ADVANCED TRANSIENT THERMAL AND STRUCTURAL ANALYSIS OF DISC BRAKE BY ANSYS WORK BENCH

S.P . Ingale[1] , Prof .A.Z.Patel[2] , Prof. D.D.Date[3] , Prof.A.B.Ghalke[4]

[1]*Department of Mechanical Engineering , . P.G.Student, TPCT's college of Engineering Osmanabad, India*

[2,3]*Associate Professor, Department of Mechanical Engineering , TPCT's college of Engineering Osmanabad, India*

[4] *Professor, Department of Mechanical Engineering , TPCT's college of Engineering Osmanabad, India*

Abstract: In this paper structural fields of the solid disc brake during short and emergency braking with four different materials is studied. The distribution of the temperature depends on the various factors such as friction, surface roughness and speed. The effect of the angular velocity and the contact pressure induces the temperature rise of disc brake. The finite element simulation for three-dimensional model was preferred due to the heat flux ratio constantly distributed in circumferential direction. Here value of temperature, friction contact power, nodal displacement and deformation for different pressure condition using analysis software with four materials namely cast iron, cast steel, aluminum and carbon fiber reinforced plastic are taken.Presently the Disc brakes are made up of cast iron and cast steel. With the value of simulation result best suitable material for the brake drum with higher life span is determined.

Keywords: Disc Brake , Structural, Thermal Analysis, Transient Analysis ,Ansys Work Bench

1. Introduction

The disc brake is a device for slowing or stopping the rotation of a wheel. Repetitive braking of the vehicle leads to heat generation during each braking event .The finite element method has become a powerful tool for the numerical solutions of a wide range of engineering problems. The disc brake is a wheel brake which slows rotation of the wheel by the friction caused by pushing brake pads against a brake disc with a set of calipers . Brakes convert motion to heat, and if the brakes get too hot, they become less effective, a phenomenally known as brake fade Disc brake consistence of a structural steel disc bolted to the wheel hub and a stationery housing called caliper. The caliper is connected to some stationery part of the vehicle like the axle casing or the stub axle as is cast in two parts each part containing a piston. In between each piston and the disc there is a frictional pad held in position by retainment pins, spring plates. The passages are so connected to another one for bleeding. Each cylinder contains rubber-sealing ring between the cylinder and piston. In this paper study about a transient analysis of the thermoelastic problem for disk brakes with frictional heat generation, did using the finite element analysis (FEA) method is reported in details. The computational results are presented for the dispersion of the temperature on the friction surface between the contacting bodies (the disk and the pad).

3.PROBLEM DEFINITION:

The action force, friction force and brake torque on rotor disc are studied by the basic formulae of disc brake and ANSYS software. The aim is to compare between the rotor disc of a standard motorcycle "BAJAJ PLUSAR" and a non-standard rotor disc to find out the relationship value between brake torque, rotor disc dimension etc

4. Material property

Name	Structural steel
Default Failure Criterion	Max von Mises Stress
Yield Strength	1.72339e+0.008 N/m2
Tensile Strength	4.13613e+0.008 N/m2
Elastic Modulus	2e+011 N/m2
Poisson's Ratio	0.28
Mass Density	7800 kg/m3
Shear Modulus	7.7e+010 N/m2

Table.2 Material property of structural steel

Material	Density 103 kgm -3	Thermal conductivity Jm-1K- 1 s -1	Thermal expansion 10-6K	Young's modulus GNm -2	Tensile strength MNm	% elongation
0.2 % C Steel	7.86	50	11.7	210	350	30

Table 1.Phyisical properties of plain carbon steel

5.Disc Structure Detail

Sr. No.	Description
Baseline Original disc	Original disc brake has been 6 holes dia 8 mm arranged equally. There are 36 holes Surrounding disc Dia 8 mm arranged equally.
New Disc 1	Original disc brake has been reduces 6 holes dia 6 mm. There are 36 holes Surround Dia 8 mm arranged equally. Original disc brake has been added with 18 cutsecton & changes central structure.
New Disc 3	15 Vanes have been arranged. 15 Elliptical shapes arranged between Vanes clockwise Inlet of air flow & outlet of air flow between the vanes is same. 15 vanes have been arranged clockwise. 15 Elliptical shape arranged between Vanes clockwise .
New Disc 4	Original disc brake has been Reduces 6 holes dia 6 mm .There is 36 holes Surrounding disc are not contain. Original disc brake has been added with 18 cutsecton & changes central structure .
New Disc 5	Original disc brake has been Reduces diameter of Surrounding holes 7 mm arranged equally & increases no of holes. There are 60 holes Surrounding disc area. Original disc brake has been added with different cutsecton & changes central structure.

