Design and Analysis of Disc Braking System limits to Two Wheelers or Motorcycles

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***Abstract:* -** Automobile technology has advanced significantly in recent years. There is rivalry for vehicle speed on the market. However, if vehicles do not come to a complete stop in a timely manner, this speed may result in an accident. Automobile disc brakes outperform drum brakes in terms of stopping performance, and The heat produced while braking is quickly dispersed because The environment is exposed to disc brakes . The disc brake material utilised in some autos, on the other hand, is the primary source of worry. Manufacturers utilise steel discs, but they have a short life cycle and are near the tyres, bulky. If the disc begins to lose its form, it might wobble dangerously close to the tyre, creating a major risk.

The organization's major proverb is to progress the quality of the plate by utilizing diverse fabric and doing the examination. Plan has been taken and dimensions plotted on Creo parametric and to begin with, we made a 2D show within Creo parametric, then we made a 3D show of the disc brake and sent it to ANSYS software after importing the model in ANSYS software, where we used three different materials such as cast iron, structural steel, and titanium alloy, and we performed various analysis such as steady state thermal modal analysis, structural analysis, and so on.

***Index Terms*-**

- Heat Analysis of Disc Brake.
- Modal Analysis.
- Design Optimization.
- Structural Optimization of Disc Brake.
- Aesthetics of Disc.

1. Introduction

In these project we study about the disc brake rotor we take the reference from Bajaj Pulsar NS-200 and created the model in Creo parametric 6.0 then we do the different analysis in ANSYS like steady state thermal analysis, structural analysis and modal analysis for these project we choose the different three material like cast iron, structural steel and titanium alloy first we check the different properties of material after selecting the material we do the different analysis on the different material like total deformation, maximum principal strain and maximum principal stress after completing these for different material we have our final result .

Which types of theory is required for which material?

For cast iron we used the fatigue analysis and non-linear stress strain.

For titanium alloy we used the thermal static and topology optimization.

For structural steel we have finite element analysis (FEM), modal analysis and thermal analysis.

A plate brake is a kind of brake that utilizes the callipers to press sets of cushions against a circle or a "rotor" to make contact. This activity eases back the turn of a shaft, like a vehicle pivot, either to decrease its rotational speed or to hold it fixed.

The plate brakes are like the brakes on a bike. At the point when tension is applied on the switch, it pulls a metal string that presses the two callipers together causing grating between the elastic cushions and the metal edge on the tire. Contact between the cushions and the plate dials the vehicle back and the circle gets extremely hot. At the point when the driver steps on the brake pedal, the power is enhanced by the brake sponsor (servo framework) and changed into a water driven pressure (oil-pressure) by the expert chamber. The tension arrives at the brakes on the wheels by means of tubing loaded up with brake oil (brake liquid). The conveyed pressure pushes the cylinders on the brakes of the four wheels. The cylinders thus press the brake cushions, which are rubbing material, against the brake rotors which turn with the wheels. The cushions clip on the rotors from the two sides and decelerate the wheels, accordingly, dialling back and halting the vehicle.

3. Identify, Research and Collect Idea

Now a days we know that many superbikes comes in the market and in superbike the brake pad of superbike is bigger than normal bikes in superbikes they provide bigger brake pads so that there is large braking area and more breaking force generate to stop the superbike and we know that the bigger the brake pad more heat is generated so to solve these problem we modify the existing design of pulsar NS-200 not limited to pulsar NS-200. in these we change the design of the disc we save the material and basically, we also improve the heat dissipation and in these we also reduce the weight of the disc, and we use the less costly material to reduce the cost of disc.

3.1 Studies and Findings

Now it is the time to articulate the research work with ideas gathered in above steps by adopting any of below suitable approaches:

3.1.1 Bits and Pieces together

In this research first we check the disc of pulsar ns -200 disc they are using the disc diameter 300mm and by seeing these we change the diameter of the disc to 280mm and after seeing the many research paper we choose the different material for the analysis like cast iron, structural steel and titanium alloy and we read the different properties of the materials and we also search for the bike torque it is 30N/m and we use the same bike torque for our analysis.

