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# Design and Analysis of Disc Brake for Honda Shine C125

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**Abstract:** *Disc brakes offer dependable and effective stopping power, making them essential parts of contemporary automotive and industrial applications. This abstract offers a thorough analysis of current developments in disc brake design, emphasizing significant inventions and technologies meant to improve the effectiveness, longevity, and safety of braking.*

**Keywords:** friction, heat dissipation, rotor design, ventilated rotor

## I. INTRODUCTION

With the goal of ensuring maximum performance, safety, and dependability under a variety of operating situations, the design and analysis of disc brakes constitute a crucial component of automotive and industrial engineering. Disc brakes are crucial parts of cars and other machinery because they offer effective braking, which is vital to the operation of the entire system and user safety.The basic ideas and goals of the design and analysis of disc brakes will be covered in detail in this introduction, along with the important factors, difficulties, and techniques that are unique to this intricate field of engineering.The basis for disc brakes' operation is the idea that frictional contact between rotating discs, or rotors, and stationary brake pads transforms kinetic energy into heat energy. Designing disc brakes with the primary goal of providing dependable and consistent braking performance throughout a variety of operating conditions—such as changing loads, speeds, temperatures, and environmental factors—is crucial. To improve frictional contact, heat dissipation, and overall durability, this entails improving characteristics including material selection, shape, surface treatments, and cooling methods. For better braking performance providing effective and dependable braking performance across a variety of operating conditions, such as changing loads, speeds, and temperatures, is the main goal of disc brake design. Ensuring the security of machines and automobiles by creating disc brakes that can reliably and efficiently slow down or stop the vehicle in an emergency, averting collisions and accidents. By limiting wear and component deterioration, disc brakes are designed to survive extended use and challenging operating conditions, resulting in long-term reliability and lower maintenance needs. Minimizing brake fade and maintaining constant braking performance by designing disc brake components, such as rotors and pads, to optimally disperse heat produced while braking. Lowering the total weight of disc brake assemblies by using lightweight components and design strategies, improves vehicle handling, fuel economy, and unsprung mass.

## II. RELATED WORK

This paper tells us that in static structural analysis, stainless steel exhibits lower maximum strain and total deformation than grey cast iron. However, grey cast iron experiences less stress overall. In a steady state thermal examination, both materials have the same temperature distribution, however, grey cast iron has a higher heat distribution. In comparison to stainless steel, grey cast iron has a higher minimum temperature and overall heat flux. Both materials have a similar price range, but stainless steel has a slight advantage due to its higher corrosionproperties. Because of its improved thermal stability, grey cast iron is a better choice for high-speed brake rotors [1].

According to this publication, the purpose of the Transient Thermal and Structural analysis of the Rotor-Disc of Disc Brake was to aid in the design and research of disc rotors and to evaluate the performance of a bicycle disc brake rotor under demanding braking conditions. To enhance the performance of the rotor disc, the deformation and stress established in the disc for both solid and vented discs composed of two different materials were determined using the coupled thermal structural analysis [2].

The braking system is a vehicle's most crucial safety component. Any braking system must be able to precisely slowa vehicle under a variety of conditions. A retarding vehicle needs to safely release its kinetic energy as heat, which is proportional to its mass and square of its speed. When the driver applies force to the brake pedal, the rotor experiences a clamping force that stops the wheels through a sequence of force manipulations. The brake rotor design is the topicof this study. The brake disc on a car is perhaps the part that gets used the most after the tire. The brake calliper's clamping force must be combined with high friction and heat on the disc. Therefore, while designing a vehicle's braking system, careful consideration of the brake disc's material and design is essential. The design technique, as well as the reasoning behind the numerous decisions taken during design, are presented in this paper. Calculations andfinite element analysis of the brake disc model are used to validate the design. In terms of weight reduction, the FEAserves both analytical and optimization purposes [3].
The study discusses the importance of brakes in converting kinetic energy to mechanical energy and the need for heat dissipation in order to prevent brake failure. The project's objective is to investigate the temperature distribution of the rotor disc and apply FEA analysis to identify critical operating temperatures. Static thermal study was performedon the disc rotor to evaluate and compare performance, and materials such AMMC, asbestos, and GCI were analyzed by comparative analysis [4].
This paper uses finite element analysis of disc braking systems to study how brake pad characteristic parameters affect structural modes. The braking system of a car uses friction between the brake pads and rotor disc to transform kinetic energy into thermal energy, which allows the car to slow down or stop. The significance of the braking system in carsis emphasized in this essay. It distinguishes between disc brakes and drum brakes, the latter consisting of a rotor, brakepads, and calipers that are powered by pistons [5].

