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Thermal Effect Controlling Analysis In Sports Bike Disk Brake

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Abstract-In present automobile sector, there is phenomenal change in the innovation from transmission framework to braking mechanism. This mechanism is considered as most essential framework from execution and also in perspective of safety. When the brakes are connected to the moving vehicle, kinetic energy gets changed over into heat. Disc brake is the ongoing pattern in car vehicles which scatters the heat much faster than the regular drum brakes. In any case, if harsh braking is done, there induces thermal stress in brake disc which generates excess temperature. If this heat isn't dispersed legitimately, there occurs distortion in disc that results in thermal cracking which paves the way for disc failure. In disc brake there are no differences in friction coefficient so there is no issue of brake fading. The vital advantage of disk brake is that only portion of disc is in contact with caliper. Henceforth there is extensive surface area in disc which can disseminate the heat to air. Explicitly the heat dispersed is in the mode of forced convention. The main objective of this proposed work is to pick best profile and best material which can disseminate most extreme amount of heat to atmosphere. The disc models are made in CATIA V5 and analysis is done in ANSYS 16.2.

Keywords: Disc brake, Thermal Analysis, ANSYS, FEA.

1 INTRODUCTION

Disc brake is for slowing the rotation or for halting the rotation of wheel. Brake plate (or rotor) normally made using cast iron or composites like carbon, silica and kevlar, is integrated with wheel or axle. To make the wheel stop, frictional material as brake pads is constrained mechanically, pneumatically, hydraulically or electromagnetically against two sides of disc. Because of Friction disc and wheel moderates or stops. Most current vehicles have disc brakes in front wheels, and some also have it on each of the four wheels. This portion of braking mechanism that does the genuine work of ceasing the vehicle [1]. In the present developing automobile industry, the competitors are growing enormously in giving efficient performance. As we know it is much important to maintain the braking system in vehicle to drive safely. The brakes intended to race need high braking proficiency. The mileage or the expense isn't major concern for manufacturer of the dashing vehicle brakes.

Fig 1. Disc brake

When caliper piston encounters with pressure, force produced on caliper results in squeezing of disc between two frictional surfaces. Since disc brakes don't utilize grating between rotor and lining to enhance braking power unlike drum brakes do, they are more averse to create a pull. The majority of the segment of disk brake is presented to atmosphere; there is best heat dispersal rate which gives quicker cooling to disc brake. This plays an imperative role in limiting fading of brake. It likewise self-cleans the residue and water is perplexed, thus decreasing frictional distinction [2].

2 LITERATURE SURVEY

Praveena Lavakumar suggested cast iron as best material for disc brake because of its minimum thermal conductivity.[3]

Ganesh and Naresh have expressed that "Aluminum metal is increasingly useful as it is light in weight, have better thermal conductivity". They likewise concluded that "Aluminum usage for manufacturing brake disc can add to increment in speeding up and decreasing the braking separation". [4]

Subhasissarkar and Pravin Rathod presented a paper by analyzing the distribution of temperature using FEA that if there is increase in vehicle speed, temperature also increases but heat produced is minimum for AMMC when compared and analyzed with grey cast iron. They likewise said that the disc brake configuration becomes a major role in transferring heat like vane thickness, opening size and so on [5]

3 DESIGNS AND CALCULATION

Design Consideration

Design is computed by considering some of the following parameters,

- Brake Power, Larger diameter rotors more will be brake power with same quantity of clamp force when considering rotor with small diameter. When coefficient of friction applied for the pad increases then maximum brake power will be produced. Dynamic Coefficient Of Friction and also considered of material used for brake rotor.
- Frictional Coefficient drops regularly if speed of vehicle increases, if more clamp force is produced and if temperature increases.
- Higher the available surface area, the better heat dissipation.
- Material to be used must be selected keenly to identify the occurrence of heat dissipation.
- Wear=k p r
- Thermal Mass must be enough to handle temperatures properly during braking.
- The brake systems on vehicles must have capacity of absorbing more horsepower than the engine typically produces because the heat (power) that is generated when braking occurs within short period.

