INTERNATIONAL RESEARCH JOURNAL OF ENGINEERING & APPLIED SCIENCES
IRJEAS NURTURING RESEARCH
ISSN: 2322-0821(0) ISSN: 2394-9910(P)
VOLUME 8 ISSUE 3 Jul 2020 - Sep 2020
www.irjeas.org

DESIGN & ANALYSIS ON BRAKE CALIPER BY USING DIFFERENT MATERIALS THROUGH ANSYS

[1]Ashish Ranjan Bhagwat, [2]Sohail Bux
[1] PG Scholar, Department of Mechanical Engineering,AGONES college of Technology,Bhopal, MP, India
[2] Professor, Department of Mechanical Engineering,AGONES college of Technology,Bhopal, MP, India

ABSTRACT- The disc brake rotor is a rotating device. Braking is a process which converts the kinetic energy of the vehicle into mechanical energy which must be dissipated in the form of heat. This project presents the analysis of the contact pressure distributions at the disc interfaces using a detailed 3 dimensional finite element model of a real car disc brake rotor . Finite element (FE) models of the brake-disc rotor are created using CATIAV5R20 and simulated using ANSYS 19.2 which is based on the finite element method (FEM). It is also investigates different levels in modeling a disc brake rotor system and simulating contact pressure distributions and temperature industry the contact analysis and thermal analysis. The effect of the angular velocity and the contact pressure distribution temperature and on disc brake rotor are investigated. In our project we take different three materials like Cast Iron Alloy, Aluminium Alloy, Composite materials Carbon fibre. we have found temperatures and heat flux, thermal stresses and deformations.Finally comparison between these materials and carried out stresses and deformations level maximum and minimum then we have find out , Carbon fiber is best materials other than materials because its light weight and durable.

Keywords: Cast Iron , Aluminium Alloy, Carbon fiber, Stresses , Deformation, CATIA, ANSYS, Disc brake roto r

I. INTRODUCTION

The brakes designed for the purpose of racing need to have very high braking efficiency. The wear and tear of the pads or the cost is not of great concern to the manufacturer of the racing car brakes. Initially the automobiles employed drum brakes in the cars. The main focus of this thesis is not for the passenger car technology but it concentrates on the automotive racing industry, NASCAR, the Nation Association of Stock Car Racing. NASCAR is a racing league similar to other racing leagues like Formula 1. The words "Stock Car" are complete purpose built race cars whose only similarity to the production vehicles replicate in exterior side profile. Major vehicle systems are designed for their specific racing purposes [2]. The chassis used by the racing car is full tube frame while that used on commercial vehicles is made of single body frame. Another difference is the drive train; race versions have eight cylinder engines with rear wheel drive whereas commercial vehicles are four or six cylinder engines with front wheel drive

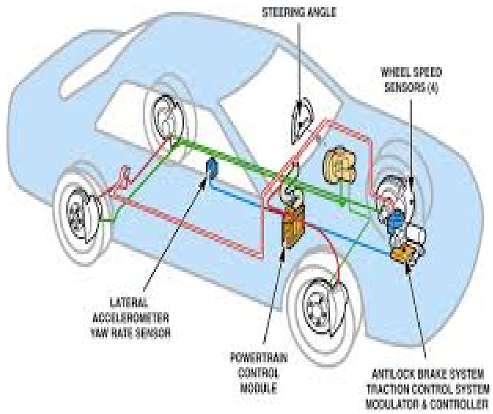

Fig. 1.1 Vehicle Brake System

1.1 How do disk brakes work?

- Disk brakes convert kinetic energy from the car into thermal energy by friction