6. Solid Modelling of disc

Solid geometry of dics are created in CATIA V5 Software

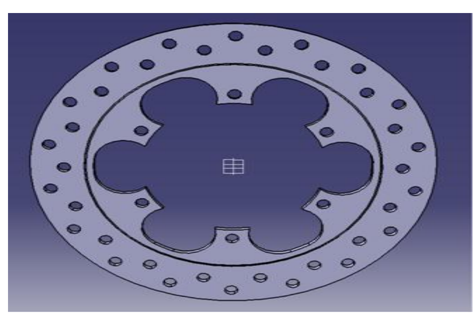

Fig.1a) Solid model of Original Disc

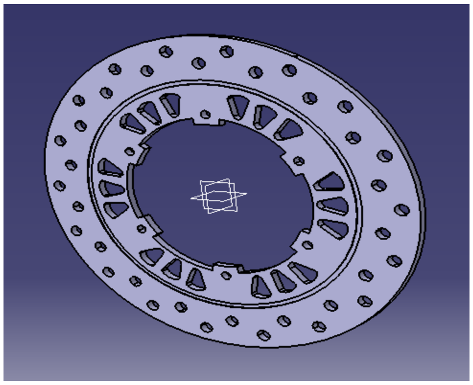

Fig.1b) Solid model of New Disc 1

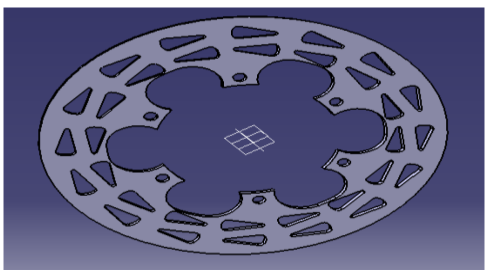

Fig.1c) Solid model of New Disc 2

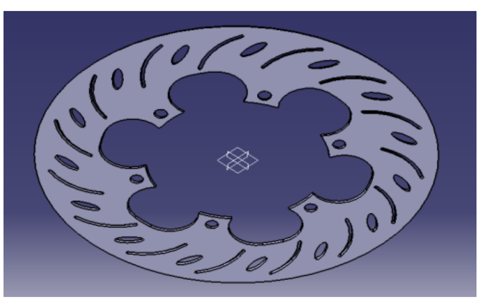

Fig.1d) Solid model of New Disc 3

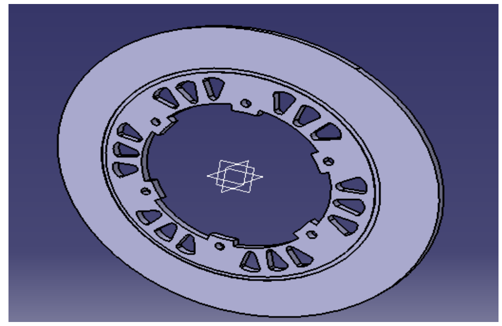

Fig.1e) Solid model of New Disc4

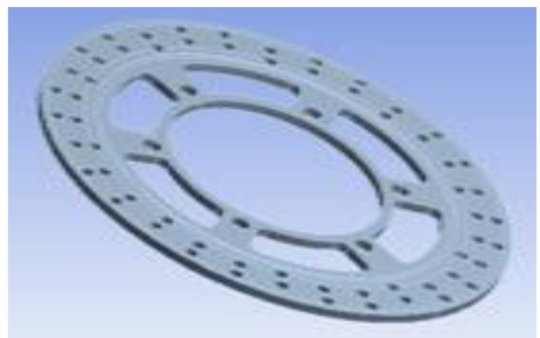

Fig.1f) Solid model of New Disc5

7. Transient Analysis Result

Solid geometry of disc is created and is imported to analysis software ansys workbench and get stress, strain, total deformation .

