INTERNATIONAL JOURNAL OF RESEARCH IN AERONAUTICAL AND MECHANICAL ENGINEERING

ISSN (ONLINE): 2321-3051

Vol.3 Issue.3,

March 2015.

Pgs: 52-60

Optimization of Disc Brake Rotor with Modified Shape

R. S. Kajabe[1], R.R.Navthar[2]

[1]*Mechanical Engg, PVVP COE, A.Nagar (kajabe.rahul@gmail.com)*

[2]*Mechanical Engg, PVVP COE, A.Nagar (ravi_navthar@gmail.com)*

ABSTRACT:

This work is presented with "Design of disc brake with modified shapes" which studies about on disc brake rotor by modeling & analysis of different shapes of slots of different vehicle's disc brake rotor with same outer diameter & inner mounting position of holes on wheel hub as like Bajaj Pulsar 150.Analysis done on real model of disc brake rotor of Bajaj pulsar 150 and disc brake rotor of different shapes of slots of different vehicle's disc brake rotor. Therefore, it gives optimize stress, deformation & weight of the modified disc brake rotor & also good heat dissipation. On the basis of weight parameter implementation of new disc brake rotor is done. Hopefully this project will help everyone to understand experimental verification of disc brake rotor and how implemented disc brake works more efficiently, which can help to reduce the accident that may happen in each day

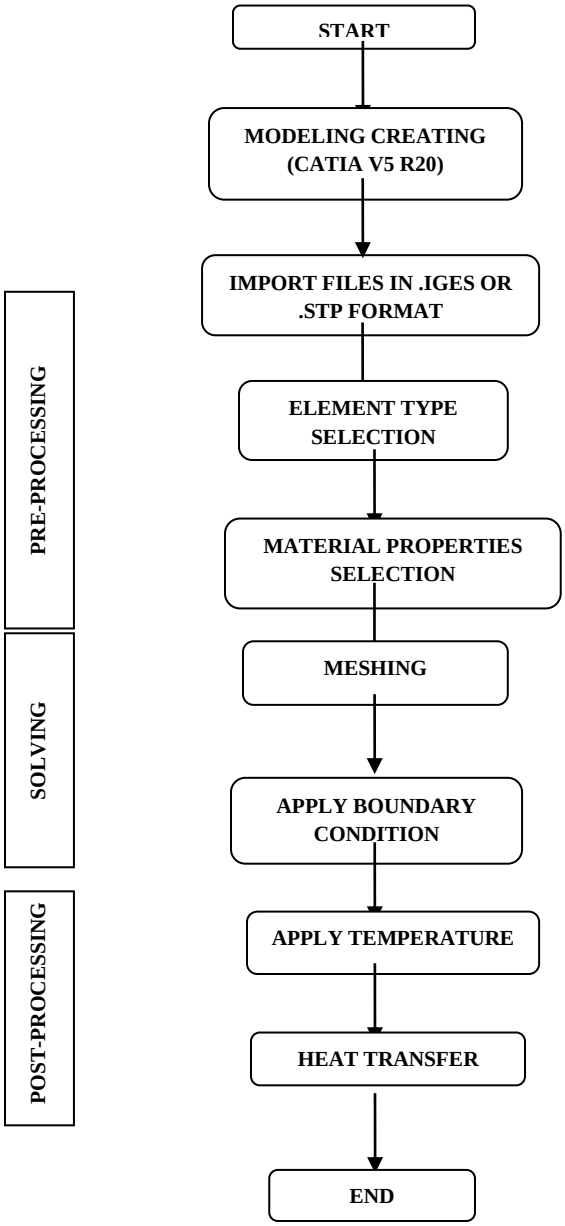
Keywords- Disc brake, optimize, slots, heat dissipation, experimental verification.

1. Introduction

In this project we study about disc brake rotor analysis of different shapes of slot. Static structural and steady state thermal analysis is done on real model of disc brake rotor of Bajaj Pulsar 150ccDTSi and also on different shapes of disc brake rotor with keeping same outer diameter and inner mounting position of hole on wheel hub. Different shapes of slots are to modify the von mises stresses, deformation & weight of disc rotor as well as good heat dissipations across the disc brake rotor. Therefore, we can optimize number of shapes to estimate the optimum von mises stresses, deformation & weight the in disc brake rotor.