## III. DESIGN METHODOLOGY

Using SolidWorks and ANSYS to design and analyze a disc brake requires a thorough technique that covers several phases, from inception to validation. First and foremost, it is essential to comprehend the requirements and specifications of the disc brake. This entails identifying elements like the operating temperature range, material restrictions, braking force requirements, and application context (e.g., automotive, industrial). Conceptualization is the first step in the design process once these parameters are set. First design concepts are created by engineers takinginto account factors such as material choice, number of vanes, size, and shape. This stage is made easier using SolidWorks, which makes it possible to create intricate 3D models that show the suggested designs. After conceptualization, the chosen concept is further refined during the detailed design phase by taking performance, aesthetics, and manufacturability into account. At this step, the SolidWorks model must be enhanced with features such as mounting points, cooling vanes, friction surfaces, and other necessary elements. During this stage, material selection is crucial. Engineers select appropriate materials for various components by taking into account attributes like cost, wear resistance, strength and thermal conductivity. Finite element analysis (FEA) using ANSYS is the following stage once the design is finalized. Engineers set boundary conditions, loads, constraints, and contact conditions by importing the SolidWorks model into ANSYS. Appropriate model meshing strikes a compromise between computing efficiency and accuracy. After that, structural analysis is carried out to assess variables like thermal behavior, deformation, and stress distribution during braking. Engineers use the FEA results as a guide to optimize the design. They examine these findings to pinpoint areas in need of development and implement the requiredchanges to improve efficiency, longevity, or performance.
Honda Shine bike specifications and analysis: This bike was chosen because of its affordability and widespread appeal. The braking system specifications are displayed in the table.

Table-1: Specifications

| Parts | Dimensions(mm) |
|---|---|
| Small hole Diameter | 8mm |
| Arc of bigger triangle | 32mm |
| Arc of smaller triangle | 22mm |
| Perpendicular distance between smallerand bigger triangle | 8mm |

| | |
|---|---|
| Inner rotor diameter | 90mm |
| Outer rotor diameter | 120mm |
| Thickness of rotor | 4mm |
| Ventilated disc | Yes |
| Number of Pads | 2 |

