THERMAL ANALYSIS OF DISC BRAKE PAD MODEL AND WEAR PREDICTION

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Abstract- Advancement in technology leads to improve the performance of each single components either in automotive or different modernizing equipment. Enrichment in the technology makes sure improvement in mechanism as well but still safety concern is foremost priority of all the sector. Braking system plays a vital role in the automobile as it ensures the safety of vehicle. In this CREO software is used for the designing of brake pad, back plate and the Rotor of the system and then further the geometry is imported to ANSYS for calculation of various statical and thermal analysis parameters. Different designs of brake pad are also created and they are assembled to in the CREO and the parameters are calculated with similar boundary condition and different graphical representations are obtained on the basis of their results. Wear model equation is used to predict the wear displacement in different geometries of brake pad, for that the contact pressure computed between brake pad and the rotor is used to calculate and predict the wear displacement.

Keywords — Thermal Analysis, Brake pad designs, Creo, ANSYS, contact Pressure, wear Prediction

1.INTRODUCTION

The most important aspect of automobile is safety. Braking comes under such crucial system which not only severs its role from safety point of view, but it allows the driver to have full control over vehicle. Thus, a brake system is required in order to retard the moving vehicle or stop the vehicle completely. Braking comes in to action when the wheel exhibits a huge friction or rubbing force against the motion. As in case of case of braking the kinetic energy of vehicle get converted in to some other form of energy, here in friction braking the kinetic energy of moving vehicle gets converted in to heat energy not complete energy is converted is converted into heat energy but some amount of energy might be dissipated in the form of vibration also. There are basically two types of frictional braking, namely Disc brake and drum brakes are the two majorly used brakes in automobile now a days.

As in both the case brakes energy is transmitted into heat, comparing in terms of heat dissipation, the disc brakes dissipated heat faster as compare with the drum brakes due to larger surface area exposed to surrounding and shows self-cleaning ability due to the centrifugal force.

In case of disc brake the brake is applied with the help brake pad coming in direct contact with disc mounted on wheel hub, brake pad is pushed against rotor with the help of piston attached in calliper. In drum brake the fluid which is present in brake lines, when brake pedal is pushed the brake oil present in master cylinder get pressurized and the transfer the pressure to brake pad with the help of brake line and piston. While comparing both the brakes in various parameter disc brake found to be more effective rather than drum brakes in terms of all the criteria which is now required for modern braking system to design

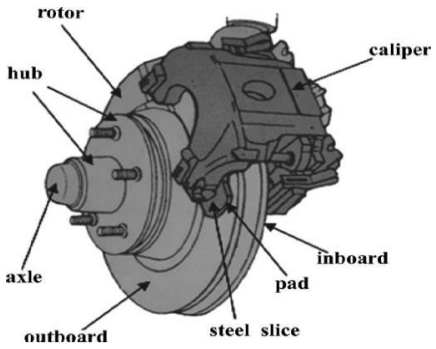


Figure-1 Assembly of disc brake

Developments in the disc brake have been the important part of research going on. Different brake pad design exist for different automotive applications. Rashid [1] give complete overview of all parts and the components used in the disc brake assembly and an idea to all the researchers for the problems and their improvements in the brake pad assembly. Belhocine et al. [2] Design plays a important role in analysis. A. Belhocine has designed three pad model which basically and these disc pad model is analyzed with the help of two approaches named mechanical and thermomechanical from this analysis various aspects had been discussed relating to stress distribution and thermal properties. Muftil Badria et al. [4] showed a work which aims at finite element simulation of thermal response and distribution of stress of palm slag brake pad composite, different brake pad model has been designed in order to investigate the various entities related to thermal and static structural. Viraj Parab et al. [3] performed the work on three rotor disc brake with different material namely cast iron, stainless steel and Carbon-Carbon Composite have been used and their analysis is performed and the result have been discussed and the best suited have been discussed by the researcher in order to have clean idea related to material and

their durability. K.Sowjanya et al. [6] had tested various composite material and their static structural analysis was performed over the rotor disc and their results were compare for various parameters subjected to deflection and stresses. The work performed by Yashvardhan singh et al. [9] on the study of thermomechanical behaviour of automotive disc brake with two brake pad profile one with simple pure pad and other with single slot design. comparison made between solid and ventilated disc.