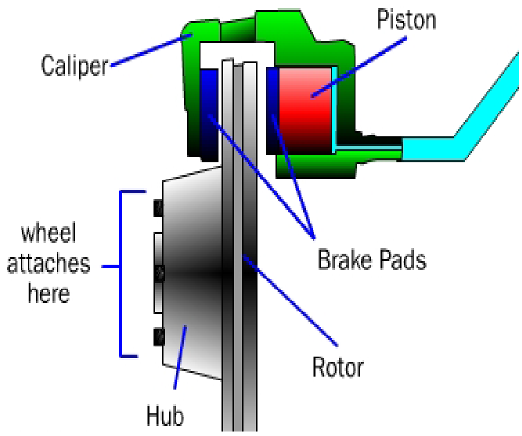

Fig.1.2 Disc brake systems

© 2020 Copyright IRJEAS. All Rights Reserved

International Research Journal of Engineering & Applied Sciences, IRJEAS
www.irjeas.org, ISSN(O): 2322-0821, ISSN(P): 2394-9910, Volume 8 Issue 3, July-September 2020, Page 28-34

1.2 Brake Caliper

The brake fluid compresses the piston inside the brake caliper applying pressure to the brake pads.

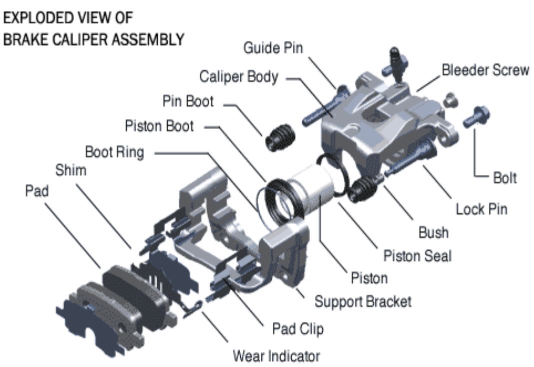

Fig.1.3 Brake Caliper Assembly Systems

1.3 Brake Rotors

- ✓ Connected to the axel – rotating at the same speed as the wheel
- ✓ Generally made out of steel
- ✓ Commonly slotted or drilled for extra heat dissipation

Fig. 1.4 Brake Rotors

1.4 Brake Pads

- Fixed in the brake caliper
- Various compounds of materials are used
- Wear over time and must be replaced

Fig. 1.5 Brake Pads

1.5 Brake Pad Materials

- Asbestos
- Semi-Metallic
- Non-Asbestos Organics
- Low Steel
- Carbon
- Exact composition of each manufacturer's pads is a closely guarded secret

II. PROBLEM IN BRAKE ROTORS

On studying the background of brakes the main purpose of conducting this research work was finalized. The main objective was to propose a conceptual design for a disc brake rotor using exiting material Aluminium Alloy, Titanium, Gray Cast iron Alloy and New materials Carbon fiber, called a modular brake caliper. The efficient working of brake system depends on how the brake behaves at high temperatures. Thus the aim of the research work will be to reduce the thermal deformation in the modular brake rotor. Since Gray Cast iron hard to machine, modular caliper will be developed as an assembly instead of single block design.

III. OBJECTIVE

Disc brake noise and vibration generation during braking has been one of the most important issues and definitely worrying problem to automotive manufacturers. Despite brake noise is not a safety issue and has little impact on braking performance, it gives customers the impression of underlying quality problems of the vehicle. In addition, the customers view that the noise emitted from the brake system is indicator of malfunctioning condition and consequently lose confidence on the quality of the vehicles.

IV. MATERIALS

4.1 Material Selection

Material selection plays a very important role in machine design. Three metals are considered for the analysis of scissor lift is epoxy e glass fiber structural steel and stainless steel.

Table- 4.1 Cast Iron Alloy Mechanical properties

Material Field Variable	Value	Units
Density	7200	Kg/m^3
Young's modulus	1.1E+11	Mpa

© 2020 Copyright IRJEAS. All Rights Reserved

Poisson Ratio	0.28	
Shear modulus	4.2969E+10	Mpa
Bulk Modulus	8.3333E+10	Mpa
Tensile Strength	240	Mpa
Compressive Strength	820	Mpa
Material Field Variable	Value	Units
Density	7200	Kg/m^3

Table- 4.2 Al-Si Alloy materials Mechanical properties

Material Field Variable	Value	Units
Density	2760	Kg/m3
Young's modulus	5.54E+10	MPa
Poisson Ratio	0.3	
Shear modulus	4.6167E+10	MPa
Bulk Modulus	2.1308E+10	MPa
Tensile Yield Strength	97	MPa
Tensile ultimate Strength	200	MPa
Compressive Ultimate Strength	76	MPa