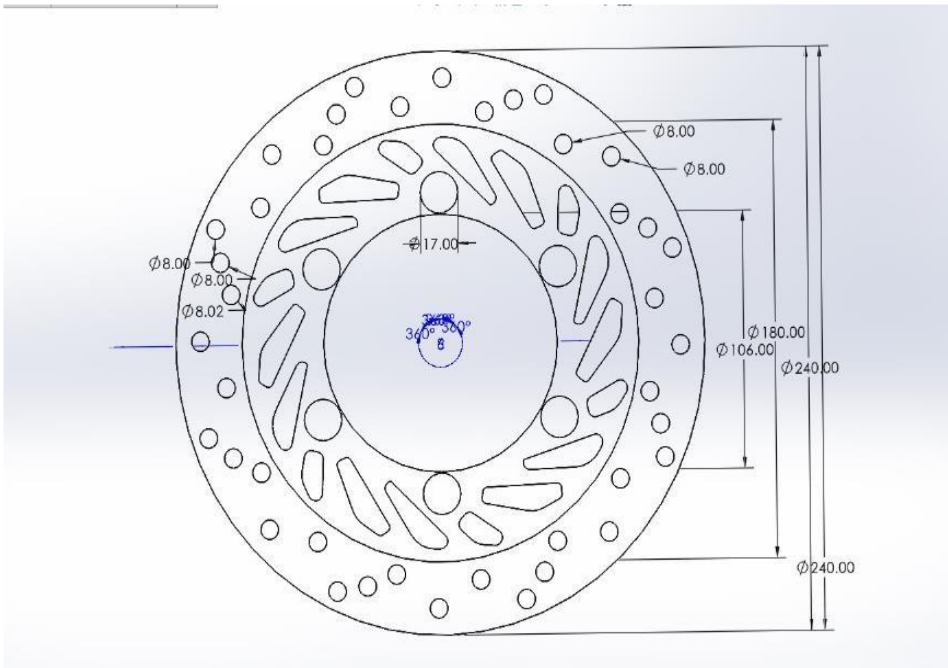

Fig-1: Schematic Design of disc brake

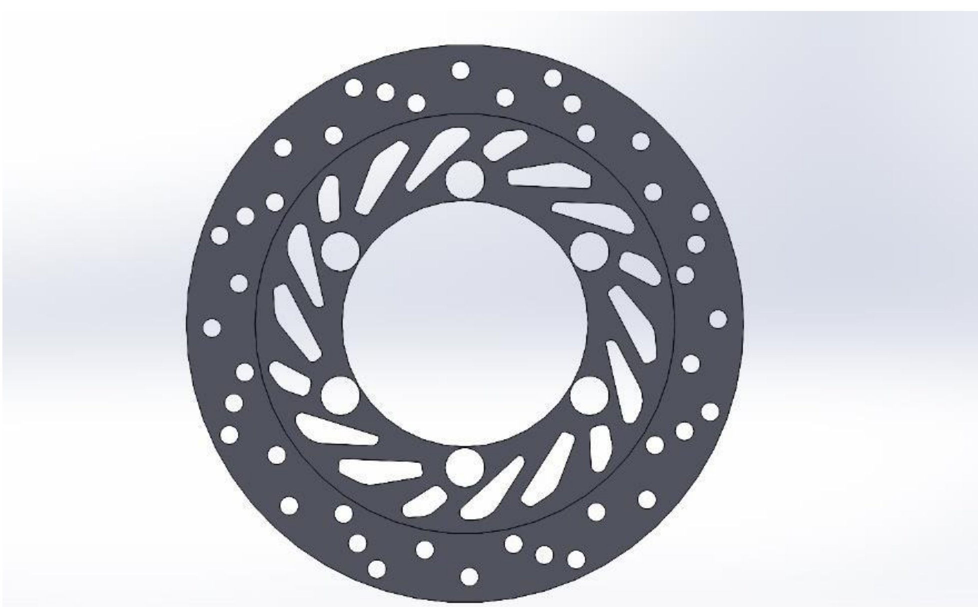
Fig-2 : Design of Disc Brake

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The following are the governing calculations needed to complete the analysis: The following external parameters are needed for the calculations:
Initial velocity=120kmph=33.33m/s^2
Stopping Distance(s)=100 m
Mass of vehicle along with driver(M)=260 kg
u=Initial Velocity(m/s) v=Final Velocity(m/s) a=Acceleration(m/s²) t=Reaction time(seconds)
T=Total timeType equation here.KE1=Final Kinetic Energy KE2=Initial Kinetic Energy
Using Newton's Laws of motion, Calculating Deceleration of vehicle;

$v^2=u^2+2\times a\times s$ …….(1)
$a=v^2-u^2/2\times s$
$a=0-33.33^2/2\times 100$
$a=5.55 m/s^2$

Stopping time taken;
$v=u+a\times t$ …….(2)
$0=33.33-5.55\times t$
t=6 sec
But in reality, human reactions take longer because of this.Ta=Time required to apply brake
Tb=time required to start decelerationTt=Total time in (seconds)
Tt=t + Ta + Tb …….(3)
Tt=7.13 secFor Disc
Braking Force(Fb):
KE2-KE1=Work Done(W) …….(4)
$1/2\times 0.72\times M\times v^2-0=Fb\times s$Fb=1039.79 N

Torque required to stop the wheel(T):
T=Fb × radius of wheel …….(5)
= 1039.79×0.228
= 237.07 Nm

Force on Brake disc(Fd):
Friction coefficient of brake pads(μ)=0.4
Fd = T/radius of disc×μ …….(6)
=4938.95 N

Cast iron is the material used for the disc; it has strong thermal conductivity and vibration resistance. These are some characteristics of cast iron and Stainless steel is shown in the above table.

