PERFORMANCE OPTIMIZATION AND ANALYSIS OF DISC BRAKE

[1]Prof.S.R.Durgavade, [2]Prof.P.S.Gaikwad, [3]Prof.C.S.Khemkar.
[1]Assistant Professor, [2]Assistant Professor, [3]Assistant Professor
[1]Department of Mechanical Engineering,
[1]ISB&M, School of Technology, Nande, Pune, India.

Abstract : ***These day technologies are improving. In Automotive Sector, All the technologies that developed by the engineers such as Car, luxury, and engines, the engine technologies are growing so fast. The design engineer gives preference for safety measure, but most of the consumers are have a lack of knowledge of safety system. So this is the most important area in which we can do focus. This paper is presents with "Performance optimization and analysis of disc brake" which studies, do analysis and optimize the performance of the modified brake discs. So to optimize the performance of the disc brake, we can modify the number of shapes of a disc. In this paper, the modeling and analysis are done on the brake disc of bajaj pulsar 220.The different modified shapes are used for the modeling and analysis. To optimize the weight and to get good thermal conductivity we must modify the shape of the disc. This paper will help everyone to study and understand performance optimization of brake disc and how this modified disc brake works more efficiently, this will help to increase the safety of the rider & reduce the chances of the accident.***

IndexTerms - Disc Brakes, Disc modeling, Analysis of the disc, optimization, slotting.

I INTRODUCTION

While braking, there is an increase in temperature as there is a conversion of kinetic energy into thermal energy.This project consists of thermal stress analysis on Pulsar 220 brake disc for transient condition and steady state. The heat dissipated along the brake disc surface during the periodic braking by three modes conduction, convection and radiation. So as to get the stable and accurate result of time step selection and element size is very important and all of these aspects are discussed in this paper. The finding of this research gives a useful design tool to improve the performance of disc brake.

II LITERATURE SURVEY

To stop the motion of the moving machine the artificial frictional resistance is applied By means of Brake.The disc is selected for investigation of the effect of strength variation on the pre-defined the stress distribution area as it is made of cast Iron. The composite materials are to be selected for such as Aluminum metal matrix and then analyzed. The solid modeling if brake disc is created by using Pro/E (Creo-Parametric 1.0). After that by using ANSYS structural analysis is done to find out the deflection, Von-misses stress and Normal stress. [1]

The surface roughness, friction and speed decide the Distribution of temperature. Due to an influence of the contact pressure and angular velocity, there is temperature rise occurs. The two-dimensional model was selected for the finite element simulation because of constant distribution of heat flux in circumferential area. The lower values of the friction contact power, nodal displacement, deformation and temperature for various pressure conditions using analysis software with different materials like Carbon fibred reinforced plastic, aluminum, cast steel and cast iron. Now days brake discs are made up of cast steel and cast iron. We can do select the best value material from calculated values of the material for the higher life span of drum used in the braking system. [2]

This work report "Force and friction on brake disc analysis" concludes that, the efficiency of the disc brake can be estimate by studying the analysis of the shear force, piston force, and normal force. [3]

This study is done on disc brake used in cars. ANSYS is used for the find out the deformation, temperature distribution, and variation of stresses along the profile of brake disc. In this report, According to predicted stress and temperature, the strength, variation in disc design and stiffness was investigated. The assurance of the long term stability and the extended service life can be given by the best design features. By using axis symmetric elements the temperature variation across the disc is find out in Transient thermal analysis. To evaluate and study the performance in severe braking situation Thermal and structural analysis is carried out. This is done to find out the best combination of flange width and material brake disc, which gives minimum von-mises stress, less deformation and low temperature distribution. [4]

To know the behavior of temperature on disc brake and the worst scenario of the transient response and steady state has been done through heat transfer analysis. In this work the behavior of brake disc and the temperature distribution is identified in transient response and steady state analysis by using finite element analysis. Ansys give the thermal analysis in both responses. Which improves the performance of the brake disc and also it helps to industry to develop effective and optimum brake disc.[5]

III PROBLEM DEFINITION

Due to the application of brakes on the brake disc, heat generation takes place due to friction and this temperature is distributed along the boundaries of the existing disc due to this the high temperature and low temperature region is created near by the edge of the disc, which causes the distortion of the material.