The knowledge gained from this project is to be able to understand the steps needed in structural &thermal analysis of disc brake rotor by using FEA method. The methods used in this project can later be used in future as reference for similar research and development .The disc brake rotor could be studied on the various areas such as material improvement on the disc brake rotor, vibration on the disc brake, noise and squeal of the disc brake and thermal stress analysis on the disc brake rotor. Hopefully this project will help everyone to understand structural and thermal analysis of disc brake rotor of modified shapes and how disc brake works more efficiently, which can help to reduce the accident that may happen in day to day life.

2. Finite Element Method (Thermal Analysis)



INTERNATIONAL JOURNAL OF RESEARCH IN AERONAUTICAL AND MECHANICAL ENGINEERING

ISSN (ONLINE): 2321-3051

Vol.3 Issue.3,

March 2015.

Pgs: 52-60

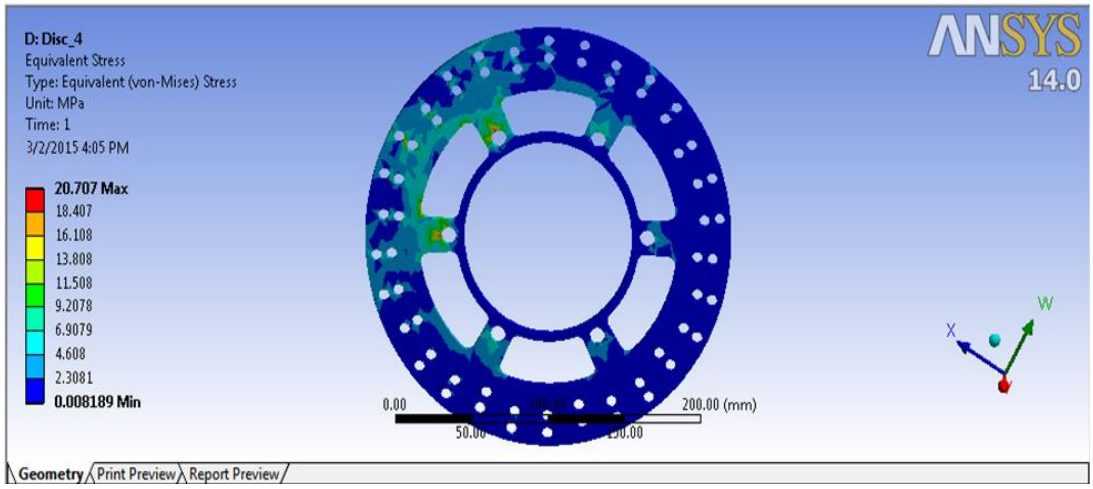


Fig.2.1 Stress distribution on modified shape 4 disc brake rotor

The Von Mises stresss distribution over the disc brake due the friction force is shownin Fig.2.1.The maximum stresses generates near the mounting holes and its magnitude is 20.707 MPa

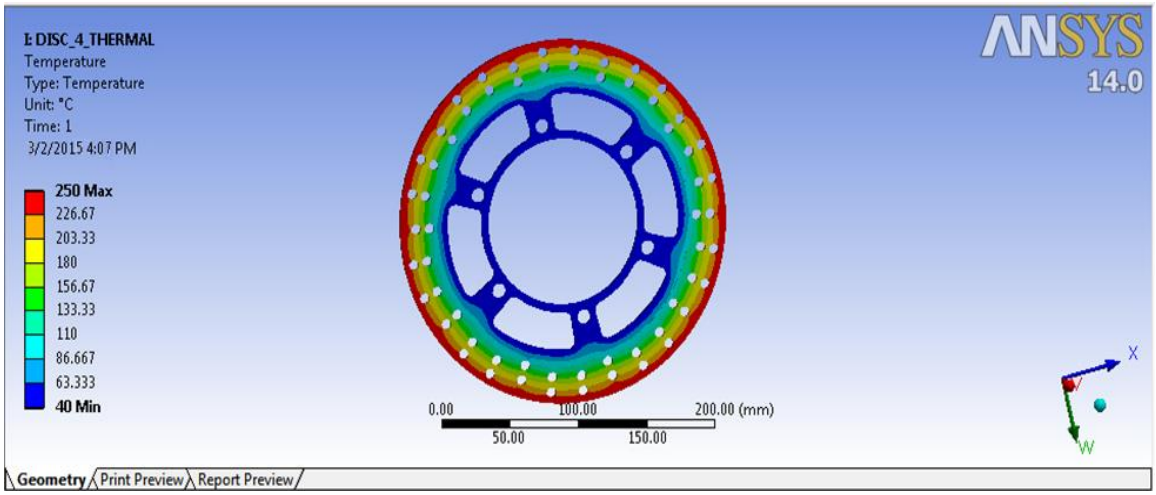


Fig 2.2 Temperature distribution on modified disc brake rotor 4

Fig.2.2 shows temperature distribution on modified disc brake rotor 4. The red colour indicates maxiumum temperature and it is obtained about 250 ºC& the blue colour indicates minimum temperature and it is obtained about 40 ºC.