3.1.2 Use of Simulation software

In these research paper we create the disc in the Creo parametric 6.0 first we draw the 2d model of the disc after completing the 3d model we go for the 3d model in Creo parametric after completing the model of the disc we export our disc file in ANSYS software to do the different analysis on the disc like steady state thermal structural analysis and modal analysis by taking the three different material cast iron, structural steel and titanium alloy.

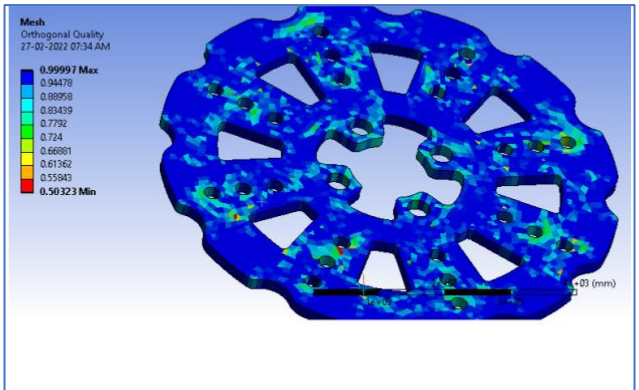

Figure I. Meshing of Disc

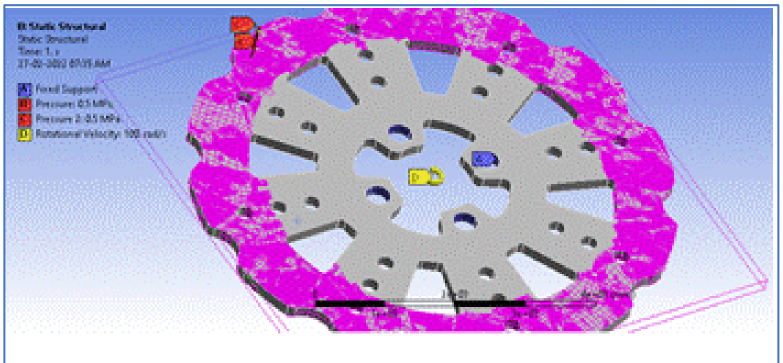

Figure II. Force Distribution

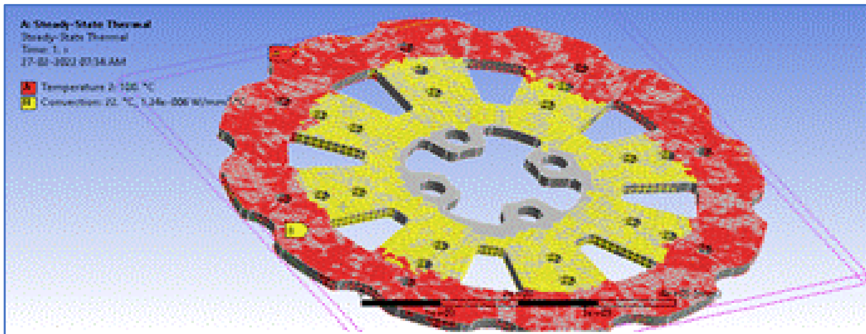

Figure III. Temperature Distribution Along Disc

A. FOR CAST IRON

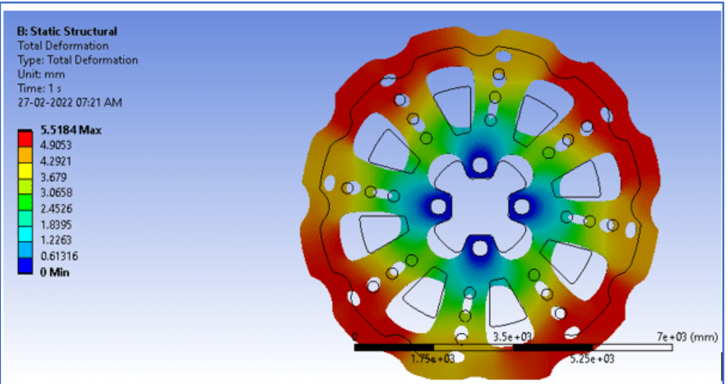

Figure IV. Total Deformation

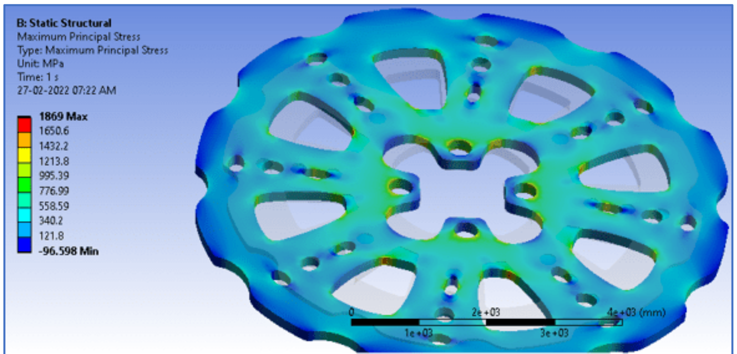

Figure V. Maximum Principal Stress

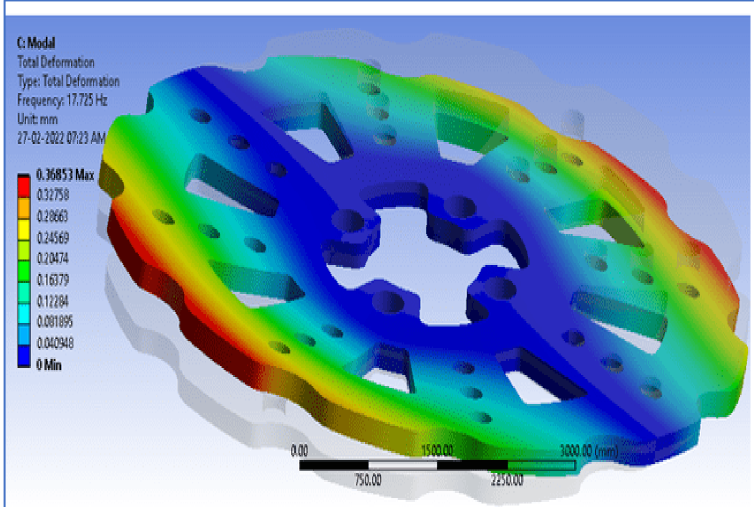

Figure VI. Modal Analysis

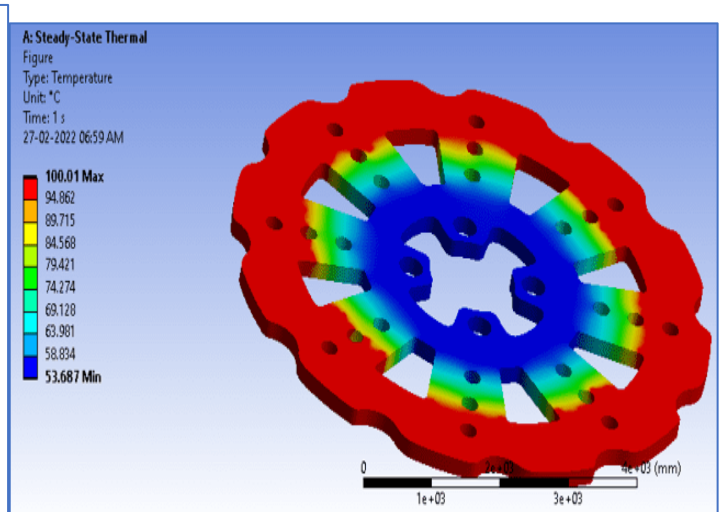

Figure VII. Temperature

B. FOR TITANIUM ALLOY

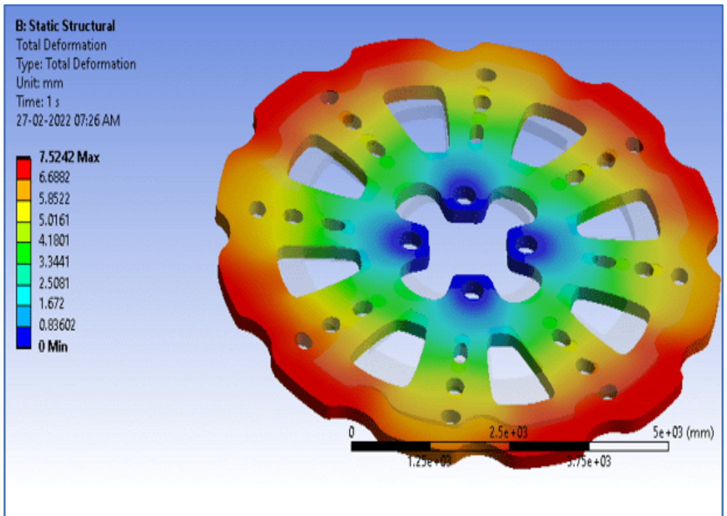

Figure VIII. Total Deformation

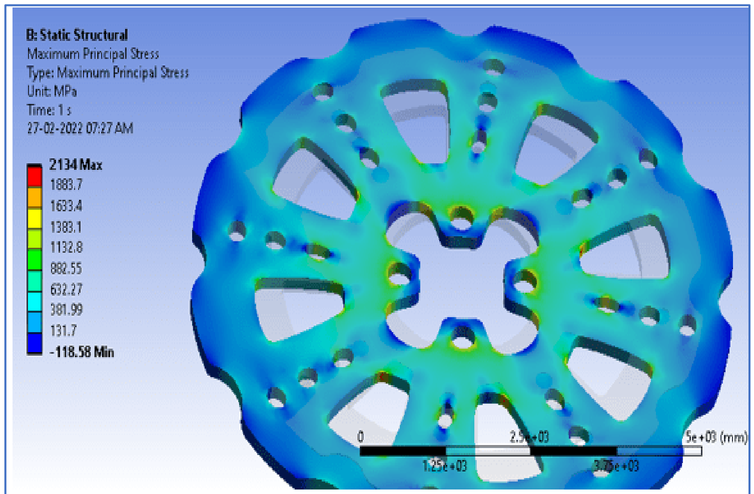