IV OBJECTIVES

1)To increase stability and rigidity of existing disc (for this structural Analysis and coupled Thermal analysis is carried out).
2)Suggesting the best combination of parameters of brake disk like, wall thickness and material.
3)Design of the disc for a disc brake system using structural analysis and thermal analysis using Ansys 14.5.
4)Determination of Heat absorption and dispersion.

5)Reduction of weight and cost.
6)Increase pad and rotor life

V DISC BRAKE STANDARD INPUT PARAMETER

In this work study standard of bicycle name "Bajaj Pulser 220"
Rotor disc dimension = 250 mm. (250×10^{-3} m)
Material used for rotor disc = grey cast iron

Pad brake area = 2000 mm2 (2000×10^{-6} m)
Material used for brake pad = Asbestos.

Coefficient of friction (Wet) = 0.08-0.12
Coefficient of friction (Dry) = 0.2-0.5
Maximum temperature = 250 ºC
Maximum pressure = 1 MPa (10^6 Pa)

Original Model of Bajaj Pulser 220

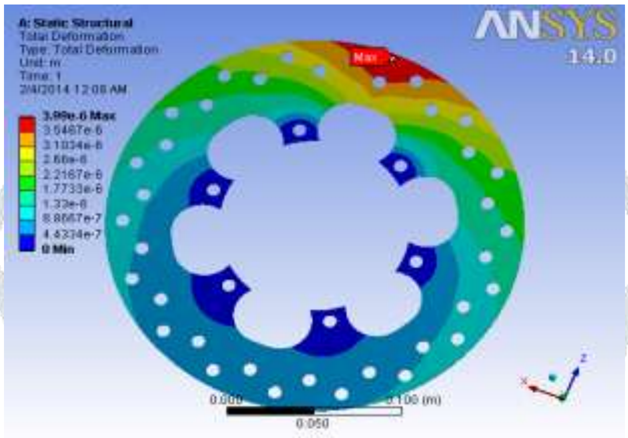

Fig. 1 Disc brake rotor deformation.

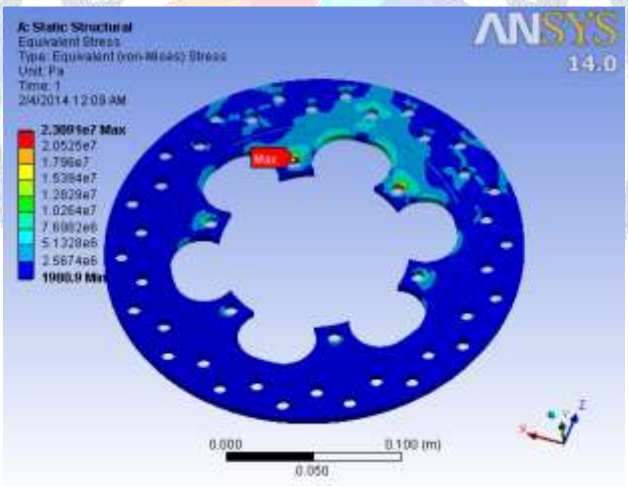

Fig. 2 original disc brake rotor due temperature at 250 ºC, showing total deformation.

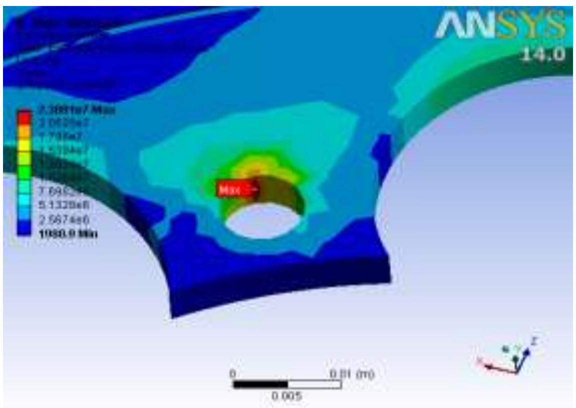

Fig. 3 Enlarged view of Disc Brake Rotor near the hole with on-misses stresses.