INTERNATIONAL JOURNAL OF RESEARCH IN AERONAUTICAL AND MECHANICAL ENGINEERING

ISSN (ONLINE): 2321-3051

Vol.3 Issue.3,

March 2015.

Pgs: 52-60

3. Experimental Setup & Result:

Disc is rotating at constant rpm due the motor arrangement. Brake is applied periodically to reduce or to stop the disc. While applying the break the friction is takes place between the disc and friction pad. These friction forces resist to the motion of disc, due to the friction between the disc and friction pad heat is generated in the disc and it distribute over the disc.

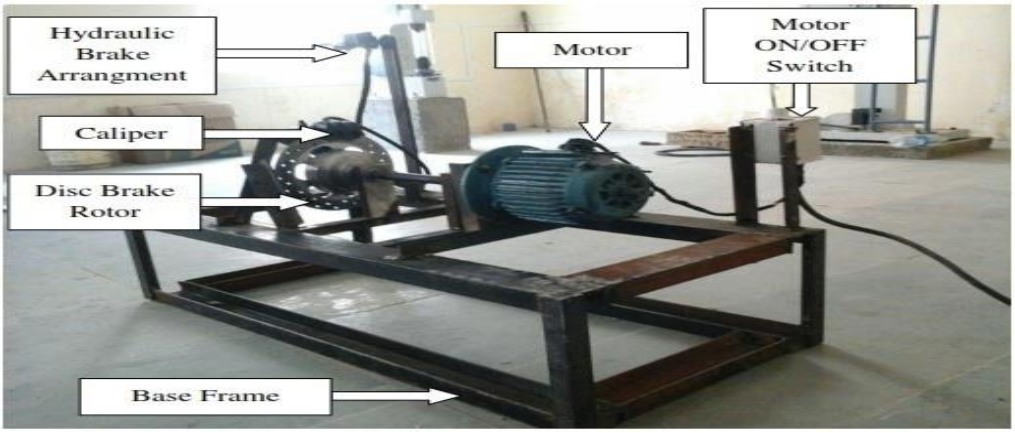


Fig 3.1Experimental Setup

The temperature at various locations is measured periodically by the non-contact type sensor such as infra-red sensor. The speed of the vehicle travel and consequently of the air circulation. Since the process of heat transfer by radiation is not too important but heat generated in the disc is dissipated by the conduction as well as convection mode of heat transfer.

Software Results

The highest stresses & deformations are reached at the contact surface disc pads. The rise in stresses & deformation is due to change in shape of disc brake rotor. For the four types of discs with original disc brake rotor, one notice that changes occurs in stresses, deformation & weight.

Table No.3.1 Results of Von mises, Deformation, Weight

Sr. No.	Disc Brake Rotor	Von-Mises Stresses (MPa)		Deformation (m)		Weight (Kg)
		Max.	Min.	Max.	Min	
1	Original disc brake rotor	19.083	0.00971	$3.695*10^{-3}$	0	1.052
2	Modified shape 1 disc brake rotor	19.67	0.00890	$3.829*10^{-3}$	0	1.15

3	Modified shape 2 disc brake rotor	15.291	0.022301	$3.730*10^{-3}$	0	1.207
4	Modified shape 3 disc brake rotor	27.456	0.009036	$5.3427*10^{-3}$	0	1.026
5	Modified shape 4 disc brake rotor	20.707	0.008189	$5.6881*10^{-3}$	0	0.954

For cast iron components, ultimate tensile strength is considered to be the failure criteria. Failure occurs when the maximum stress in the component due to external force exceed the ultimate tensile strength even once. Cast iron components have a non homogeneous structure. To account for these factors, a large factor of safety, usually 3 to 5, based on ultimate tensile strength is used.

The effects of the friction material properties on the contact ratio of friction surfaces are examined and the larger influential properties are found to be the thermal expansion coefficient and the elastic modulus. From Table 3.1 we can say that modified shape 4 disc brake rotor is the suitable shape for the braking operation and all the values of weight obtained from the analysis are less than original disc brake rotor & also has allowable strength. Hence the brake disc design is safe based on the strength and rigidity criteria. Therefore maximum heat dissipation modified shape 4 disc brake rotor the best possible disc brake rotor for the present braking application

Steady state temperature Results.