Figure IX. Maximum Principal Stress

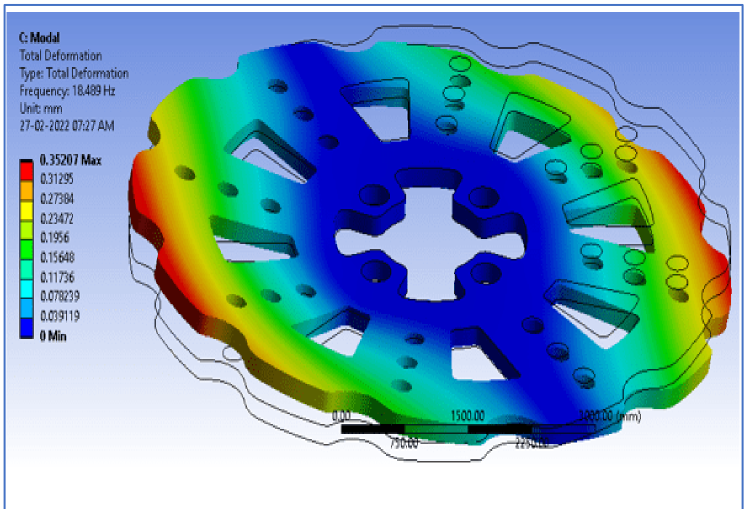

Figure X. Modal Analysis

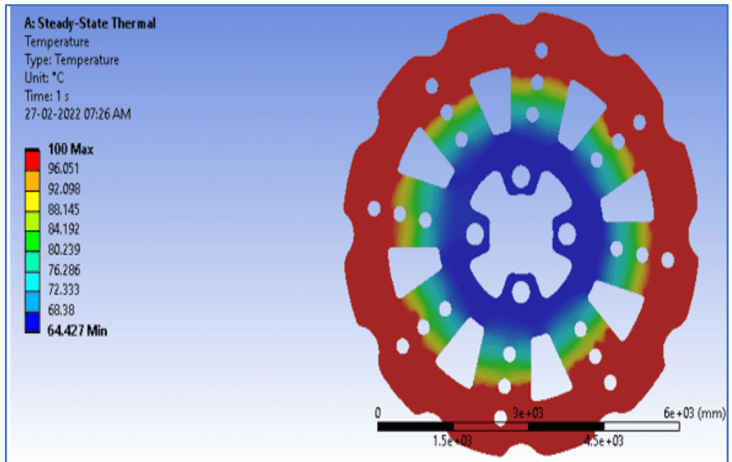

Figure XI. Temperature

C. FOR STRUCTURAL STEEL

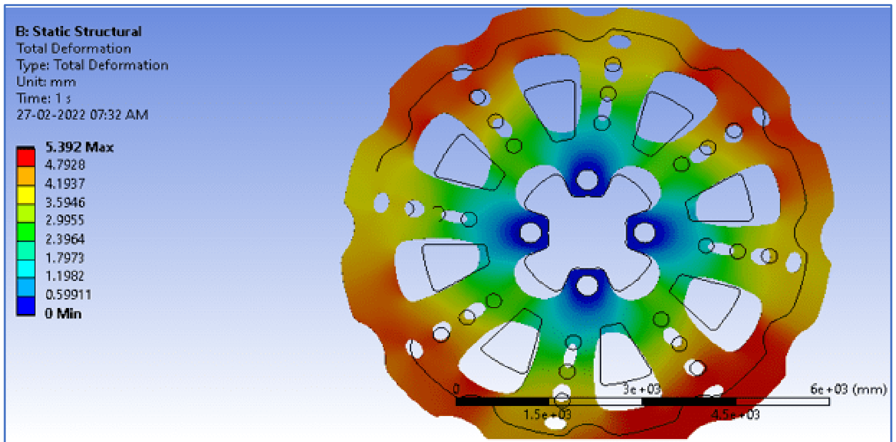

Figure XII. Total Deformation

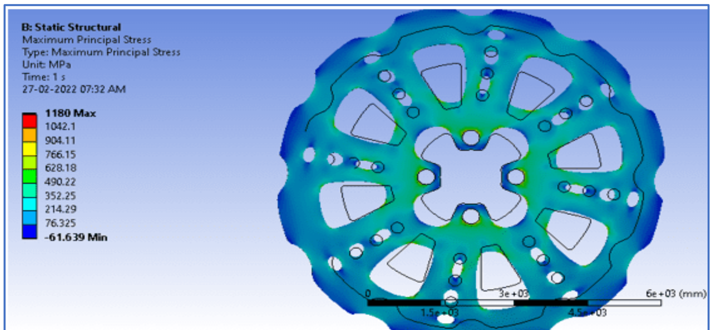

Figure XIII. Maximum Principal Stress

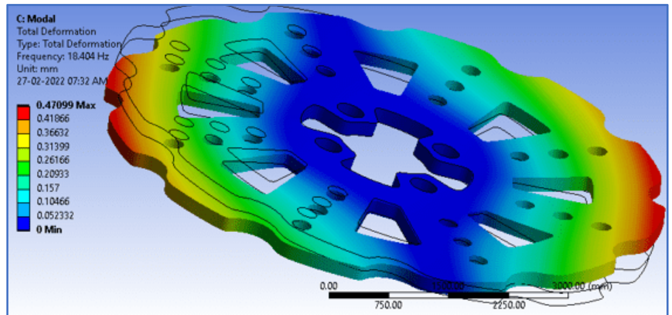

Figure XIV. Modal Analysis

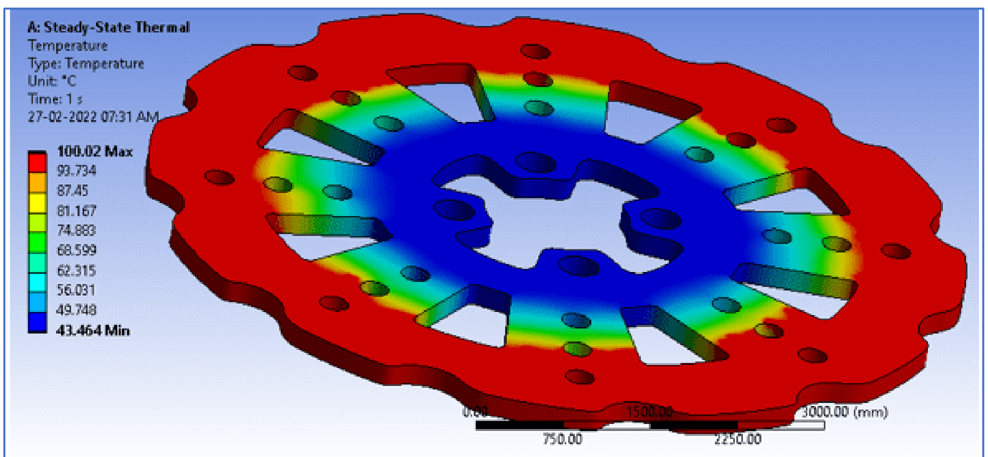

Figure XV. Temperature

4. CONCLUSION

In figure I, meshing has a maximum value of 0.99997 and a minimum value of 0.50323 in these. As a result, we can state that our meshing design has been optimised.

In figure II, the pink area is where we apply breaking force, the blue area is where we apply fixed support, and the yellow area is where we apply rotating velocity.

In figure III, the red portion represents the temperature as a result of the braking, while the yellow portion represents free convection.

For Cast Iron:

As we know we do the different analysis by using the different materials.