Fig.2 & Fig. 3 showing original disc brake rotor due temperature at 250 ºC, with occurrences of Von-misses stresses.

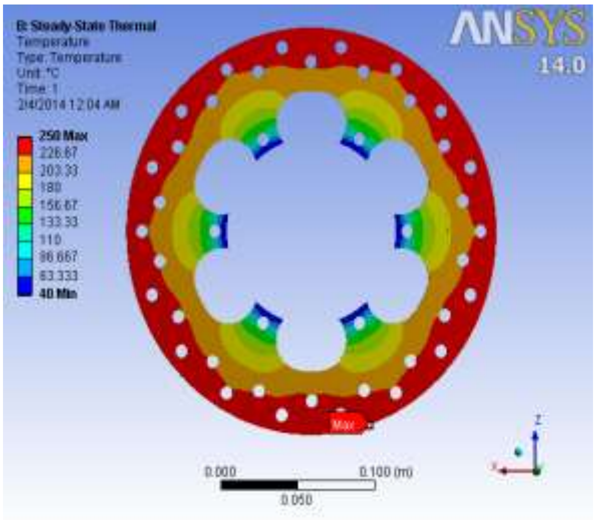

Fig. 4 Thermal analysis of Disc Brake Rotor(Steady State). shows Thermal analysis of original disc brake rotor at 250 ºC temperature (Steady State).

RESULT OF DISC BRAKE ROTOR

Table No.-1 Analysis Result of Disc Brake Rotor

Sr. No	**Max. Temp.**	**Max. Deformation**	**Max.Von-misses stress**
1	250 ºC	3.99×10^{-6} m	2.30×10^{7} Pa

Modified Shape Model-1

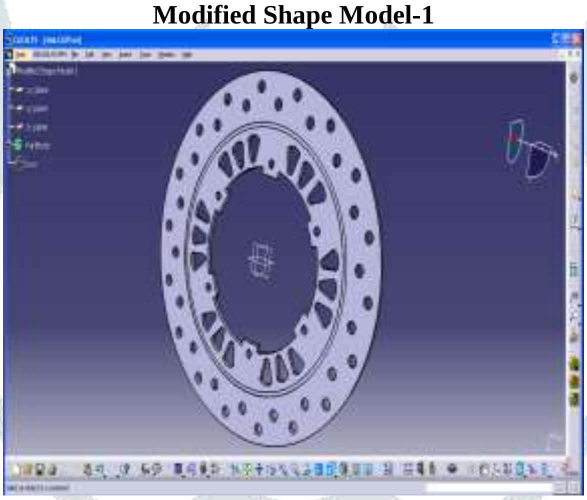

Fig. 5 Modification in previously Modified Shape Model-1 of Disc Brake Rotor shows Modification in of previously Modified Shape of Disc with slots done in CATIA

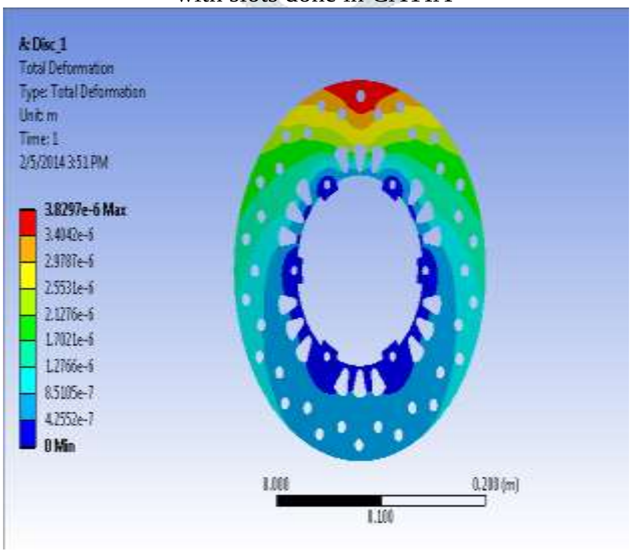

Fig. 6 Modified Shape Model-1 with total deformation. shows Modified Shape Model-1 of disc brake rotor due temperature at 250 ºC with total deformation occurred.