Table- 4.3 Carbon fiber materials Mechanical properties

Material Field Variable	Value	Units
Density	1950	Kg/m^3
Young's Modulus	300000	MPa
Poisson Ratio	0.30	
Shear modulus	1.153E+5	MPa
Bulk Modulus	2.5E+5	MPa
Tensile Strength	5090	MPa

V. MODELING & SIMULATION

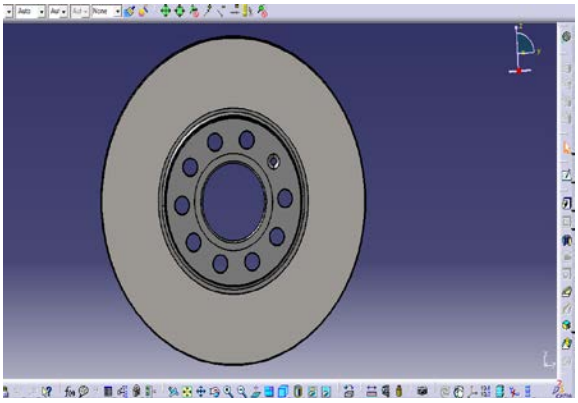

Fig. 5.1 CAD Model generate in CATIA

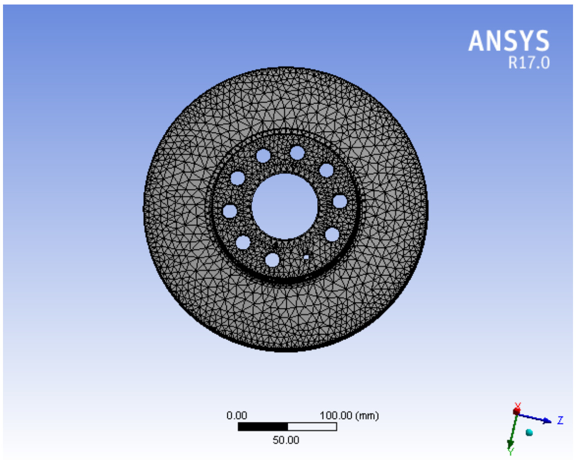

Fig. 5.2 CAD Model import in ANSYS and generate meshing

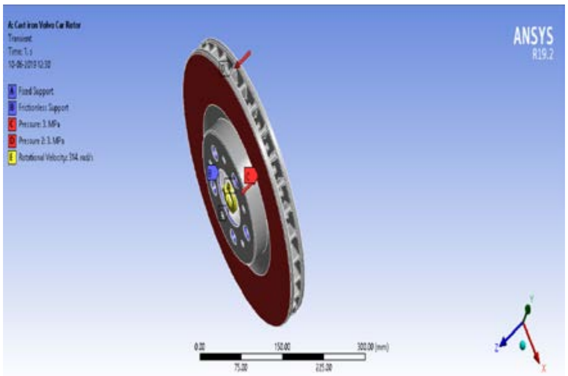