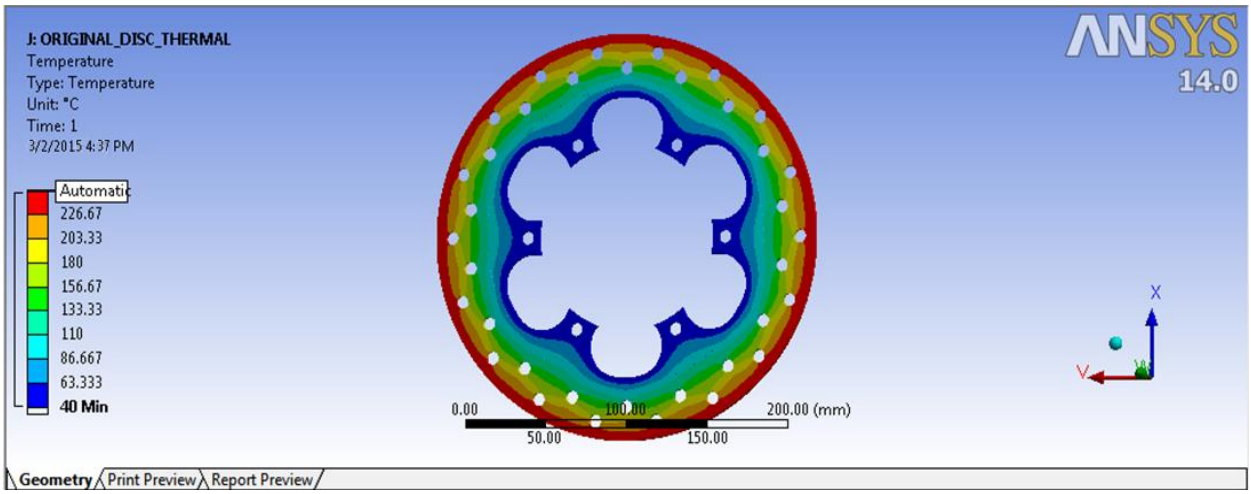


Fig.3.2 Steady state Temperature of original disc brake rotor

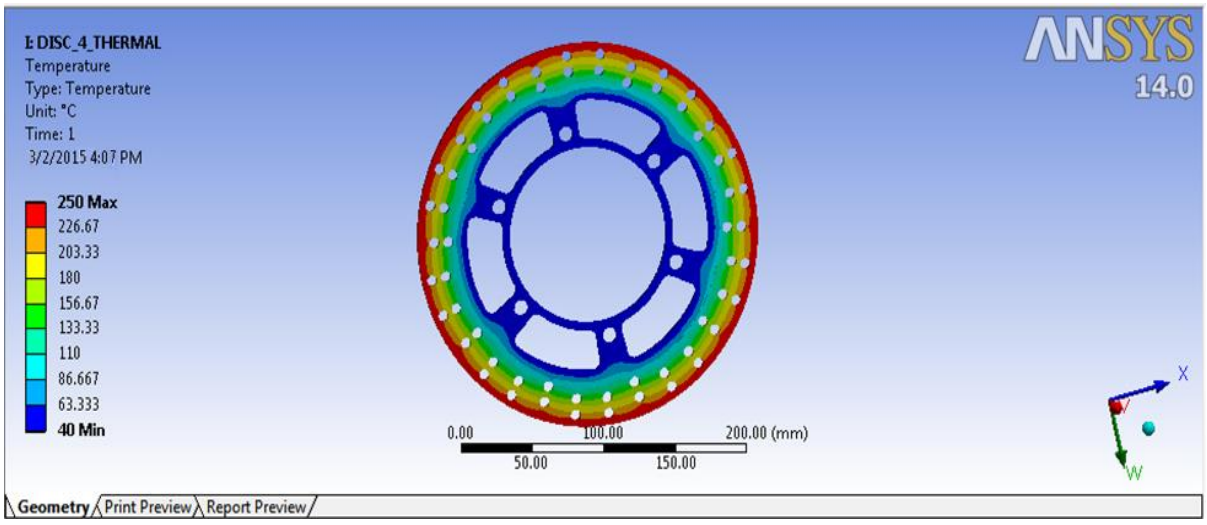


Fig.3.3 Steady state Temperature of modified shape 4 disc brake rotor

Fig. 3.2 & Fig 3.3 indicates the temperature distribution across the disc brake rotor with various region-wise diameter which decreases from outer diameter to mounting position holes of disc brake rotor on wheel hub i.e maximum temperature occurs at outer side due to friction between friction pad and disc brake rotor

Experimental Result:

From the software results on the criteria of strength & weight modified shape 4 disc brake rotor gives optimum results in term of stress & deformation so modified shape 4 disc brake rotor is selected for experimental validation of steady state temperature distribution.

