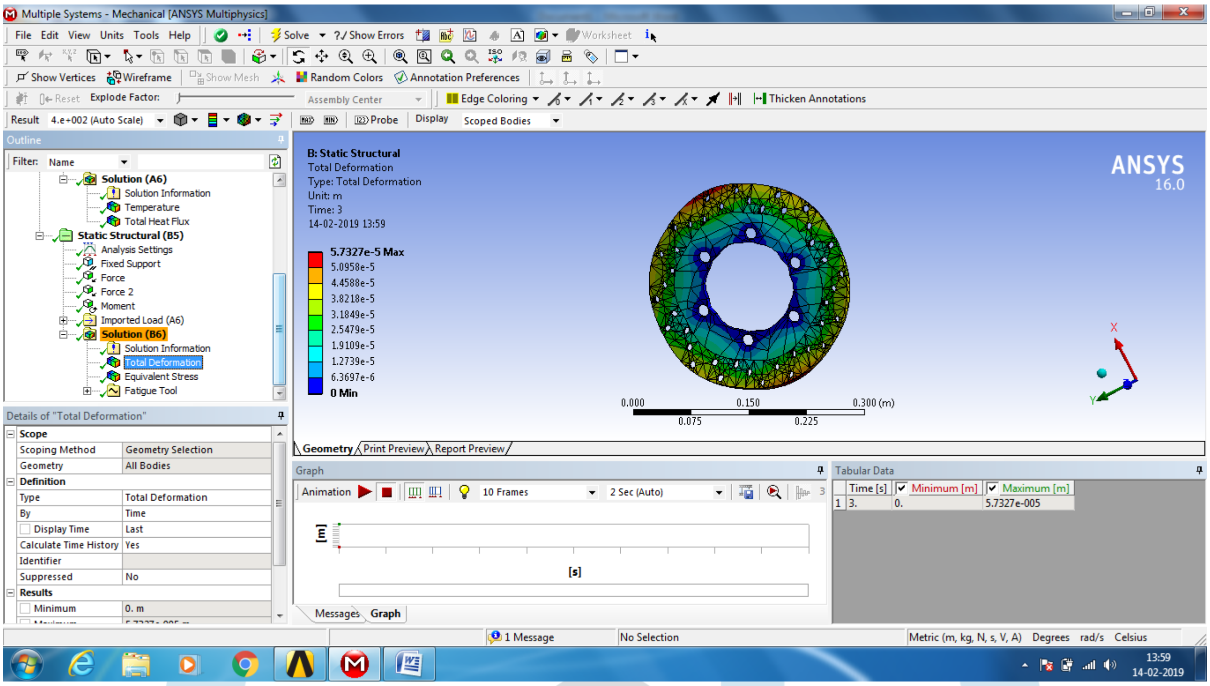
Temperature

5.2 Total Heat Flux



Total Heat Flux

5.3 Total Deformation



Total Deformation

VI. CONCLUSION

Dimensions of rotor are accurately calculated by using basic principles of engineering. 3D model of rotor is prepared on CRE-o software and thermal analysis is done in ANSYS software.

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