2. MODELING OF DISC BRAKE PAD MODELS

A CREO modelling software is an astounding drawing that is growing amazing asset on account of a noteworthy helpfulness it offers. It engages an improvement of superior grade mechanical things. It empowers customers to design shapes with 3D drawing and insight features. Most importantly, its get together, drawing and system planning capacities make it very accommodating for a thing manufacturing industry.

The model for brake pad is prepared in the CREO software which is based on the assumptions and the and references which is taken from source of a literature survey. with the help of the model generated from the CREO software it is then imported to analysis software i.e. ANSYS here in the analytical software various boundary conditions related to structural and thermal are applied in order to calculate the desired result

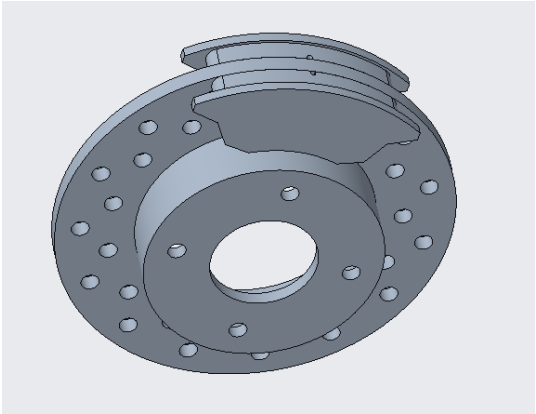


Figure-2 Assembly of brake pad model

Here in this work different brake pad geometry are designed and on the basis of that design various parameters and the results are evaluated and compare and on the basis of that best suited design is suggested a total of five designs are created.

2.1 MESHED MODEL

ANSYS provides an auto generated mesh although the sizing generated from the auto meshing is not uniform throughout, for accuracy and precision in result the meshing should be fine enough, so that the results obtained from the analysis is very much closer to the practical scenario.

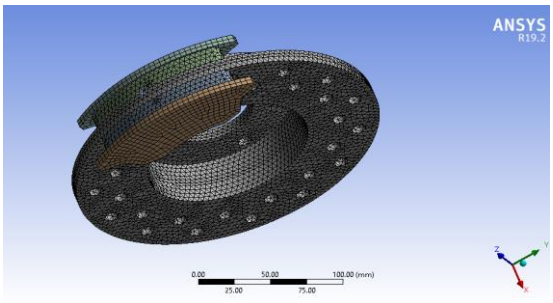


Figure-3 Meshed model of disc brake assembly

Properties	**Isotropic Material (Pad)**
Density (g/cc)	2.31
Elasticity (MPa)	12.65
Young's modulus (GPa)	2.30
Flexural modulus (GPa)	4.80
Thermal conductivity (Wm−1 K−1)	2.41
Specific heat (J kg−1 K−1)	1076

Table-1

2.2 ANSYS

Thermal analysis in ANSYS used to examine the phenomenon causing the changes in the body related to thermal and heat transfer background. Parameters such as temperature distribution, heat flux are to be evaluated, specified material holding the properties of thermal are tested and their values are obtained under different thermal boundary condition

2.3 BOUNDARY CONDITIONS

Boundary condition which are to be applied from the thermal point view are shown in the figure.

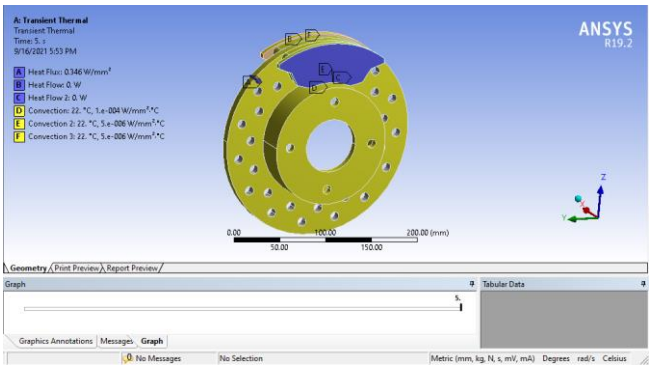


Figure-4 Applied Thermal Boundary condition in ANSYS

2.4 BRAKE PAD DESIGNS

Here in this work different brake pad geometry are designed and on the basis of that design various parameters and the results are evaluated and compare and on the basis of that best suited design is suggested a total of five designs are created.