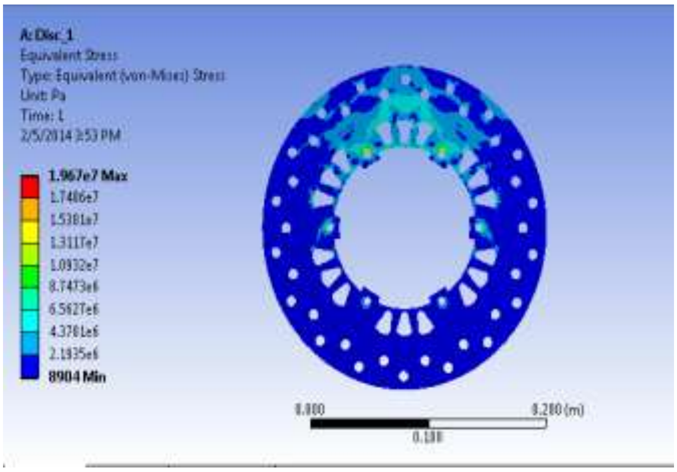

Fig. 7 Modified Shape Model-1with Von-misses stress. shows Modified Shape Model-1 disc brake rotor due temperature at 250 ºC Von-misses stresses occurred.

Modified Shape Model-2

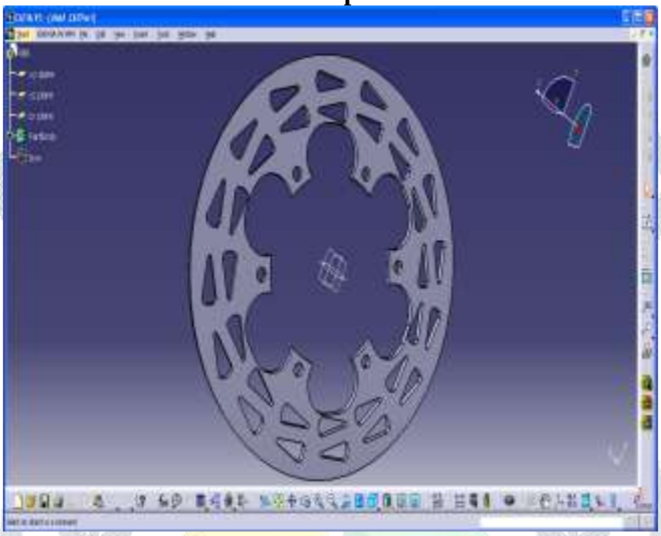

Fig. 8 Modification of Modified Shape Model-2 of Disc Brake Rotor shows Modification of Modified Shape of Disc Brake Rotor with slots done in CATIA

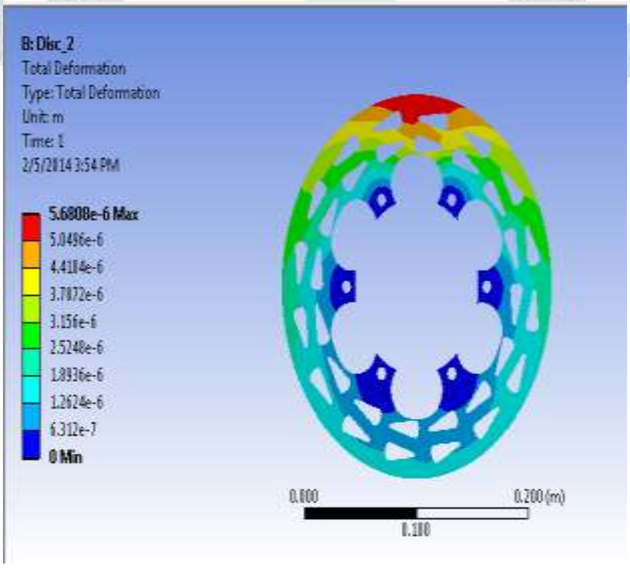

Fig. 9 Modified Shape Model-1with total deformation
shows Modified Shape of Model-2 of disc brake due to the temperature at 250 ºC with total deformation occurred.