Table 2: Material properties

| Material Properties | 1. Cast Iron | 2. Stainless Steel |
|---|---|---|
| Density(kg/m³) | 7100 | 7700 |
| Elastic Modulus(GPa) | 110 | 210 |
| Poisson's Ratio | 0.25 | 0.3 |
| Coefficient of friction(μ) | 0.4 | 0.22 |
| Specific Heat(j/kg-k) | 586 | 500 |
| Young's Modulus(GPa) | 125 | 190 |

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## IV. RESULTS AND DISCUSSIONS

When a disc brake is designed and analyzed with SolidWorks and ANSYS, the findings are usually displayed using a variety of metrics and visualizations that shed light on the structural integrity and overall performance of the braking system. The analysis yields the following important results:

### A] For Grey Cast iron

In Fig -3, we have done the static structural equivalent stress using Ansys software. The maximum equivalent(von Mises) stress is 380.48 MPa and the minimum equivalent(von Mises) stress is 0.02873 MPa.

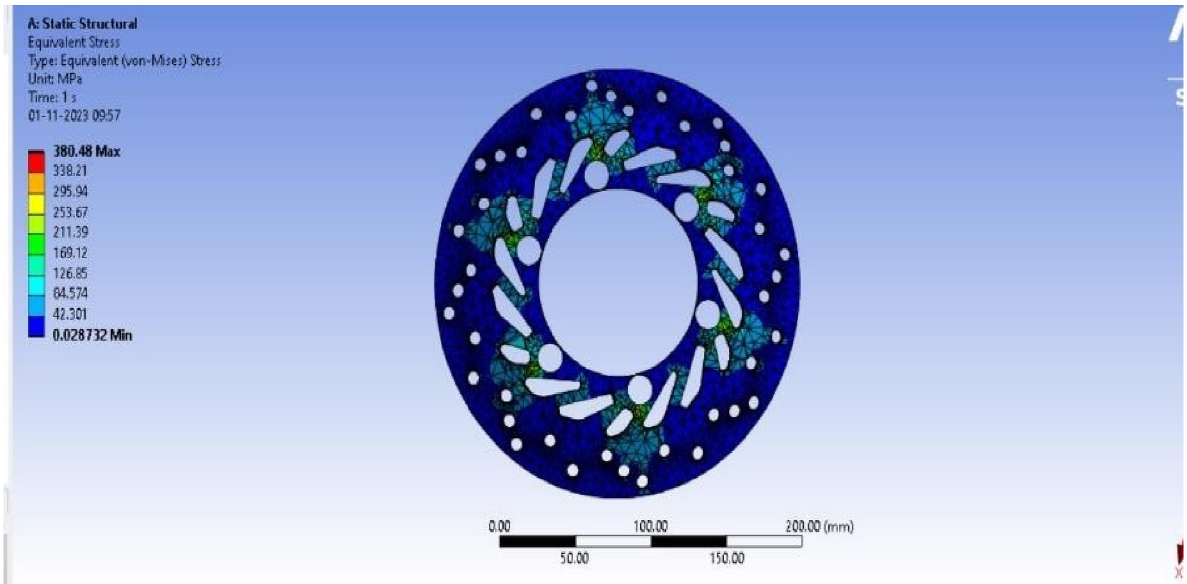


**Fig-3:Equivalent(von-Mises) stress**.

In Fig-4, we have done the static structural total Deformation using Ansys software. The maximumdeformation is 0.3618 mm and the minimum total Deformation is 0 mm.