Fig. 5.3 Applied boundary conditions on Carbon fiber materials

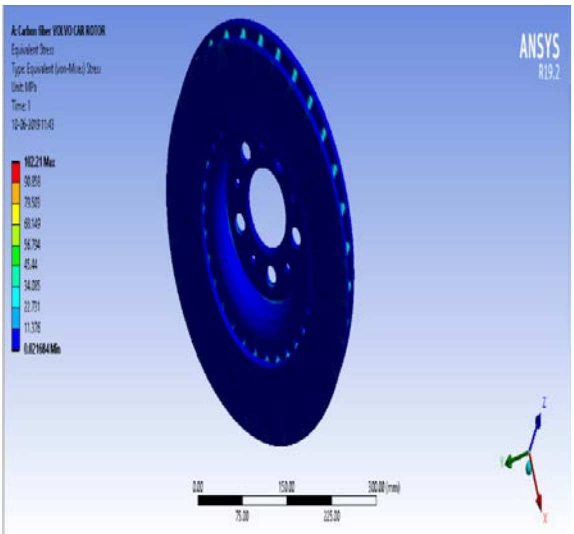

Fig. 5.4 Thermal Von misses stresses in Carbon fiber Brake Rotor

© 2020 Copyright IRJEAS. All Rights Reserved

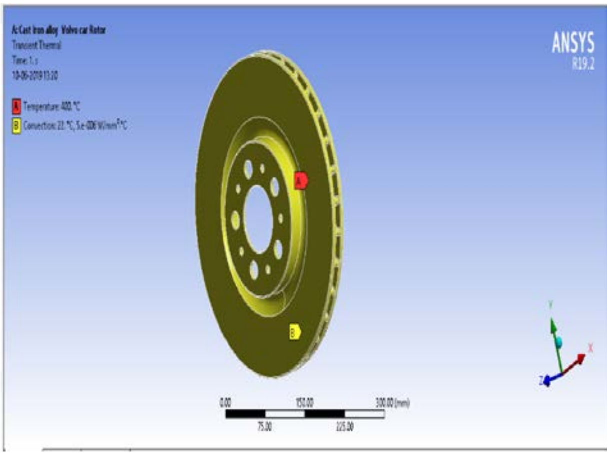

Fig. 5.5 Rotor disc Carbon fiber material thermal boundary condition

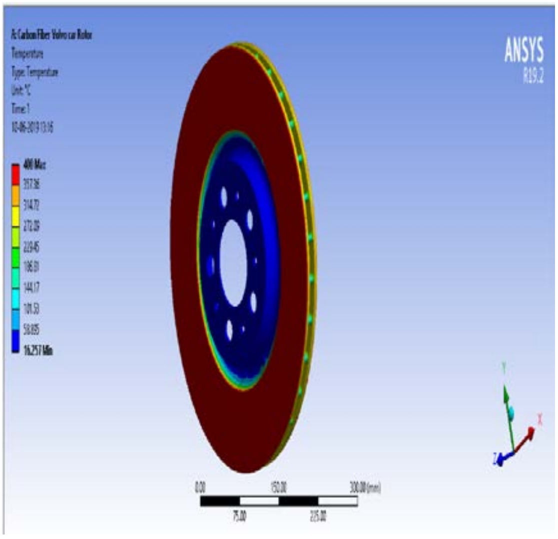

Fig. 5.6 Rotor disc Carbon fiber material temperature

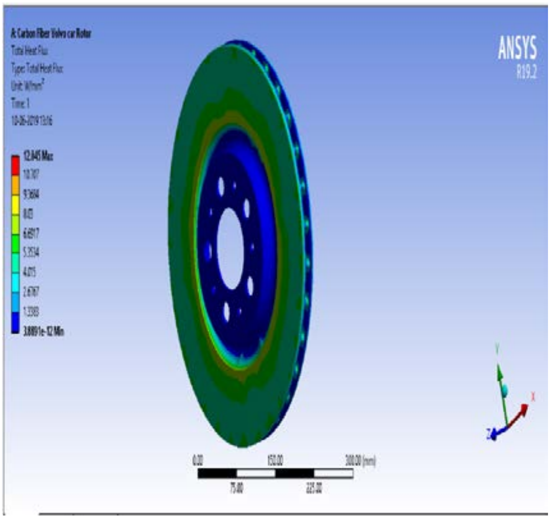

Fig. 5.7 Rotor disc Carbon fiber material heat flux