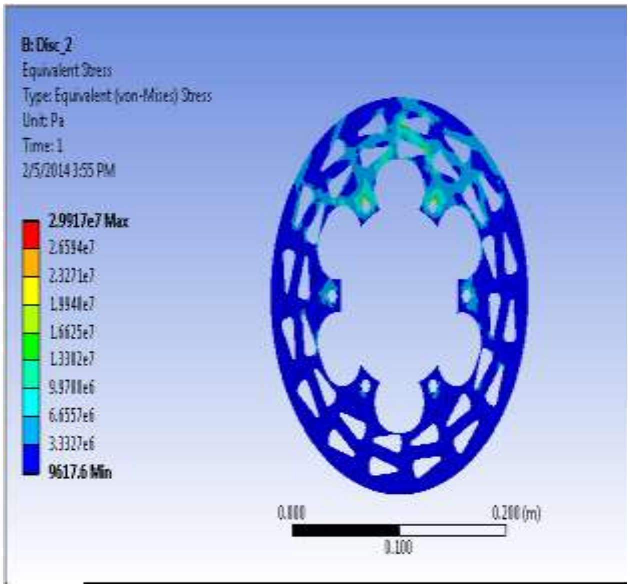

Fig. 10 Modified Shape Model-2, with Von-misses stress.

shows Modified Shape Model-2 disc brake rotor due to the temperature at 250 ºC with Von-misses stress occurred.

Modified Shape 3

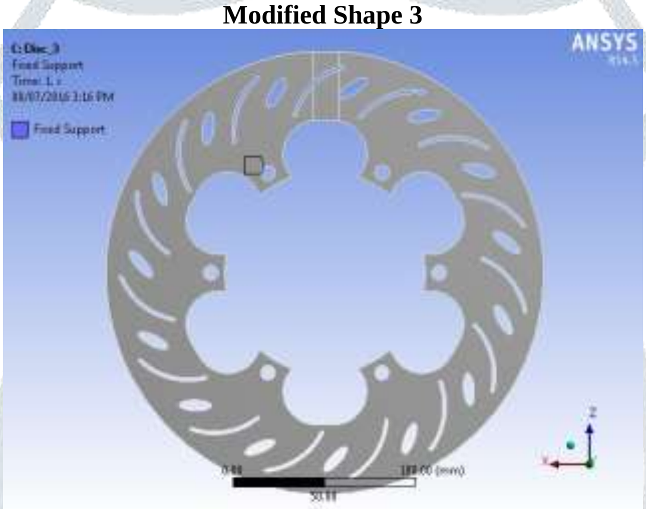

Fig. 11 Modification of Modified Shape Model-3 of Disc Brake Rotor shows Modification of Modified Shape of Disc Brake Rotor with slots done in CATIA

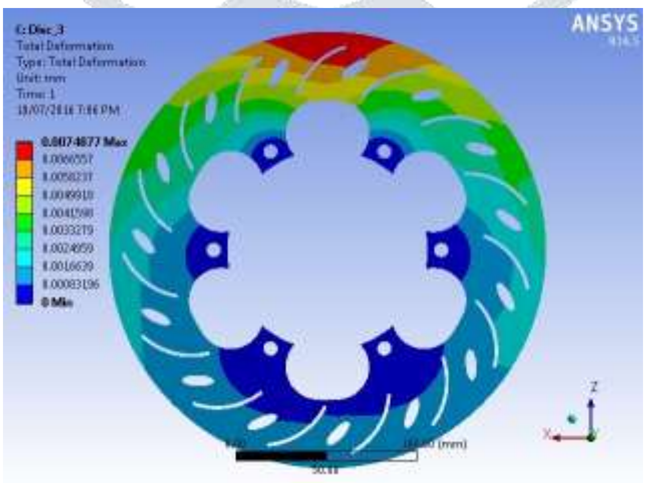

Fig. 13 Modified shape Model-3 with total deformation. shows Modified Shape of Model-3 of disc brake due to the temperature at 250 ºC with total deformation occurred.