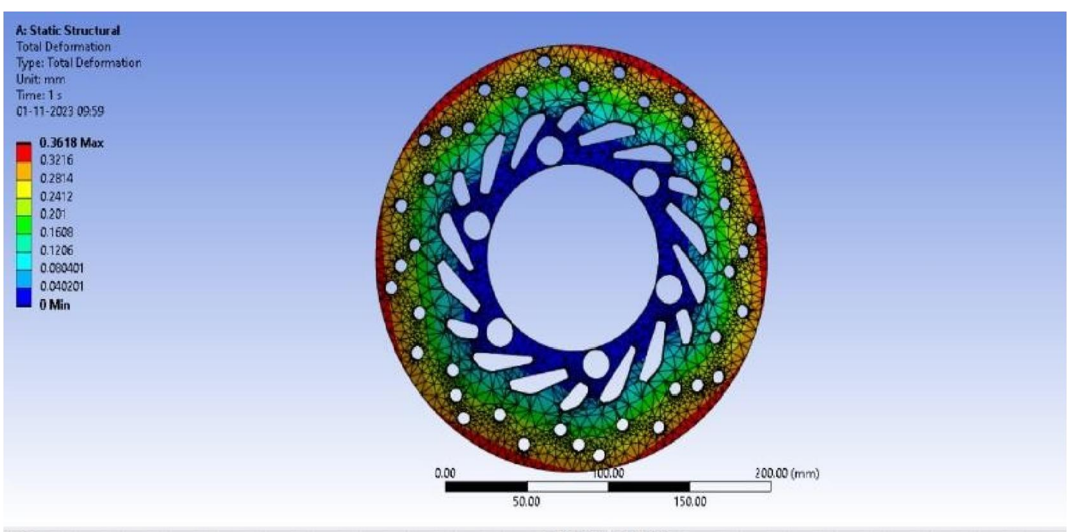


Fig-4:Total Deformation

In Fig-5, we have done the static structural Equivalent Elastic Strain using Ansys software. The maximum Equivalent Elastic Strain is 0.0019027 and the minimum Equivalent Elastic Strain is 1.8573e-7.

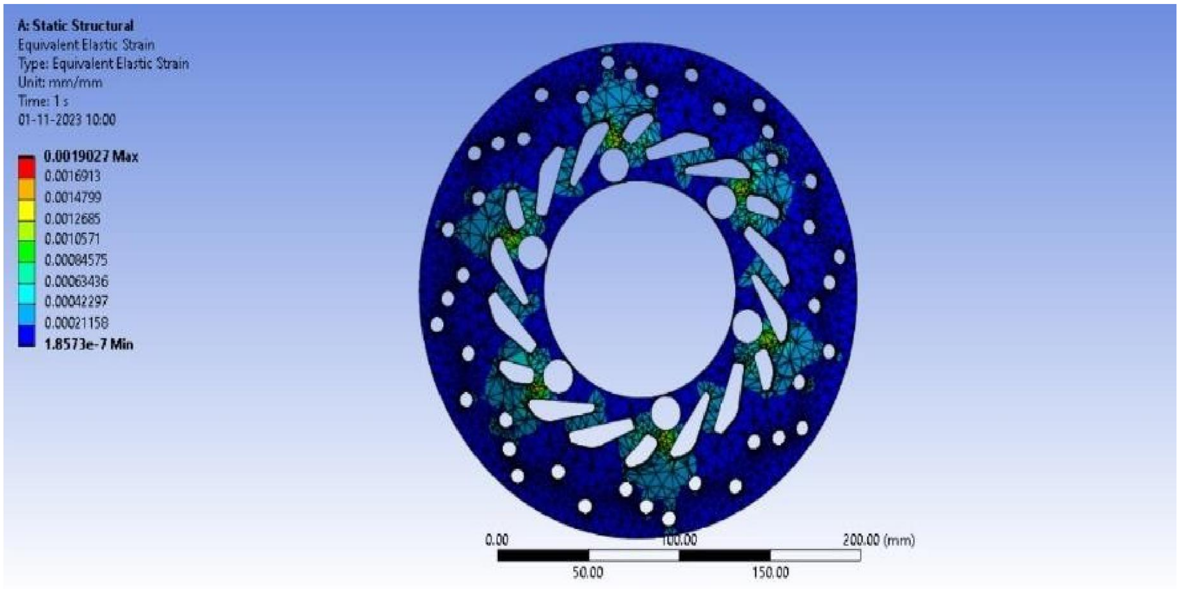


Fig-5 : Equivalent Elastic Strain

**B] For Stainless Steel**

In Fig -6, we have done the static structural equivalent stress using Ansys software. The maximum equivalent(von Mises) stress is 234 MPa and the minimum equivalent(von Mises) stress is 0.01348 MPa.