It is not possible to measure the temperature of the disc which is mounted on bike. Hence need to make the set up which gives the actual condition as bike. Hydraulic brake arrangement with caliper set on the disc brake rotor. Temperature measuring set up mount the disc on the frame and gives it rotation by the motor with 960 rpm with constant speed. Experiment test takes on both disc brake rotors i.e. original & modified shape 4 disc brake for an hour applying brake periodically & temperature measurement is taken after 1 hour and notices that temperature of both disc brake rotor Region-wise diameters. During experiment maximum temperature of original & modified shape 4 disc brake rotor could not go beyond 115 ºC & 107.2 ºC respectively, because frictional heat escapes in the air ambient by convection and radiation. The thermal analysis precise determination of the quantity of heat friction produced and as well as the distribution of this energy between the disc and the brake lining. During an emergency braking, all the heat produced with the interface is equal to the heat absorbed by the disc and the brake lining. At the time of braking process, a part of the consequently, the determination of the heat transfer coefficients is essential. Their exact calculation is however rather difficult, because these coefficients depend on the location and the construction of the braking system, the speed of the vehicle travel and consequently of the air circulation. Since the process of heat transfer by radiation is not too important.

Table No. 3.2 Result of original disc brake rotor

Sr. No.	Region-wise diameter (mm)		Software Result (Average Temp. in ºC)	Experimental Result (Average Temp. in ºC)
	Region	Diameter		
1	I	240-220	238.33	115
2	II	220-200	191.67	88.3
3	III	200-180	145	66.7
4	IV	180-170	98.33	43.2
5	V	170-110	51.67	25

Table No. 3.2 shows the variation in temperature distribution by region-wise diameter according to software & experimental results in original disc brake rotor.

Table No.3.3Result of modified shape 4 disc brake rotor

Sr. No.	Region-wise diameter (mm)		Software Result (Average Temp. in ºC)	Experimental Result (Average Temp. in ºC)
	Region	Diameter		
1	I	240-220	226.66	107.2
2	II	220-200	168.33	81.3
3	III	200-180	110	59.4
4	IV	180-170	75	39.2
5	V	170-110	51.66	24.9

Table No. 3.3 shows the variation in temperature distribution by region-wise diameter according to software & experimental results in modified shape 4 disc brake

INTERNATIONAL JOURNAL OF RESEARCH IN AERONAUTICAL AND MECHANICAL ENGINEERING

ISSN (ONLINE): 2321-3051

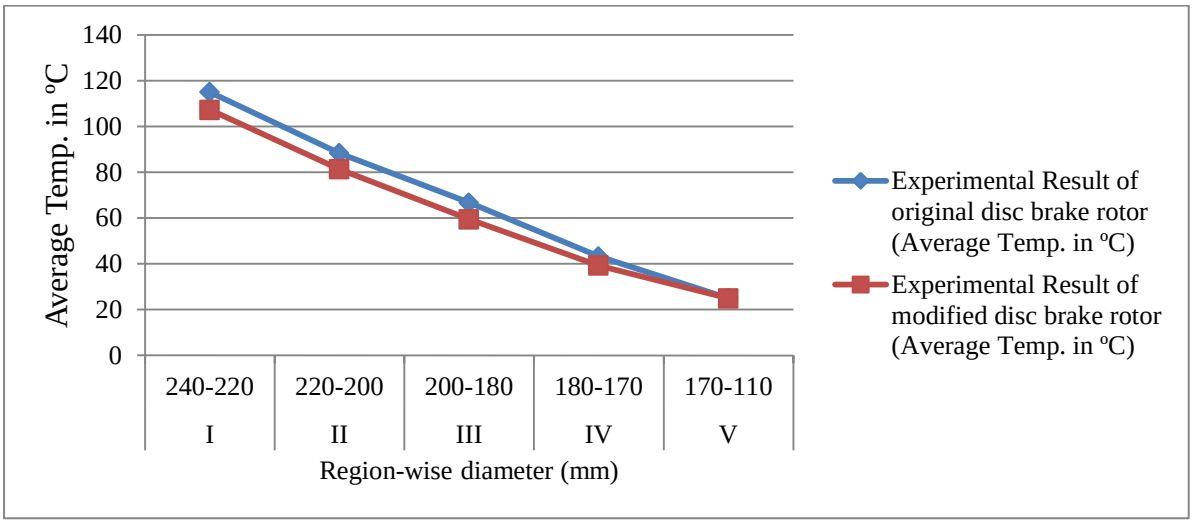
Vol.3 Issue.3,

March 2015.