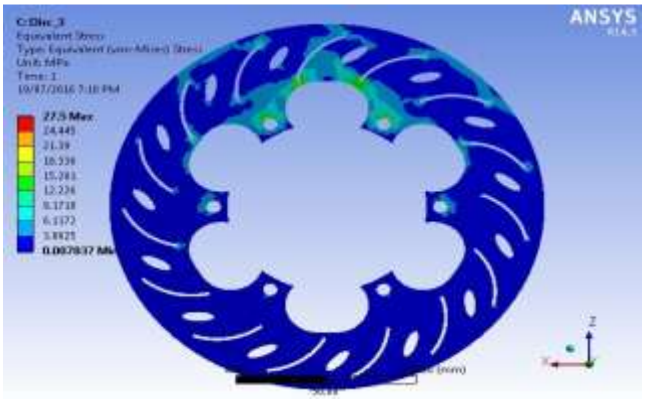

Fig. 14 Modified Shape Model-3, with Von-misses stress. shows Modified Shape Model-3 disc brake rotor due to the temperature at 250 ºC with Von-misses stress occurred.

Modified Shape 4

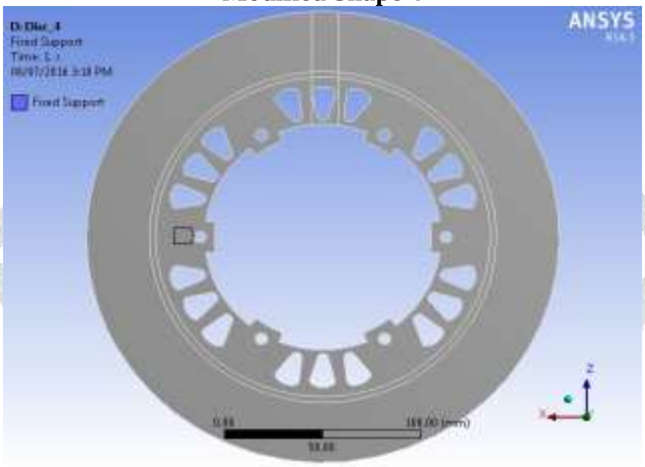

Fig. 15 Modification of Modified Shape Model-4 of Disc Brake Rotor shows Modification of Modified Shape of Disc Brake Rotor with slots done in CATIA

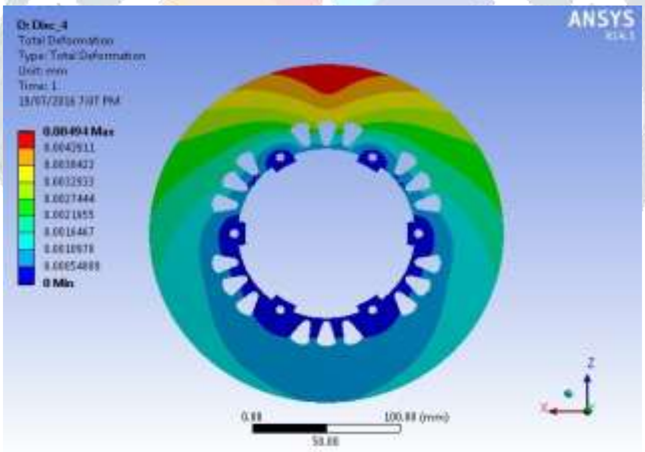

Fig. 16 Modified shape Model-4 with total deformation. shows Modified Shape of Model-4 of disc brake due to the temperature at 250 ºC with total deformation occurred.