I. In figure IV, the overall deformation of the Cast Iron on the exterior of the disc is greater on the outside side of the disc, and as we go inside, the deformation of the disc reduces and the heat dissipation is good at the disc's periphery. Case hardening can be used to reduce total deformation.
II. In figure VI, we use Cast Iron to perform the modal analysis. There is greater modal analysis on the outside of the disc when utilising Cast Iron, and as we travel inwards, the modal analysis of the disc decreases. This indicates that our disc is more stable. When a car is going at a fast speed and we press the brakes, the vehicle wobbles and is unable to stop.
III. In figure VII, we have temperature using Cast Iron; the temperature at the outside of the disc is higher, and as we move inwards, the temperature drops; the temperature at the outer of the disc is extremely low, and we can reduce the temperature at the outside of the disc by making more holes.

For Titanium Alloy:

I. In figure VIII, on titanium alloy, we perform complete deformation. Although total deformation on the outside of the disc is minimal and very low on the interior, titanium alloy has a low total deformation value when compared to cast iron and structural steel.
II. In figure X, modal study is performed on Titanium alloy at the periphery of the disc, but it is low inside the disc, indicating that our disc is stable. It cannot shake when we apply the brake.
III. In figure XI, the temperature is higher on the disc's edge, and it gradually falls on the inside. Titanium alloy has a minimum temperature of 43°C, while cast iron has a minimum temperature of 53°C and structural steel has a minimum temperature of 64°C. As a result, we can prefer titanium alloy, but it is more expensive, so we prefer cast iron for disc manufacturing.

For Structural Steel:

IV. In figure XII, when we use structural steel to accomplish total deformation, the total deformation is greater at the disc's periphery and gradually decreases as we move inside the disc. At the disc's outer edge, the distortion is quite little. It has a greater overall deformation value than Cast Iron.
V. In figure XIV, when we use structural steel for modal analysis, the modal analysis in the end of the disc is higher, while it is very low at the outer, indicating that our disc is more stable.
VI. In figure XV, we have a much higher temperature at the periphery of the disc, but as we move inside the disc, the temperature gradually decreases to a minimum. We can reduce the temperature at the outside of the disc by creating more holes on the outside of the disc, as this allows for better heat dissipation and thus lower temperature.

We have done the analysis on the disc using different material through Creo 6.0 and Ansys and from this analysis we have the following conclusion can be drawn that that when if we are taking

In cast iron the total deformation and maximum principal strain is very less as compared to the titanium alloy and structural steel so we are taking the cast iron as because the titanium alloy is costlier than cast iron.

In structural steel the total deformation is higher than the cast iron and maximum principal strain and maximum principal stress is higher so we cannot use these materials.

In titanium alloy the total deformation is much higher and maximum principal strain is also higher and the maximum principal stress is less than structural steel but it is very costly so we cannot use these materials for the disc.

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