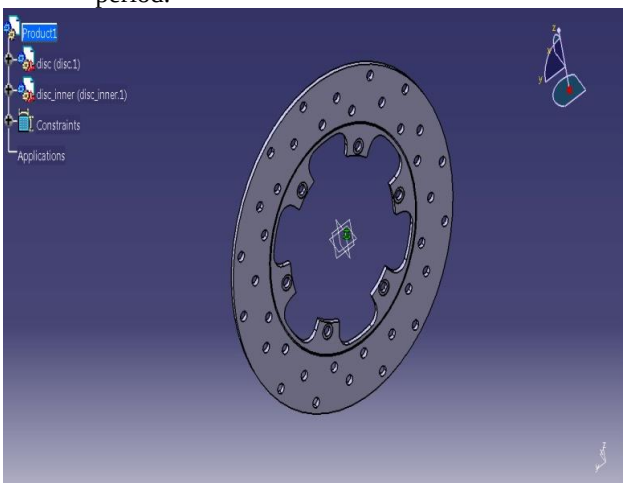


Fig 2.Design Model of Disk Brake

Calculation

v = $\sqrt{\mu g d}$= 15.002 m/s

Distance of stopping: $\frac{v^2}{2a}$=$\frac{(160x1000/3600)^2}{2x12.9}$=76.56m

Rotational Speed (ω) = $\frac{v}{R_t}$= 44.91 rad/sec

ts = 3.44 s

Kinetic energy (K.E) =$\frac{1}{2}$ mv^2= 149664.9027 Joules

Generated heat (Q) =mC$_p$ Δt= 7740 joules

Restored Energy (RE) = 3% of kinetic energy = 4489 joule

Total energy = K.E + R.E = 154154.8498 Joule

Area = total energy × (R2-R$_1$) = 15415484.98 mm^2

Force on disc (F$_d$) = $\frac{30\%*(\frac{1}{2}mv^2)}{2*\frac{R_\gamma}{R_t}(v°t_S-\frac{1}{2}(\frac{v}{t_S}*t^2S))}$=2641.7669N

External pressure between disc and pad

= force applied to the disc

=$\frac{F_d}{Ac*\mu}$ = $\frac{2641.7237}{8892*0.3}$= 0.99 ≈ 1mpa

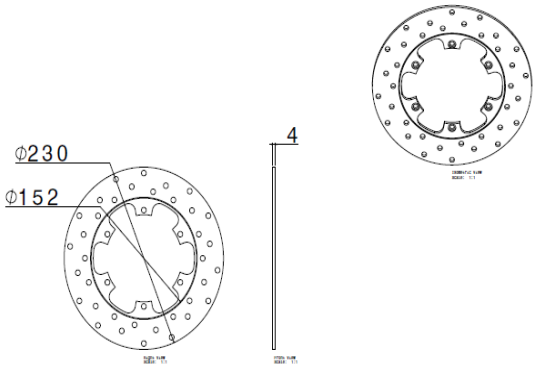


Fig 3.Detailing of Disk Brake

4 METHODOLOGY

The following methodology is being adopted to carry out to get efficient results:

1. The ansys achieved by aircraft landing gear and CAD model was designed by CATIA V5
2. Using ANSYS the overall thermal distribution are computed and tried to validate with classical theory.
3. Using these equivalent properties of cast iron the structural result is computed.