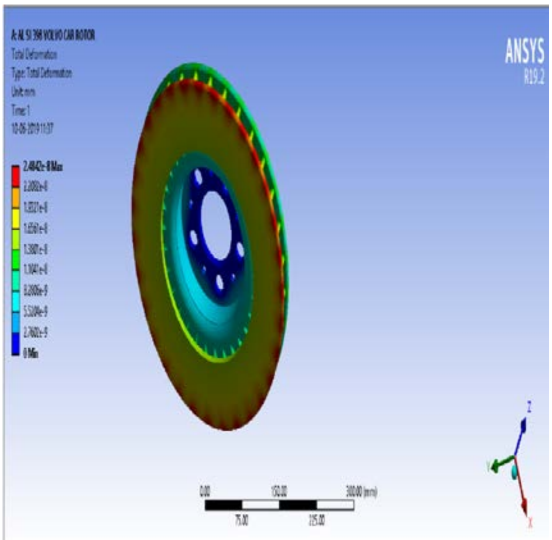

Fig. 5.8 Von misses stresses in Al-Si Alloy Brake Rotor

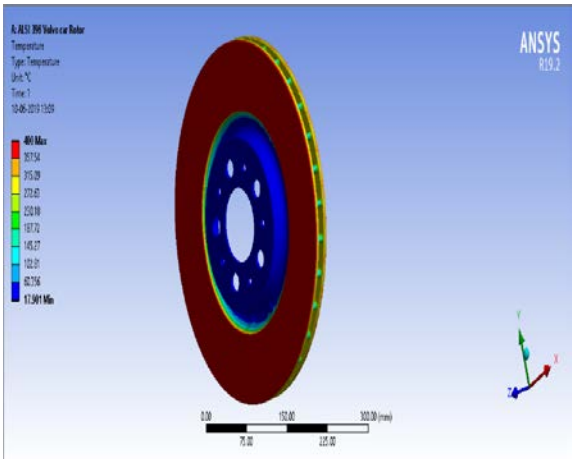

Fig. 5.9 Rotor disc Al-Si Alloy temperature

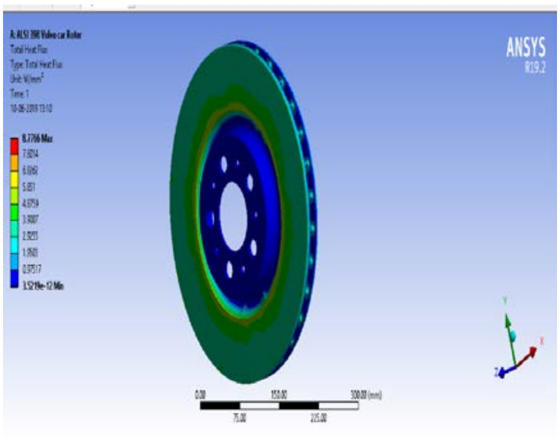

Fig. 5.10 Rotor disc Al-Si Alloy heat flux

© 2020 Copyright IRJEAS. All Rights Reserved

International Research Journal of Engineering & Applied Sciences, IRJEAS
www.irjeas.org, ISSN(O): 2322-0821, ISSN(P): 2394-9910, Volume 8 Issue 3, July-September 2020, Page 28-34