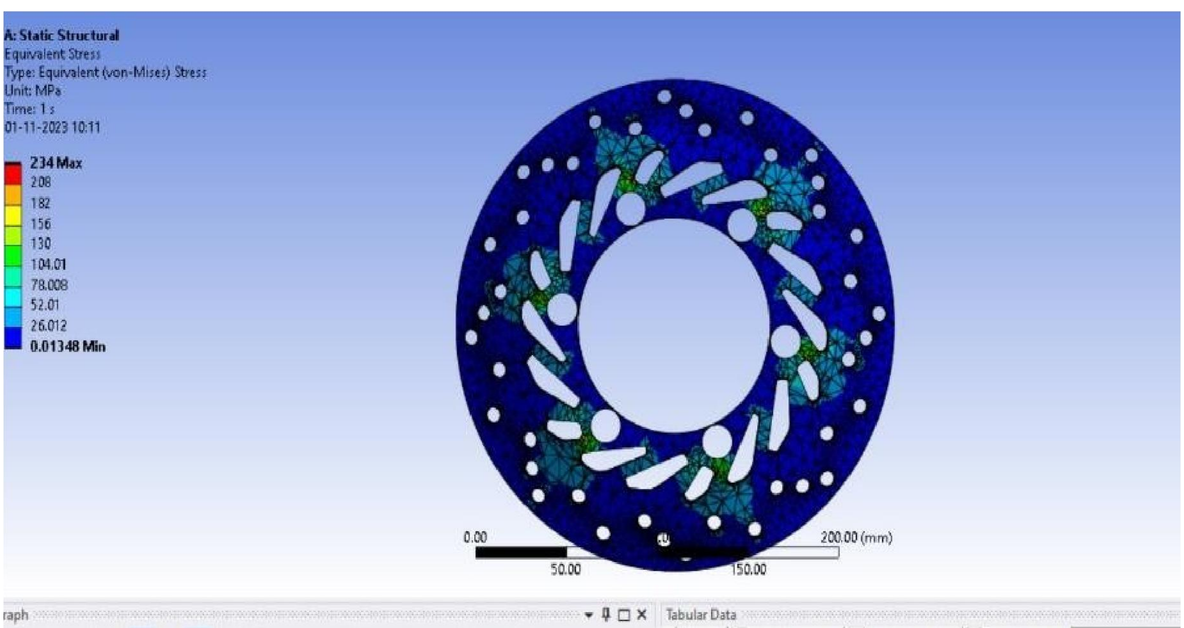


**Fig 6-:Equivalent(von-Mises) stress.**

In Fig-7, we have done the static structural total Deformation using Ansys software. The maximumdeformation is 0.20683 mm and the minimum total Deformation is 0 mm.

