ISSN (Online) 2456-1290
International Journal of Engineering Research in Mechanical and Civil Engineering (IJERMCE)
Vol 2, Issue 2, February 2017

Thermal and Model analysis of DISC brake

[1] Ankush B. Khot, [2] Harshwardhan C [3] Ketkale Koustubh S, [4] HajareYuvraj M. Shet
[1][2][3] Student, Department of Mechanical Engineering,
DKTE's Textile and Engineering Institute, Ichalkaranji (INDIA)

Abstract- **Disc brakes are exposed to large thermal stresses during routine braking and extraordinary thermal stresses during hard braking. The aim of the project is to analysis the modal and thermal stresses in the disc. Modeling is done in CATIA. Catia is a 3D modeling software widely used in the design process. Analysis is done by using software like HYPERMESH and ANSYS. By performing analysis we can estimate the stresses induced and deformation of the disc. The result obtained from software will help to predict that the disc brake is safe or not and the further appropriate action can be taken.**

***Keywords*— Disc Brake, CATIA, Thermal analysis, Modal analysis, HYPERMESH, ANSYS.**

I. INTRODUCTION

Braking is the process which converts the kinetic energy of the vehicle into thermal energy which must be dissipated in the form of heat. Disc brake is a device used for slowing or stopping the rotating wheel of the vehicle. A brake disc is usually madeup of cast iron or ceramic material composites, is connected to the wheel or the axle. While braking in the vehicle at high speed the more heat is generated due to friction between brake pad and disc interface. In case of high speed braking the disc undergoes the breakage due to high temperature. Modeling of disc is done on the CATIA software and analysis is performed on the HYPERMESH and ANASYS software. The main purpose of this project is to study the thermal analysis of the disc brake for the cast iron material.

Modeling in Disc on CATIA

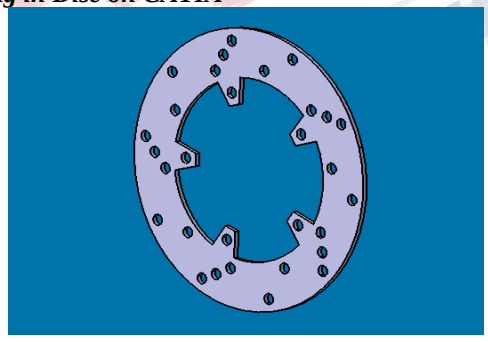

Fig 1.Isometric View of disc

Material of Disc:-

The material used for disc brake is of cast iron. Cast iron usually refers to grey cast iron, but identifies a large group of ferrous alloys, which solidify with a eutectic. Iron accounts for more than 95%, while the main alloying elements are carbon and silicon. The amount of carbon in cast iron is the range 2.1-4%, as ferrous alloys with less are denoted carbon steel by definition, cast irons contains appreciable amounts of silicon, normally1-3%, and consequently these alloys should be considered ternary Fe-C-Si alloys. Here graphite is present in the form of flakes. Disc brake discs are commonly manufactured out of material called grey cast iron,

Young's modulus (E) = 125Gpa
Poisson's ratio (v) = 0.25

Properties:

Properties	Cast Iron
Density (Kg/m^3)	7200
Thermal Conductivity (W/m-k)	54.5
Specific Heat (J/kg-k)	460

Assumptions:-

- The kinetic energy produced by the vehicle is converted into heat by neglecting losses.
- Heat flux is constant throughout the disc rotor.
- Material of the disc is isotropic.
- 60% of the kinetic energy transferred to the rear wheel and 40% of the kinetic energy transferred to the front wheel.
- Maximum speed of vehicle is 80kmph.
- Mass of vehicle (Total mass) is 210kg.
- The analysis is based on pure thermal loading. The analysis does not determine the life of the disc brake.
- Thermal conductivity of the material used for the analysis is uniform throughout.

