Two Wheeler Disc Brake Shape Optimization for Optimization in Temperature Distribution in Disc

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Abstract— A brake is a device by means of which artificial frictional resistance is applied to moving machine member in order to stop the motion of a machine. In the process of performing this function the brakes absorb kinetic energy of the moving member and dissipate the absorbed energy in the form of heat. Brakes may be a drum type or a disc type and are operated frequently as and when needed resulting in temperature rise of the brake disc as well as brake pads leading to wear and failure of the system. One of the desired devices is a disc brake testing machine to test the average rise in temperature of brake disc surface while braking is applied frequently with a selected braking/un-braking cycle. In the present study, a disc brake test rig has been selected for design; development and testing a brake disc for temperature rise and optimize brake disc design for of a two wheeler (PULSER).

Keywords: Two Wheeler Disc Brake, ANSYS

I. Introduction

Braking system is one of the important safety components of a vehicle. Braking system is mainly used to decelerate vehicles from an initial speed to a given speed. Friction based braking systems are the common devices to convert kinetic energy into thermal energy through friction between the brake pads and the disc faces. The passenger requires high speed braking system to use the vehicle for low speed/ high speed which cannot be met with drum braking systems. Excessive thermal loading can result in surface cracking, judder and high wear of the rubbing surfaces. High temperatures can also lead to overheating of brake fluid, seals and other components. The stopping capability of brake increases by the rate at which heat is dissipated due to forced convection and the thermal capacity of the system. Hence it is necessary to develop a suitable test setup to measure disc temperature distribution under repeated braking and unbraking cycle, usually applied in practice.

II. Literature review

Daniel Das. et al. [1] have investigated the temperature fields and also structural fields of the solid disc brake during short and emergency braking with four different materials. The distribution of the temperature depends on the various factors such as friction, surface roughness and speed including effect of the angular velocity and the contact pressure induces the temperature rise of disc brake. The finite element simulation for two-dimensional model is also presented using Aluminum Alloy and Carbon Reinforced Polymer is safe for Disc Brake. It has been concluded that by observing analysis results, Carbon Reinforced Polymer is best material for Disc Brake.

Nouby M. Ghazaly et al. [2] analyzed forces and torque on the rotor disc. The main parameters are tangential force, brake torque, and the motorcycle's stopping distance. The result of force value on rotor disc by tangential force and the motorcycle's stop distance are similar. Case studies on changing the dimensions of disc did not have an effect on normal and tangential forces, but have an effect on break force.

Thundil karuppa et al. [3] simulated the three dimensional temperature distribution through the brake rotor vanes by solving the appropriate governing equations viz. conservation of mass, momentum and energy using the commercial CFD tool, ANSYS CFX 12. The predicted results have been validated with the results available in the literature.. The effect of number and diameter of vanes in the circular pillared rotor is studied and the geometry is optimized for better mass flow and heat dissipation characteristics.

Guru Murthy Nathi et al. [4] evaluated the performance under severe braking conditions and there by assist in disc rotor design and analysis. An attempt has been made to investigate the effect of stiffness, strength and variations in disc brake rotor design on the predicted stress and temperature distributions. By identifying the true design features, the extended service life and long term stability is assured. A transient thermal analysis has been carried out to investigate the temperature variation across the disc using axisymmetric elements.

III. Scope of work:

In recent decades the improvement of the braking performances are required as the two wheelers run at high speeds. The generated frictional heat, during braking operation causes several negative effects on the brake system such as brake fade, premature wear, thermal cracks and disc thickness variation. It is then important to determine the temperature field of the brake disc which will be in the safe range. The brake disc manufacturing industries are in need of a suitable test setup to test the brake disc temperature with selected braking cycle and a selected braking force including related instrumentation. It is proposed to fulfill this need.