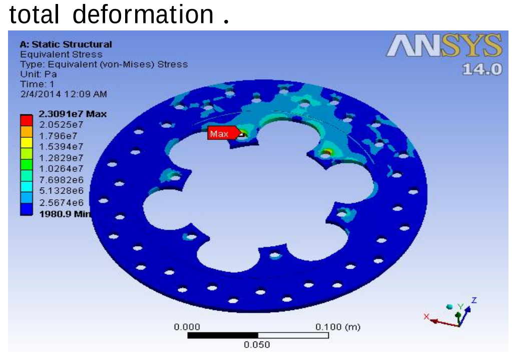

Fig2a) Stress Distribution of Original Disc

International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395 -0056
Volume: 02 Issue: 04 | July-2015 www.irjet.net p-ISSN: 2395-0072

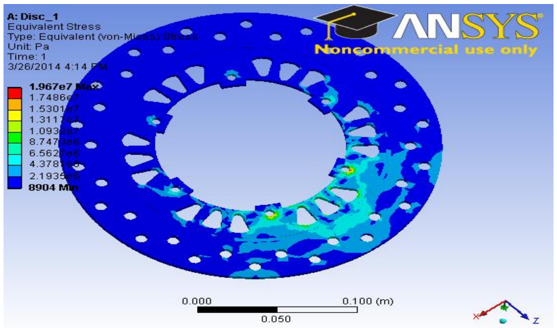

Fig.2b) Stress Distribution of New Disc 1

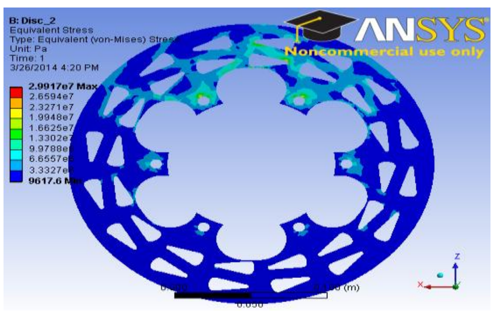

Fig.2c) Stress Distribution of New Disc 2

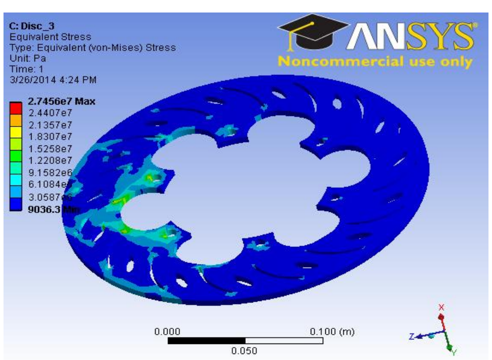

Fig.2d) Stress Distribution of New Disc 3

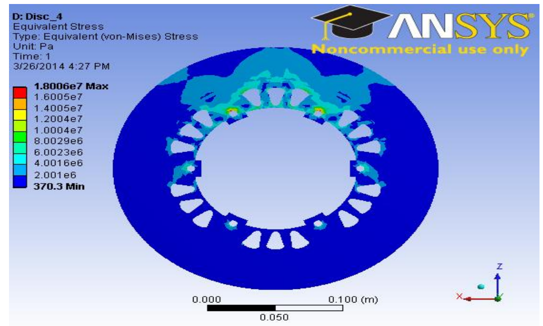

Fig.2e) Stress Distribution of New Disc 4

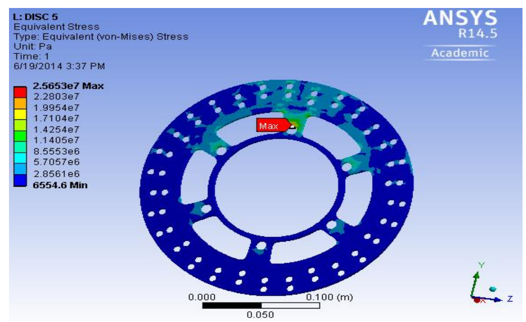

Fig.2f) Stress on New Disc 5

