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ADVANCED TRANSIENT THERMAL AND STRUCTURAL ANALYSIS OF DISC BRAKE BY USING ANSYS IN TWO WHEELER

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ABSTRACT
In these 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, aluminium and carbon fibre 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.

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 callipers . 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 calliper. The calliper 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 detainments 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 thermo elastic 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).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.

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 cut section & changes central structure.
New Disc 2	Original disc brake has been 6 holes dia. 8 mm arranged equally same .Original disc brake has been added with cut section inlet & outlet airflow is large & small respectively. The thickness has been 5mm.
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 cut section & 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 cut section & changes central structure.

Transient Analysis Result Solid geometry of disc is created and is imported to analysis software ANSYS workbench and get stress, strain, total deformation.

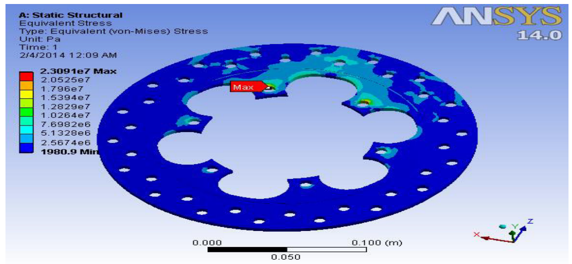
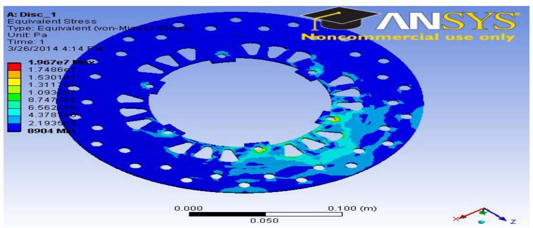


Fig.01 Stress Distribution of Original Disc



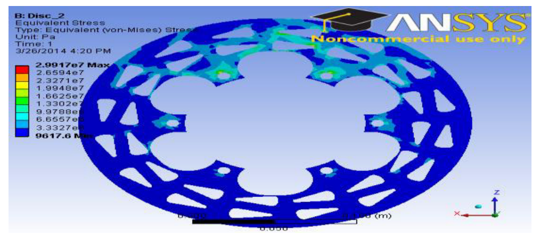
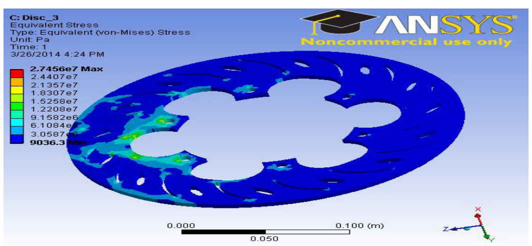


Fig.02 Stress Distribution of New Disc 1 **Fig.03 Stress Distribution of New Disc 2**



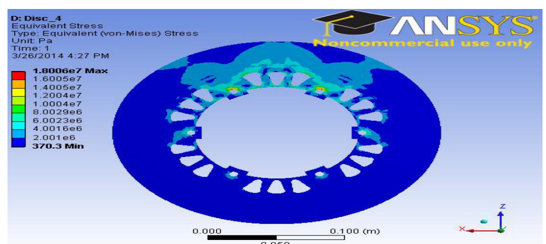


Fig.04 Stress Distribution of New Disc 3 **Fig.05 Stress Distribution of New Disc 4**