Pgs: 52-60

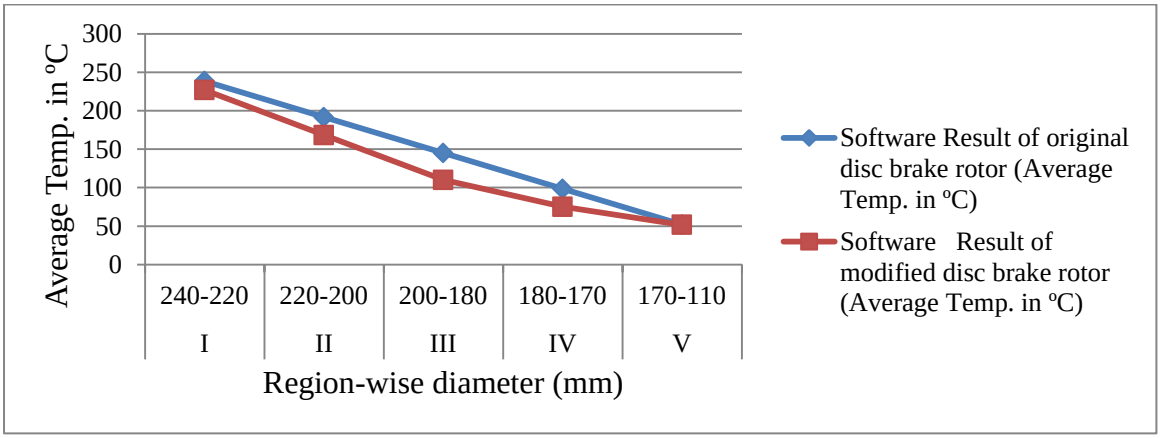
Comparisons between original & modified shape 4 disc brake rotor

Graph 3.1Experimental result of original & modified shape 4 disc brake rotor



From graph 3.1 on the basis of experimental results it is clearly understand that average temperature occurs in modified shape 4 disc brake rotor is minimum as compared to original disc brake rotor.

Graph 3.2 Software result of original & modified shape 4 disc brake rotor



From graph 3.2 on the basis of software results it is clearly understand that average temperature occurs in modified shape 4 disc brake rotor is minimum as compared to original disc brake rotor

4. CONCLUSION

1. The static structural & steady state analysis of disc brakes during periodic braking that performed are achieved
2. The weight of the modified shape 4 disc brake is up to 0.954 kg which is reduced about 100 grams than the original disc brake rotor.
3. Cost of the disc brake rotor ultimately reduces due to minimization of the weight disc brake rotor.
4. Stress induced in modified shape 4 disc brake rotor is 20.707 MPa which is allowable. Maximum tensile strength of cast iron is 200MPa
5. During the continuous braking process gives a different value of temperature Distribution as a result of the frictional heat generated on the rotor surface which is heat dissipated properly

REFERENCES

1. Sowjanya K., S.Suresh, "structural analysis of disc brake rotor", IJCTT, July 2013, vol. 4 Issue 7, pp 2295-2298
2. Daniel Das. A, Christo Reegan Raj V, *et. al*. "structural and thermal analysis of disc brake in automobiles", IJLTET, May 2013, Vol. 2 Issue 3, pp 18-25.
3. Thilak V. M. M., "Transient analysis of rotor disc of disc brake using ANSYS", IJMIE, Aug. 2012, Vol. 2, Issue 8, pp. 502-514.
4. Guru Murthy N., Charyulu T. N., *et. al.*, "Coupled structual / thermal analysis of disc brake", IJRET, Dec 2012, Vol. 1, Issue 4, pp. 539-553.
5. Belhocine A., Bouchetara M., "Thermal behavior of full and ventilated disc brakes of vehicles", Springer Publication, JMST, June 2012, pp. 3643-3652.
6. Thilak V.M.M., Krishnaraj R., *et. al.* "Transient thermal and structural analysis of the rotor disc of disc brake", IJSER, Aug. 2011, Vol. 2, Issue 8, pp. 1- 4.