IV. Modeling of disc brake:

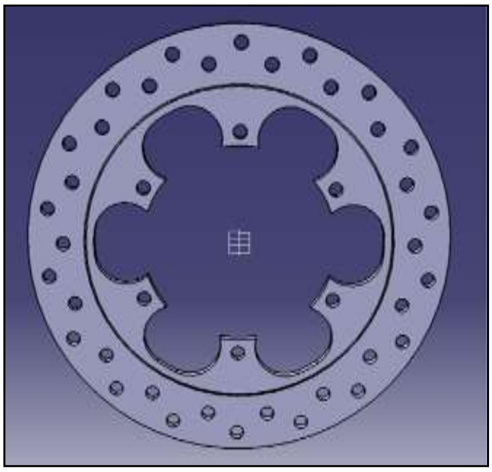

Fig. 1: Original Disc 3D model

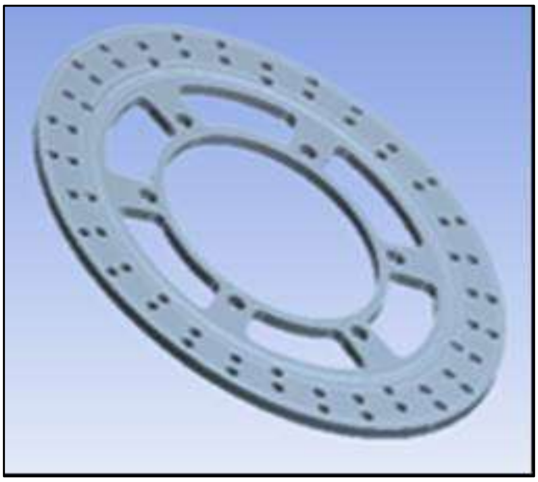

Fig. 2: New Disc brake 3D Model

V. ANALYSIS OF DISC BRAKE

A. Sample Disc 1: Nonlinear Transient Thermal Analysis Result

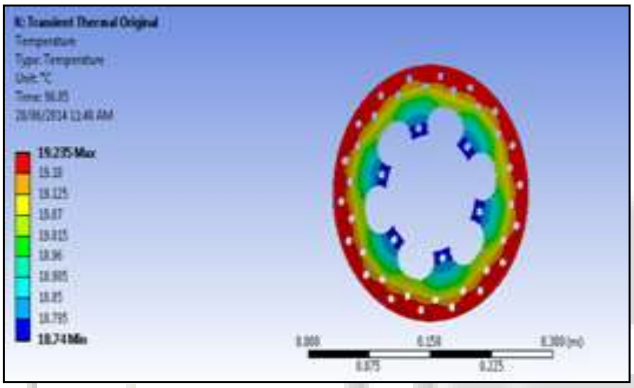

Fig. 3: Transient Thermal Analysis Result- Selected Disc (sample disc 1)

Nonlinear Transient Thermal Analysis Result of new disc

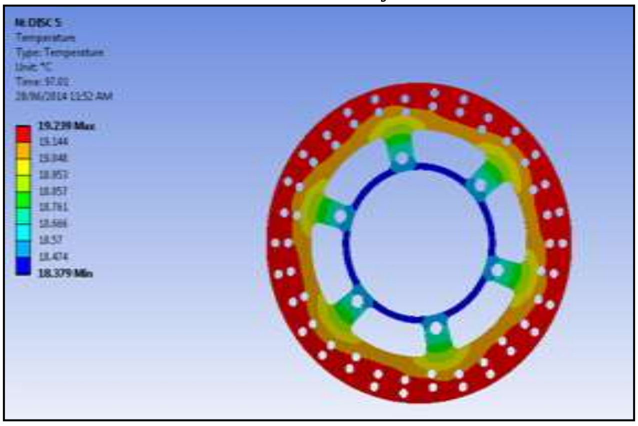

Fig. 4: Transient Thermal Analysis Result (ANSYS) of New Disc

VI. EXPERIMENTAL SET UP

Experimental set up has various sub components as shown in schematic fig. 5. In this work, C channel angle frame base contains C channels of 80×40×5 and L channels of 35×35×5. This all frame structure is welded by arc welding and formed into predefined structure. The motor of 1.5Hp is selected directly from market. This motor has a starter i.e. ON/OFF switch fixed on a channel of 25×25×3. This is coupled to shaft of length 200mm and diameter 25 mm. On this shaft, ball bearings equipped in the bearing housing of the size 25×60×150.