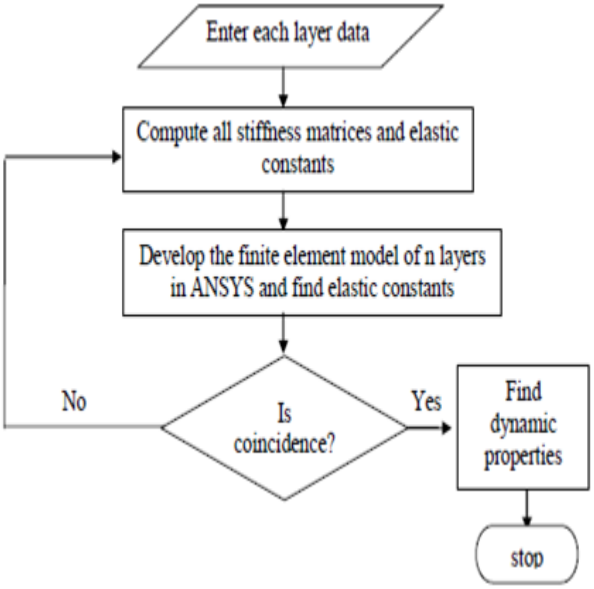


Fig 4. Flowchart for Present methodology

Nodes	120820
Elements	69651

Fig 5.Meshing of Geometry

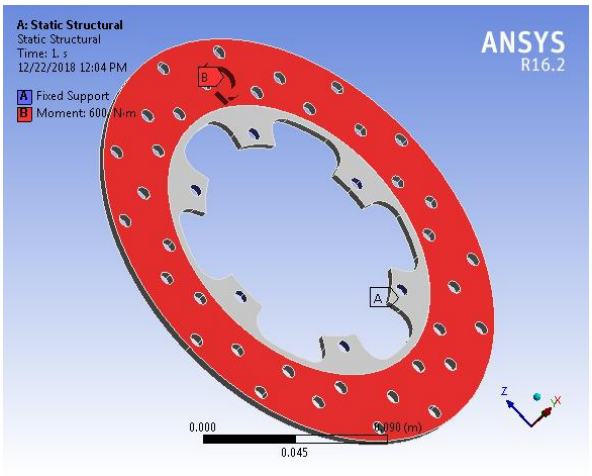


Fig 6. Boundary Condition

5 INTRODUCTION TO FEA

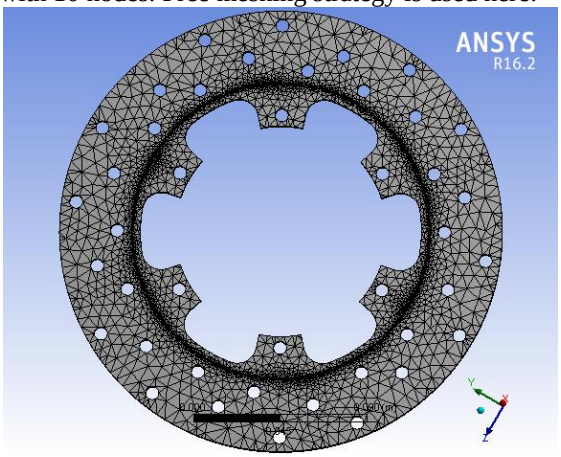
FEA comprises of PC model of a material or structure that is focused and investigated for explicit outcomes. It is utilized in new product structure, and existing item refinement. An organization checks proposed structure's capacity that whether it can perform to the customer's particulars preceding assembling or development. Altering a current item or structure is used to qualify the item or structure for another administration condition. In the event of auxiliary failure, FEA might help in deciding the plan changes to meet the new upcoming condition. FEA utilizes complex arrangement called nodes that makes the mesh grid. This mesh is customized to contain the material and auxiliary properties which characterize how the structure will respond to certain stacking conditions. Nodes are relegated at a specific thickness all through the material relying upon stress levels of specific region. Practically FEA comprises of three chief advances, they are as follows,

- **Preprocessing**
- **Analysis**
- **Post processing**

STRUCTURAL ANALYSIS

Mesh Integration

Generation of Mesh is an imperative advance in the preprocessing of limited component strategy, and it consumes much time. The right and sensible meshing is the way to numerical reproduction of limited component strategy. The nature of mesh will straightforwardly decide the speed, accuracy and precision of final examination. This progression plays a broad role in legitimacy and unwavering quality of limited component investigation. At the point when the brake drum is meshed, 3D substance Solid tetrahedron component is chosen, and every unit is with 10 nodes. Free meshing strategy is used here.



6 RESULT AND DISCUSSION

The outcome obtained by genuine experimentation and the examination is checked and the outcomes are deciphered as shown .In ANSYS, the two fundamental arrangements are determined, first is temperature and other is heat flux. The outcomes received by ANSYS are reanalyzed. Contour diagrams are shown below. The outcomes acquired by software are checked by experiment process which is obtained from experiment work. The principle advantage from software examination is that it discreteness the entire model into fragment of small size. Boundary conditions are initially applied to nodes and after that last arrangement is accomplished by the expansion of individual node. In this manner, the outcomes obtained by software are more exact than experimental value. There is slight variation between values obtained from experimental results and software results.