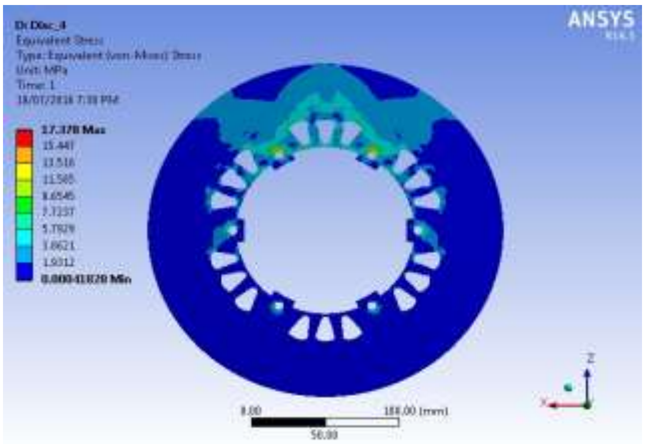

Fig. 17 Modified Shape Model-4, with Von-misses stress.
shows Modified Shape Model-4 disc brake rotor due to the temperature at 250 ºC with Von-misses stress occurred.

Modified Shape 5

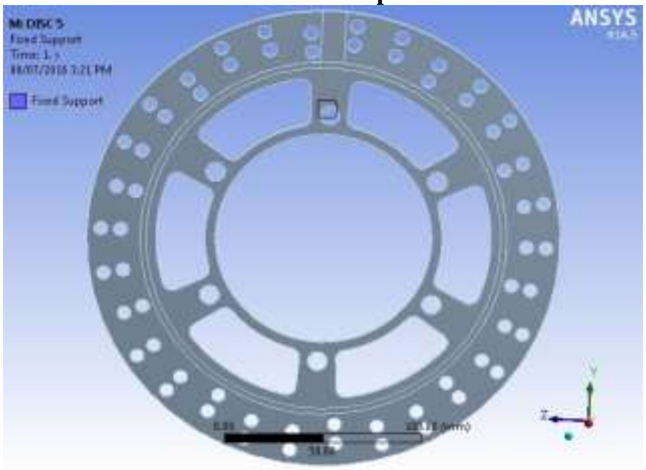

Fig. 18 Modification of Modified Shape Model-5 of Disc Brake Rotor shows Modification of Modified Shape of Disc Brake Rotor with slots done in CATIA

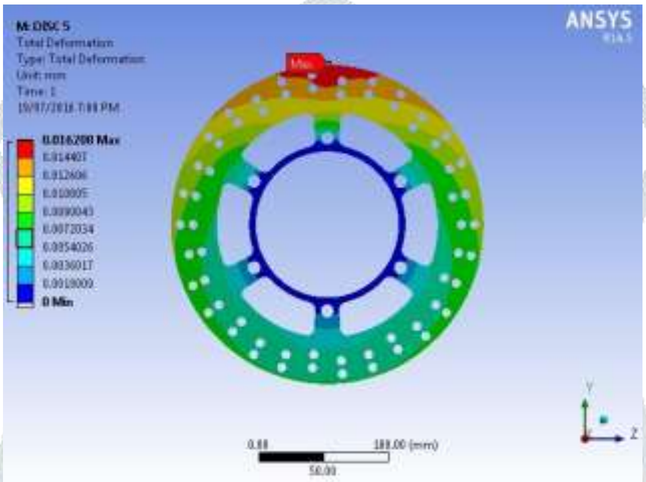

Fig. 19 Modified Shape Model-5 with total deformation

shows Modified Shape of Model-5 of disc brake due to the temperature at 250 ºC with total deformation occurred.