<u>Fig.2 Stress Distribution results for Discs</u>

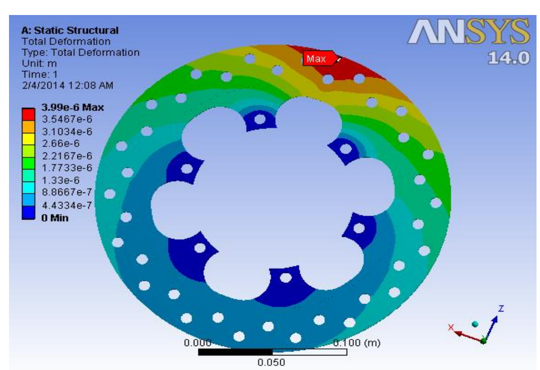

Fig3a) Deformation on Original Disc

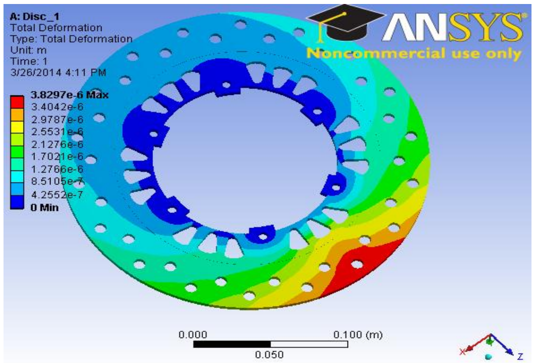

Fig3b) De Formation on New Disc 1

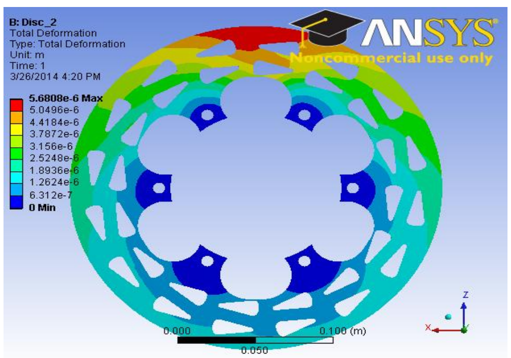

Fig.3c) Deformation on New Disc 2

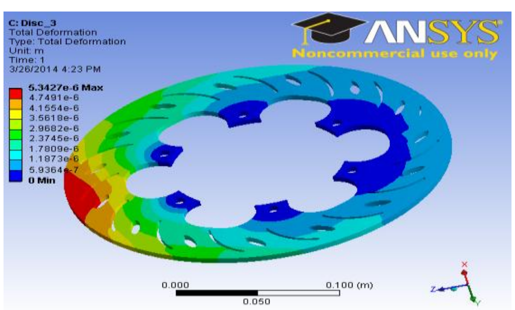

Fig.3d) Deformation on New Disc 3

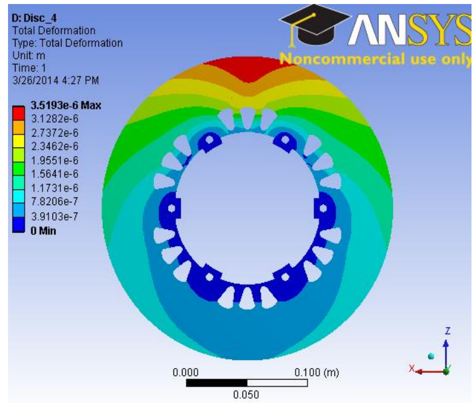

Fig.3e) Deformation on New Disc 4

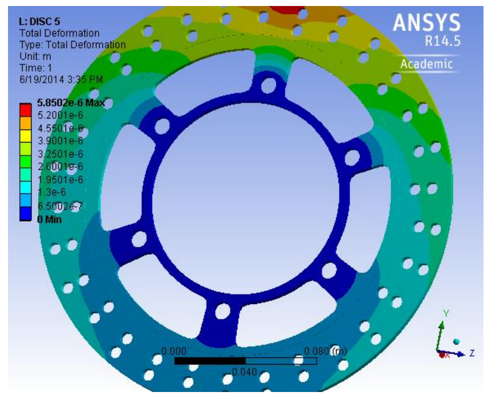

Fig.4f) Deformation on New Disc 5

Fig 3 .Deformation results for Discs

8.Relationships between Dimension of rotor disc and Brake torque.