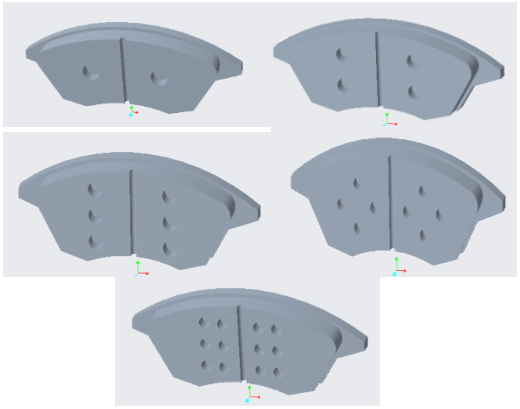
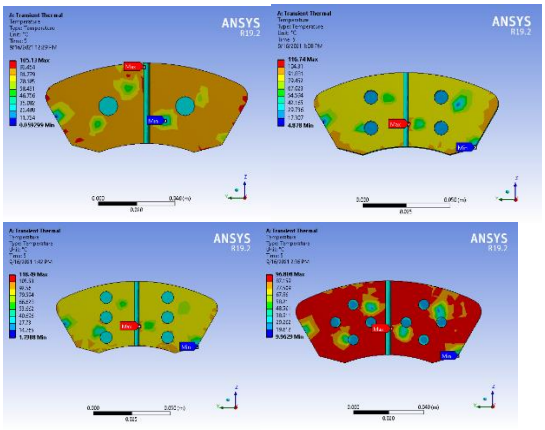