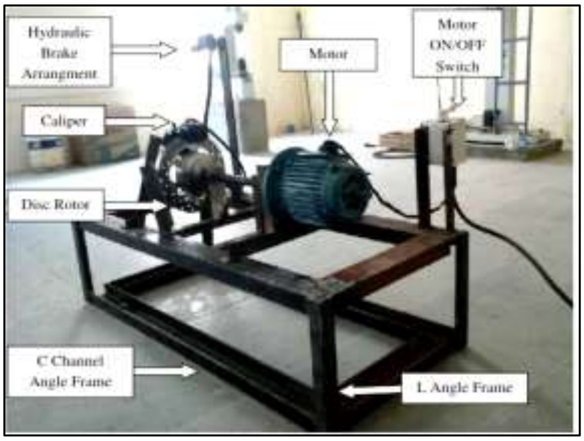

Fig. 5: Experimentation Setup

VII. TEST RESULTS AND DISCUSSION

Time	Min Temp in °C	Max Temp in °C
600	24.1	24.8
1200	31	31.3
1800	36	37.4
2400	44.212	45.188
3000	51.5	52.151
3600	58.21	58.9

Table 1: Test Results of Sample Disc 1

Time	Min Temp in °C	Max Temp in °C
600	23.15	23.9
1200	30	31.1
1800	36.44	36.952
2400	44.151	45.1
3000	51.433	52.15
3600	57.99	58.131

Table 2: Test Results of New Disc

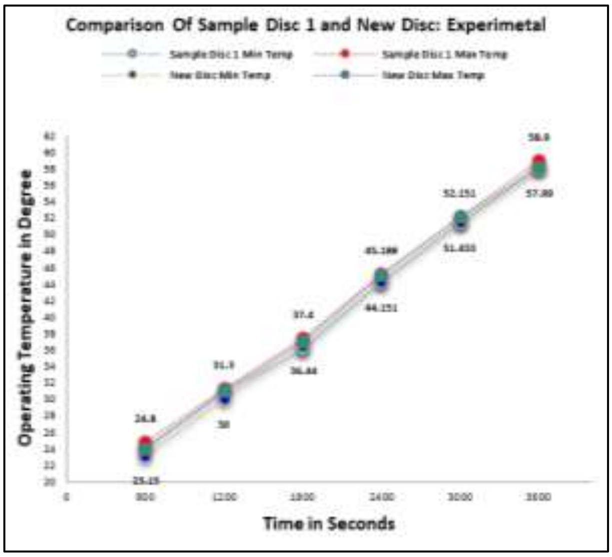

Fig. 6: Comparison of original disc and New Disc: Experimental

In this graph shows that the new disc has better results than sample original.

Result of Discs	Mass(Kg)	Remark
Sample Disc	0.98541	Good
New disc	0.95155	Very Good

Table 3: Thermal analysis result

VIII. Comparison of ANSYS and Experimental Results

The ANSYS simulated analysis should be evidences or supported by empirical results. This is achieved by comparing ANSYS results with experimental results as shown in following graph.

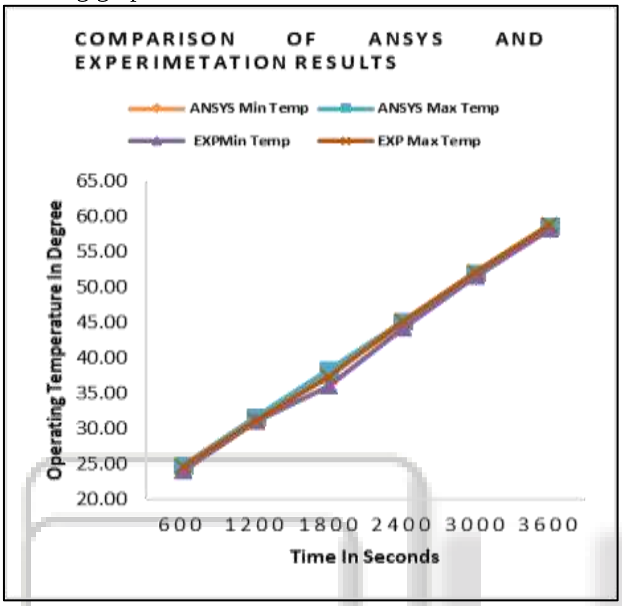

Fig. 7: Comparison of ANSYS and Experimental Results

Above graph shows a better fitment of ANSYS values with experimental observation. This shows that simulated approach is correct as compare to the practical experimentation. This shows the physical agreement to the simulation work.

IX. Conclusion

The present study can provide a useful design and improved the brake performance of disk brake system.

From the above results, it is clear that performance of new designed disc in transient thermal analysis is better and optimized in accordance with braking temperature and thermal distribution over the disc area in comparison with given set of discs.

For structural analysis, result of both computational & experimental analysis of the new brake disk evidences the safer design.

High brake force carrying capacity of new designed disc during running condition without any crakes is demonstrated well.

References

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