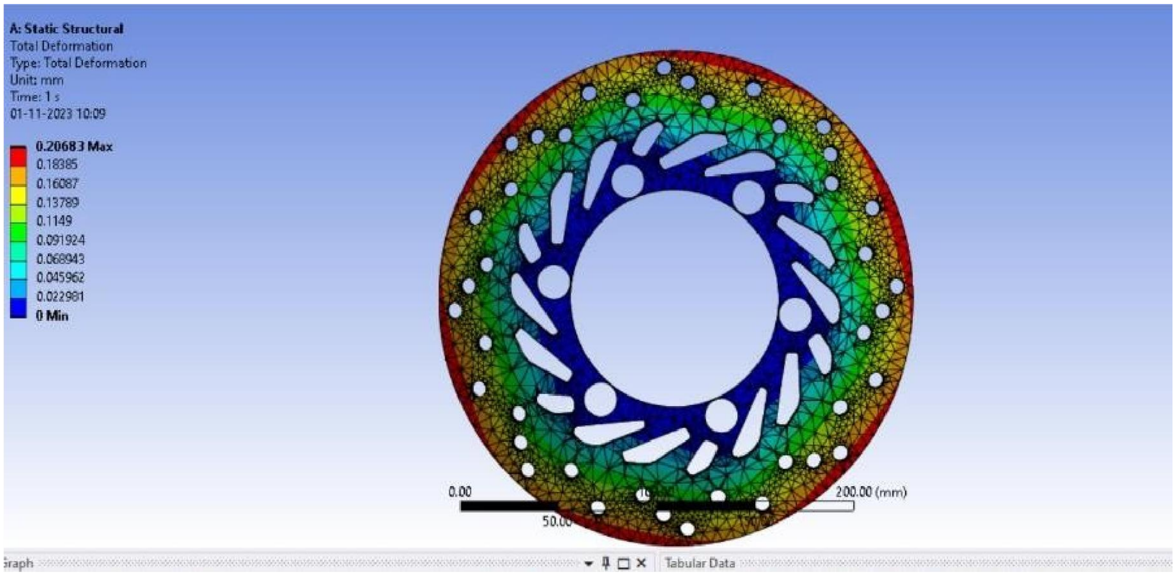


Fig-7:Total Deformation

In Fig-8, we have done the static structural Equivalent Elastic Strain using Ansys software. The maximum Equivalent Elastic Strain is 0.0011702 and the minimum Equivalent Elastic Strain is 1.454e-7.

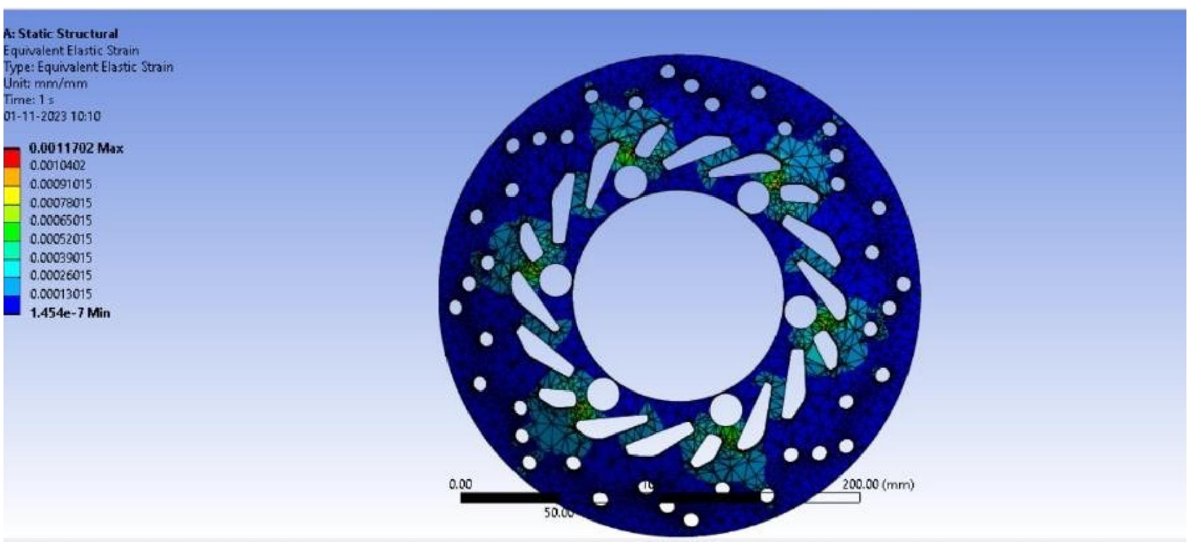


Fig-8 : Equivalent Elastic Strain

Table 3 Analysis table for Cast Iron and Stainless steel

| Material | Stress(MPa) | Strain | Deformation(mm) |
|---|---|---|---|
| Cast Iron | Max:380.48<br>Min:0.0287 | Max:0.0019027<br>Min:1.8573e-7 | Max:0.3618<br>Min:0 |
| Stainless Steel | Max:238<br>Min:0.013 | Max:0.00117<br>Min:1.45e-7 | Max:0.268<br>Min:0 |

## V. CONCLUSION

This paper describes the Solidworks front disc brake design for a Honda Shine C125 and how the disc rotor pressureis calculated. Von Misses Stress, and Strain, are provided by Ansys, in that order. It has been found that cast iron hasstress ,strain and deformations values 380.48 MPa , 0.0019027 and 0.3618mm respectively and stainless steel has stress, strain and deformation values 238MPa ,0.00117 and 0.268mm respectively. From this values we can conclude that cast iron can bear more stress than stainless steel and hence cast iron is more preferable than stainless steel.

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