ISSN (Online) 2456-1290
International Journal of Engineering Research in Mechanical and Civil Engineering (IJERMCE)
Vol 2, Issue 2, February 2017

Calculations:

Assume
Initial velocity=V1=80kmph=22.22 m/s
Final velocity=V2=0kmph
Mass = m =210kg
Thermal conductivity=ρ=54.5 W/m-k
Outer diameter = d_1 = 200mm
Inner diameter = d_2 = 138mm
Hole diameter = d = 8mm
No of holes = n = 25

Area without holes = $A_1 = 16458.8mm^2$
Area of all holes = $A_2 = 1256.64mm^2$
Effective Area = $A = 15202.16mm^2$
Kinetic energy = $\frac{1}{2} m (v_1^2 - v_2^2) \times 0.6$
$= \frac{1}{2} (210) \times (22.22)^2 \times 0.6$
$= 31104.89$ J
Brake Power (P_b) = K.E/t = 6309.3 W
Heat flux = $\Psi = P_b/A = 0.41$ w/mm^2

Thermal Analysis:-

Thermal analysis is a branch of material science where the properties of materials are studied as they change with the temperature. Thus to know the effect the temperature on disc with respect to time we have carried out the steady thermal analysis on ANSYS software.

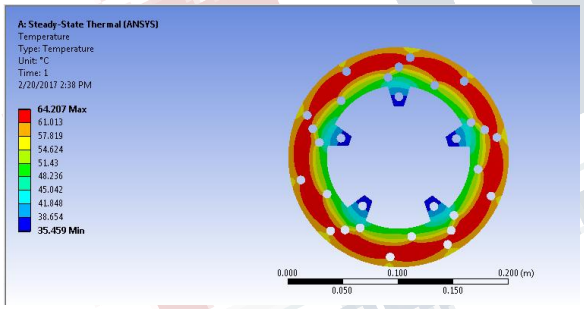

Figure 2 Temperature plot

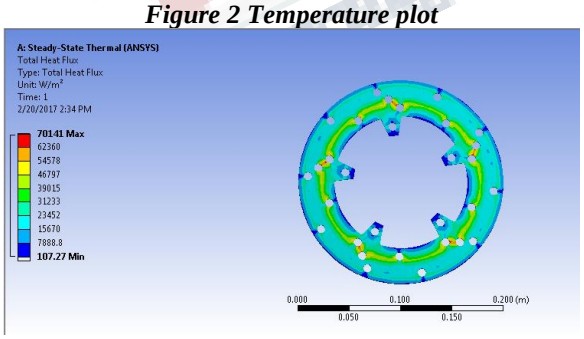

Figure 3 Heat flux plot

Modal analysis:

Modal analysis is the study dynamic properties of components under vibrational excitation.so the modal analysis is done to check the natural behavior of component at different frequency, so we have done modal analysis also to see the behavior of disc when it is exposed to different frequency and vibrations.

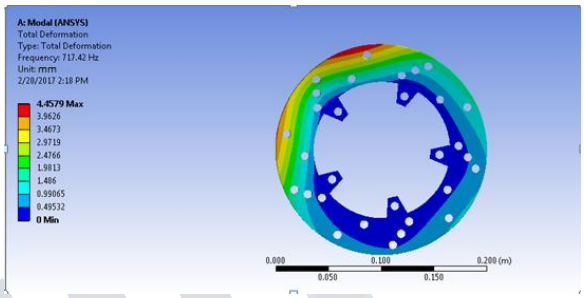

Figure 4 Modal analysis of disc

CONCLUSION

- As we know at high speed braking foe example 80 kmph the temperature / heat in the disc will be more, thus by analyzing disc at different points we get to know the effect of the temperature on disc. Thus for our model the value of temperature produce in disc are in desired limits therefore disc is safe.
- From above model analysis we conclude that the displacement of disc is not more i.e 4.457 mm. Thus we can assure that our disc is safe.

REFERENCE

1) Finite Element Analysis of Two Wheeler Disc Brake Rotor by Vijay Kumar B P.
2) Design Analysis & Optimization of an Automotive Disc Brake by G.Ranjith Kumar.
3) TRANSIENT THERMAL AND STRUCTURAL ANALYSIS OF ROTOR DISC OF DISC BRAKE BY B.H. MARUTHI.