Figure-5 Different designs of brake pads

3. RESULTS

3.1 Temperature distribution in Brake pads



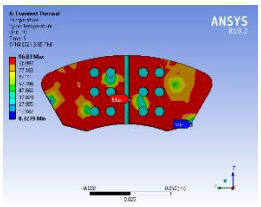


Figure-6 Different designs of brake pads

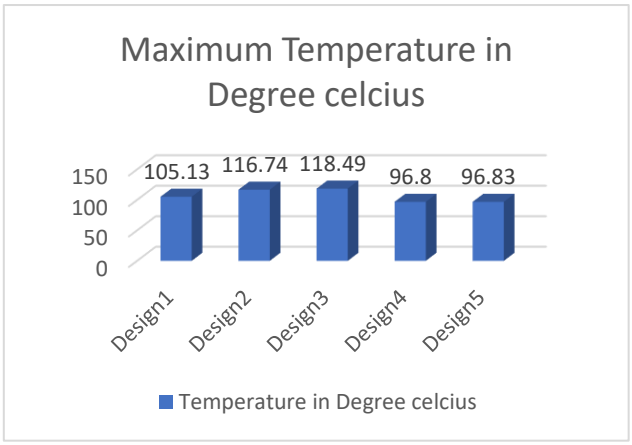


Figure-7 Maximum temperature in brake pad

3.2 TOTAL PAD DEFORMATION

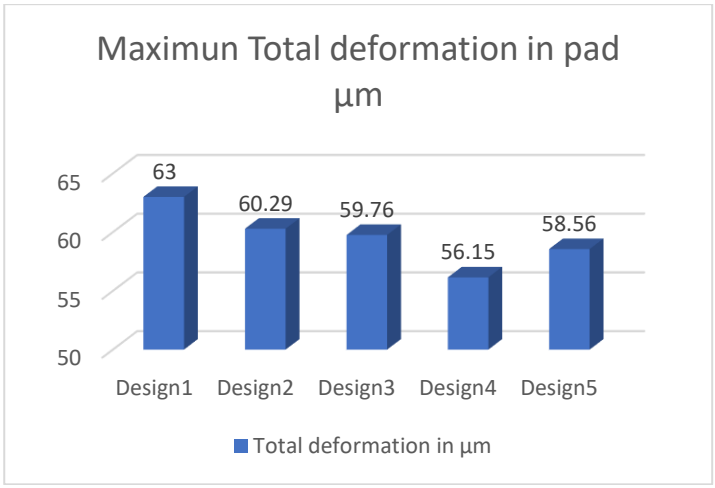


Figure-8 Maximum total deformation pads

3.3 TOTAL HEAT FLUX IN THE BRAKE PAD

Below are the results that are obtained of the total heat flux in the brake pad in design it can be clearly seen that the design has maximum value of heat flux generated. A graph is

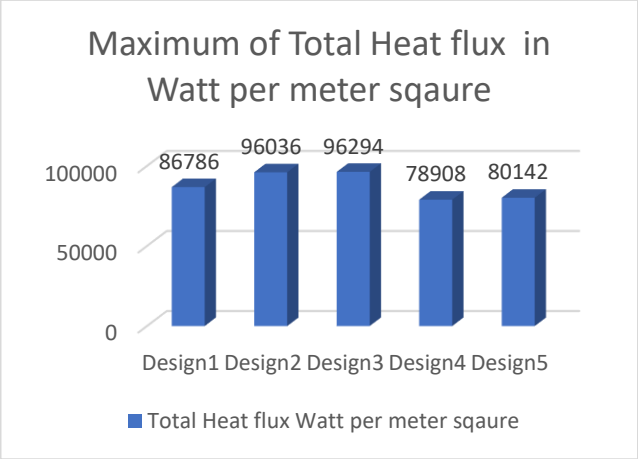


Figure-9 Maximum total heat flux in the pads

3.4 Contact Pressure

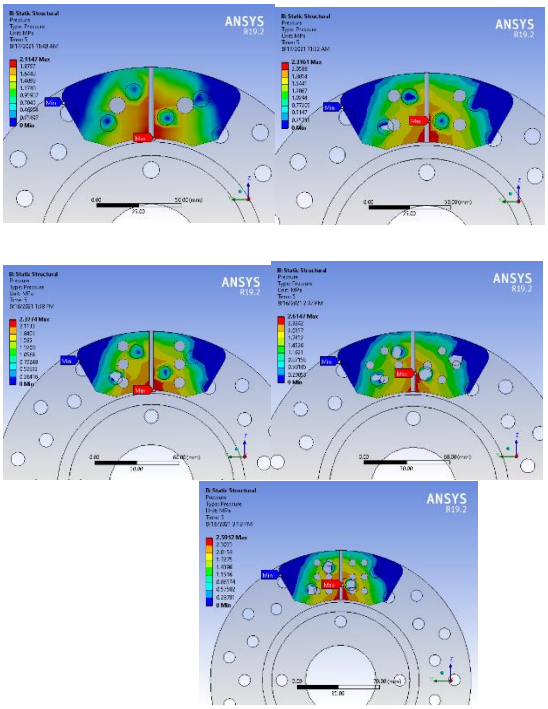


Figure 9- contact pressure of brake pads

3.5 WEAR DISPLACEMENT

Rhee's original wear formula can't be utilized in the current examination. Since mass loss, because of wear is directly linked with the displacement that happen on the rubbing of surface Rhee's wear equation is modified as,

$$\Delta h = kP^{\cdot 9}\omega rt$$

Th value of k as mentioned in the Rhee's paper

k=1.78* $10^{-13} m^3/Nm$ [7]

The value of contact pressure is maximum in the fourth design of brake pad. That is 2.6147 Mpa. The value for Δh = .015512 mm

CONCLUSION

- It is found that in the Different designs of brake pad, larger the formation always occurs at the outer radius of rotor.
- Maximum amount of heat flux is found at the center of the groove.
- Maximum temperature is found in the third designs of brake pad, whereas the lowest temperature at design number fourth.

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