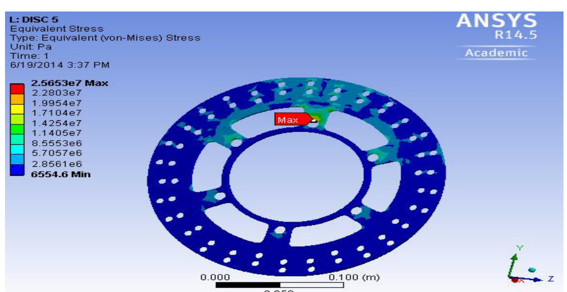


Fig.06 Stress Distribution of New Disc 5 Stress Deformation results for Discs

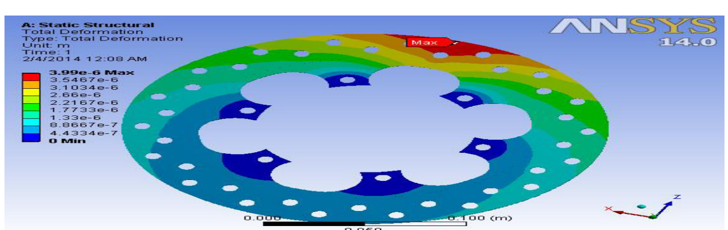


Fig.07 Deformation on Original Disc

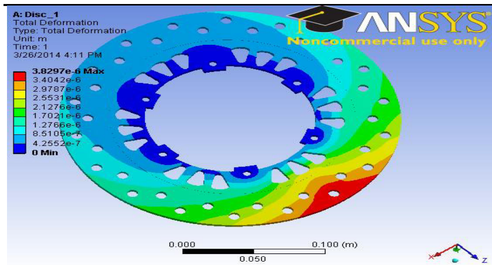


Fig.08 Deformation on New Disc 1

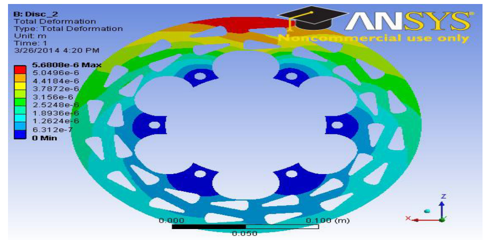


Fig.09 Deformation on New Disc 2

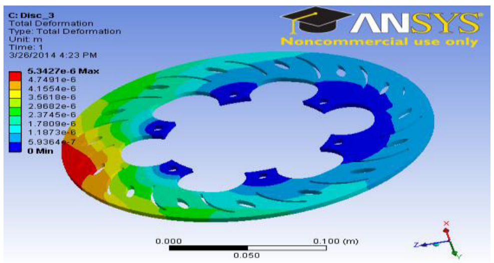


Fig.10 Deformation on New Disc 3

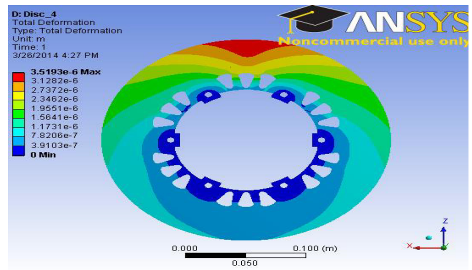


Fig.11 Deformation on New Disc 4

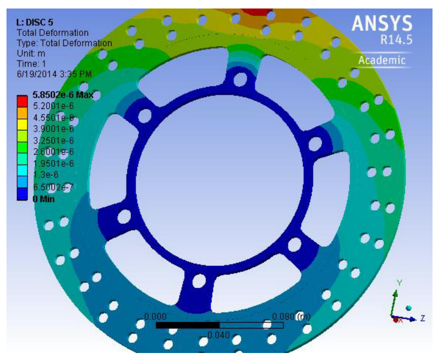


Fig.12 Deformation on New Disc 5

A DESIGN OF DISC BRAKE DIMENSIONS :-
CALCULATION-DISC BRAKE STANDARD
In this project study standard of two wheeler name "BAJAJ" model PLUSOR Factor;
Rotor disc dimension = 240 mm.
(Rotor disc material = Gray cast iron)
Pad brake area = 2000 mm2 (2000×10-6 m)
Pad brake material = Asbestos
Coefficient of friction (Wet) = 0.08-0.12
Coefficient of friction (Dry) = 0.2-0.5
Maximum temperature = 250 ℃
Maximum pressure = 1 MPA (106 Pa)
TANGENTIAL FORCE
TANGENTIAL FORCE BETWEEN PAD AND ROTOR. (INNER FACE), FTRI
FTRI = µ1.FRI
Where FTRI = Normal force between pad brake and rotor (inner)
µ1 = Coefficient of friction = 0.5
FRI = P max/2 × A pad brake area
So, FTRI = µ1.FRI
FTRI = (0.5) (0.5) (1×106 N/m2) (2000×10-6 m2)
FTRI = 500 N.

BRAKE TORQUE (TB)

With the assumption of equal coefficients of friction and normal forces FR on the inner and outer faces:
TB = FT.R
Where TB = Brake torque
μ = Coefficient of friction
FT = Total normal forces on disc brake, FTRI + FTRO
FT = 1000 N.
R = Radius of rotor disc.
So, TB = (1000) (120×10-3)
TB = 120 N-M

BRAKE DISTANCE (X)

We know that tangential braking force acting at the point of contact of the brake, and
Work done = FT. x
Where FT = FTRI + FTRO
x = Distance travelled (in meter) by the vehicle before it come to rest.
We know kinetic energy of the vehicle.
Kinetic energy = (mv2) / 2 (Equation B)
Where m = Mass of vehicle
v = Velocity of vehicle
In order to bring the vehicle to rest, the work done against friction must be equal to kinetic energy of the vehicle.
Therefore equating (Equation A) and (Equation B)
FT. x = (mv2) / 2
Assumption v = 100 km/hr = 27.77 m/s
M = 132 kg. (Dry weight)
So we get **x =** (mv2) / 2 FT
x = (132×27.772)/ (2×1000) m.
x = 50.89 m.

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-

Table 01

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

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.

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