Dimensions (mm)	200	225	240	275	300
Brake Torque(Nm)	100	112.5	120	137.5	150

Forces and torque analysis on the rotor disc was studied which, are divided by tangential force, brake torque, and the motorcycle's stopping distance. Brake force that can be converted into tangential force during rotation of disc brake. The result of force value on rotor disc by tangential force and the motorcycle's stop distance are similar. When dimension of disc brake was changed, the value of brake torque was different by rotor disc dimension at 300 mm, which has the most value of brake torque, and rotor dimension at 200 mm, which has the least value of brake torque

9.Result and Discussion

The investigation into utilization of new materials is needed which improve the braking efficiency and allow for larger constancy to vehicle. The comparison of the initial and modified designs on the various parameters are given below

Result of Discs	Mass (Kg)	DEFORMATION (mm	Stress (N/mm2)
Original disc	0.98541	0.0036951	19.083
New disc 1	1.0811	0.0038297	19.67
New disc 2	0.8776	0.0056808	29.917
New disc 3	0.96511	0.0053427	27.456
New disc 4	1.1481	0.0035193	18.006
New disc 5	0.897	0.0058502	25.653

1)Considering initial design for a disc , simulation results showing deformation of original disc is 0.0036951 mm and modified designs deformation of disc 4 is 0.0035193 mm.
2) In dimensional solution , dimension of existing disc changed for lower deformation result than existingdisc .
3) Stress and deformation induced in the Proposed new disc 5 lower the existing disc but less than the allowable stress and used for reducing weight of existing disc

10.CONCLUSION

The present study can provide a useful design and improve the brake Performance of disk brake system. From the above result we can say that a max blue colour occur in new disc 5 i.e. min temperature distribution occur in Modify (New Disc 5) as compared to actual standard Bajaj Pulsar 2 Wheeler & other new discs. Also for structural analysis result of both computational & experimental we have found the new brake disk design is safe based on the strength and rigidity criteria. Comparing the different results obtained from analysis. Plane carbon steel is best material for Disc Brake.

11. References:

1.N. Balasubramanyam, Smt. G. Prasanthi, "Design and Analysis of Disc Brake Rotor for a Two Wheeler", International Journal of Mechanical and Industrial Technology (IJMIT)-Vol. 1, Issue 1, pp: (7-12), Month: October 2013-March 2014.

2.V. Chengal Reddy, M. Gunasekhar Reddy,G. Harinath Gowd, " Modeling And Analysis of FSAE Car Disc Brake Using FEM", International Journal of Emerging Technology and Advanced Engineering Journal, Volume 3, Issue 9, September 2013.

3.Subhasis Sarkar, Pravin P. Rathod, " Review Paper on Thermal Analysis of Ventilated Disc Brake ",International Journal of Engineering Research & Technology (IJERT)

4.Belhocine Ali, Bouchetara Mostefa , " Thermo mechanical Modelling of Disc Brake Contact Phenomena",FME Transactions (2013) 41, 59-65

5.Daniel Das.A ,Preethy.S, " Structural and Thermal Analysis of Disc Brake in Automobiles ", International Journal of Latest Trends in Engineering and Technology (IJLTET)- Vol. 2 Issue 3 May 2013

6.Guru Murthy Nathi, T N Charyulu, K.Gowtham , P Satish Reddy, " Coupled Structual / Thermal Analysis Of Disc Brake",2012

7.Atul sharma and M.L. Aggarwal , " Deflection and stress Analysis of Brake Disc using Finite Element Method", Oct 19-20, 2012

8.Sharath Kumar T. and S.Vinodh Novel "Design and Analysis of a Brake Rotor", 2012

Ameer Fareed Basha Shaik1, Ch.Lakshmi Srinivas2 "structural and thermal analysis of disc brake with and without crossdrilled rotar of race car", International Journal of Advanced Engineering Research and Studies IJAERS/Vol. I/ Issue IV/July-Sept., 2012/39-43 Research Paper,

9.Zhang Jian Xia Changgao Research of the "Transient Temperature Field and Friction Properties on Disc Brakes".

10.Ji-Hoon Choi ," Finite element analysis of transient thermoelastic behaviors in disk brakes",29 October 2002.