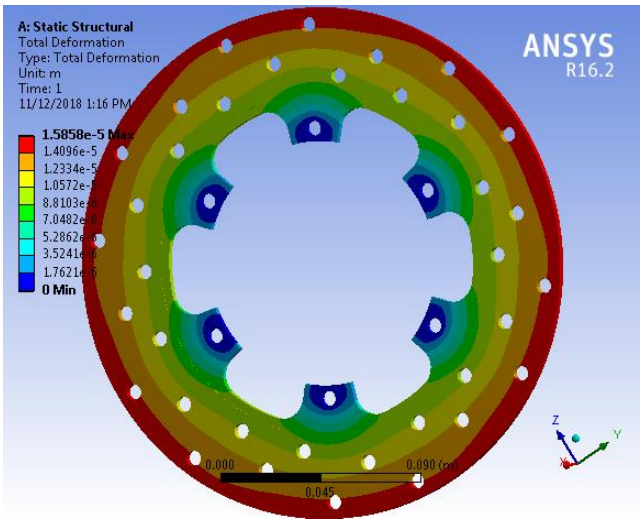


Fig7. Deformation of Disk Without air hole

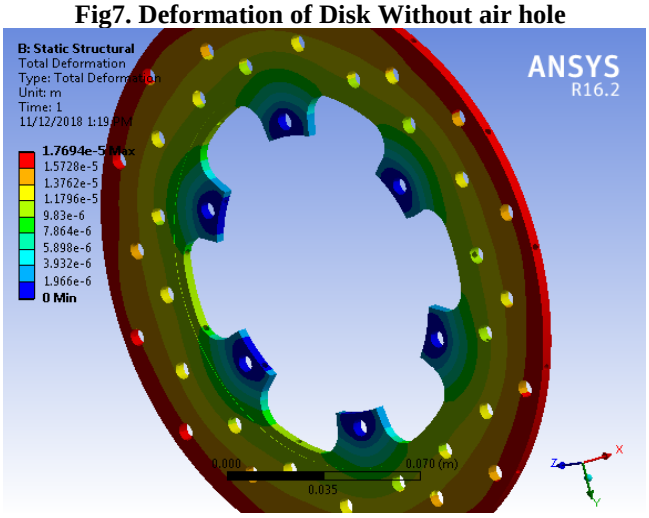


Fig8 . Deformation of with air hole

Name	Displacement(m)	Stress(MPa)
Displacement	**1.5e5**	**88**
Stress	**1.7e5**	**101**

Thermal analysis:

Results	
Minimum	36.58°C
Maximum	50. °C

Thermal Analysis is presumably the most widely recognized utilization of limited component strategy. The term structure suggests not just thoughtful designing structures, for example, scaffolds and structures, yet additionally aeronautical, navel and mechanical structures, for example, deliver frames, air ship bodies, and machine lodgings, and additionally mechanical segments, for example, cylinders, machine parts, and devices. Thermal examination is done to compute heat flux, temperature angle and temperature variety. For limited component Analysis of Engine Head-Tetrahedral component has been utilized. Aggregate number of components created is 69651.

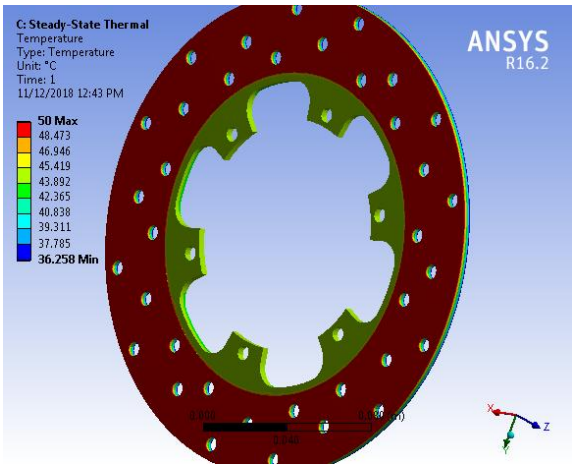


Fig 9.Temperature Distribution of Disk without holes

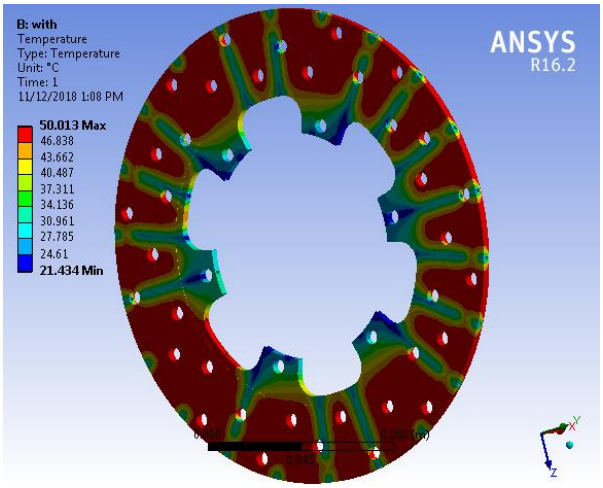


Fig 10. Temperature distribution of with air hole of disk brake

Design	Maximum Temperature	Minimum temperature
Without Hole	**50^{o}**	**36.58^{o}**
With Hole	**50^{o}**	**21^{o}**

7 CONCLUSION:

This paper shows thermal-structural analysis of a disk brake with and without hole for ventilation. The examination is done using commercial FE programming bundle, ANSYS where FE demonstrate just comprises of a plate, it is discovered that by contrasting the distinctive consequences of temperature rise, redirection, and stress field received from investigation. It demonstrates that in ventilated disc with cast iron decrease in temperature, 42%.The deformation and stresses by 15% and 13% expanding despite the fact that that new structure under safe condition just . It is inferred that ventilated disk brake is best for present application. Every values acquired from examination is not exactly their suitable value. Consequently the brake plate configuration is sheltered dependent on the Thermal circulation.

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