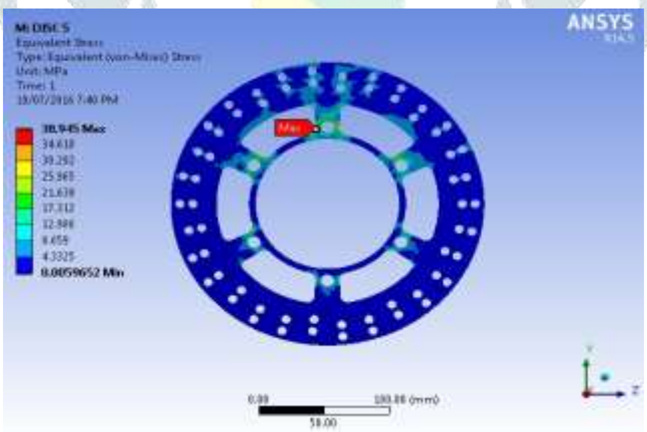

Fig.20 Modified Shape Model-5, with Von-misses stress. shows Modified Shape Model-5 disc brake rotor due to the temperature at 250 ºC with Von-misses stress occurred.

VIRESULT TABLE

Table No.-2 Properties of materials used for disc

Disc Name	Material Used	Young's Modulus N/mm^2	Ultimate Tensile Strength MPa	Compressive Ultimate Strength MPa	Poisson's Ratio	Density kg/mm^3
Original Disc	Cast Iron	$1.52 X 10^6$	304	910	0.211	$7.4 X 10^{-6}$
New Disc 1	Grey Cast Iron	$1.1X 10^6$	240	820	0.28	$7.2 X 10^{-6}$
New Disc 2	Grey Cast Iron	$1.1 X 10^6$	240	820	0.28	7.2 X 10-6

New Disc 3	Grey Cast Iron	1.1×10^6	240	820	0.28	7.2 X 10-6
New Disc 4	Grey Cast Iron	1.1×10^6	240	820	0.28	7.2 X 10-6
New Disc 5	Grey Cast Iron	1.1×10^6	240	820	0.28	7.2 X 10-6

Table No.-3 Outcome of Modified Shape Models & original Disc Brake Rotors.

Sr.No	**Maximum Stress MPa**	**Minimum Stress Mpa**	**Deflection (mm)**
Original Disc	19.083	0.00971	0.0036951
New Disc 1	18.932	0.009316	0.0053748
New Disc 2	29.814	0.010856	0.010292
New Disc 3	27.5	0.007837	0.0074877
New Disc 4	17.378	0.00041828	0.00494
New Disc 5	38.945	0.0059652	0.016208

VII EXPERIMENTATION

The modified test models can be physically manufactured and tested on the designed test bench having, and total disc brake assembly mounted on it. The best outcome rotor is to be mounted on the shaft of motor fitted with the test bench. The test can be carried out at various speeds and results are to be analyzed.

Fig 21 Setup for the testing of Disc

Table No.-4 maximum Temperature In steady state and Transient analysis

Sr. No.	**Disc**	**Max. Temperature by Steady state**	**Max. Temperature by Transient state**
1	Original Disc	250	86.405
2	New Disc 1	250	85.036
3	New Disc 2	250	85.635
4	New Disc 3	250	83.021
5	New Disc 4	250	82.064
6	New Disc 5	250	80.543

Table No.-5- Temperature variation in Disc 5 by Analytical and Experimental Method.

Time duration (S)	**Temperature in Degrees**	
	Ansys Results	**Experimental**
600	32.037	29.26
1200	41.76	40.48
1800	51.457	47.89
2400	61.153	54.87
3000	70.848	69.72
3600	80.543	79.45

Table No.-6 Measured Weight of Disc

Result of Discs	Mass (Kg)	Remark
Original disc	0.98541	Good
New disc 5	0.87276	**Very Good**

VIII CONCLUSION

For derived result from the modification and analysis of disc brake, we can conclude that modification shape 5 is the best outcome for using as rotor disc in a disc brake. Also the weight of the disc is reduced by 0.11265 kg.

IX FUTURE SCOPE

1) All shape analyzed for Static Thermal analysis.
2) Optimized shape can be concluded on the practical model for Thermal analysis.

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