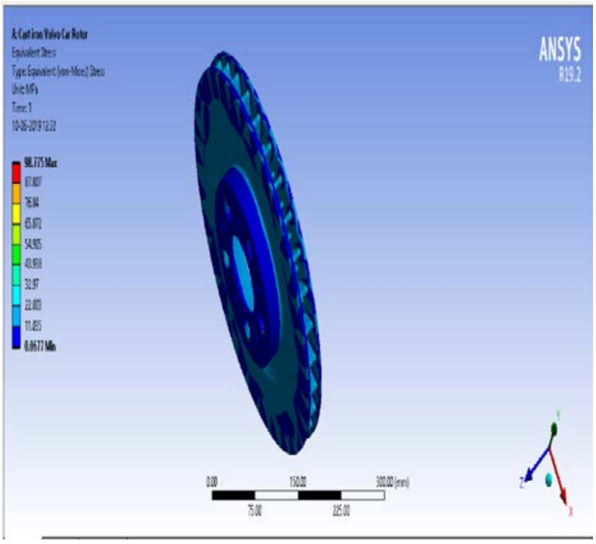

Fig.5.11 Rotor disc Cast iron alloy thermal von misses stresses

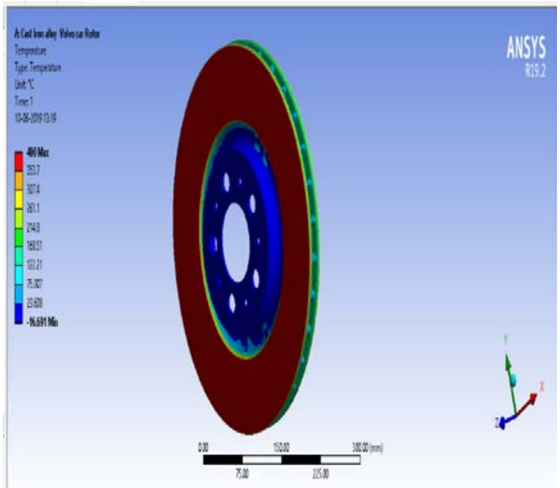

Fig. 5.12 Rotor disc Cast iron alloy temperature

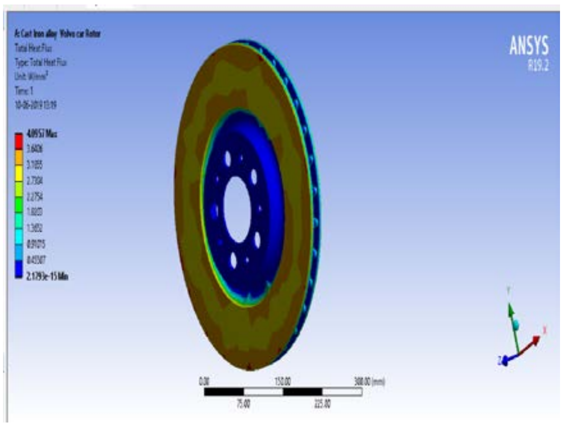

Fig. 5.13 Rotor disc Cast iron alloy heat flux

VI. ANALYTICAL CALCULATION

Volvo S60

Car Kerb weight = 1636 kg

Velocity (v) = 90 km/hr = 25 m/sec

KE =1/2 mv^2 = 1/2 x 1636 $(25)^2$ = 5.1 $x10^5$ Joules

Braking force (F_B) = work/ Distance = W/s = 5.1 $x10^5$(J)/50(m) = 10000 N = say 10000 N

Now we take 60% and 40% ratio

So 60% Front wheels (6000 N on two wheel), Rear wheels (4000 N on two wheel)

For Single wheel (Front) Force = 6000/2 = 3000 N

Force by one piston = 3000/4 = 750 N

Engine Specification: 143 hp

N = 3000 RPM

w= 2ΠN/60 = 2 X 3.14X 3000 / 60 = 314 rad/sec

Piston Pressure = Force / Area

P = F /A

Area = Π / 4 x d^2= Π / 4 x $(28)^2$ = 615.75 mm^2

P_1= 750/615.75 = **1.22MPa**

P = P1 + P2 = 1.22 + 1.22 = 2.44MPa

P = 3 MPa

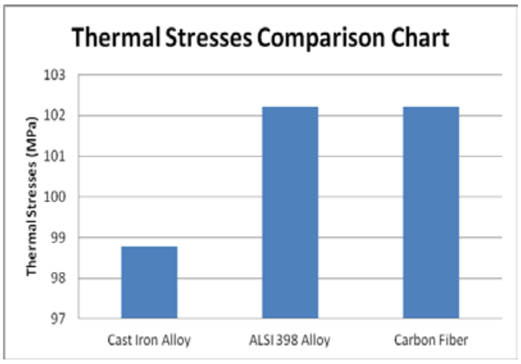

Fig. 6.1 Thermal Stresses comparison Charts

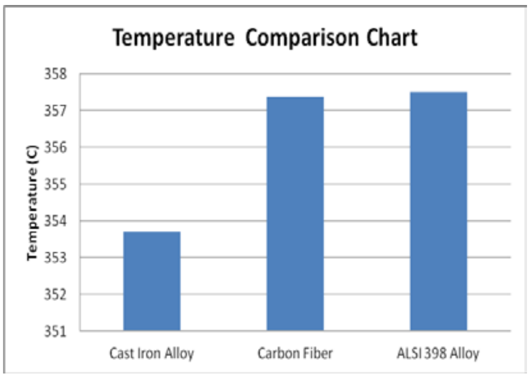

Figure 6.2 Temperature Comparison Chart

© 2020 Copyright IRJEAS. All Rights Reserved

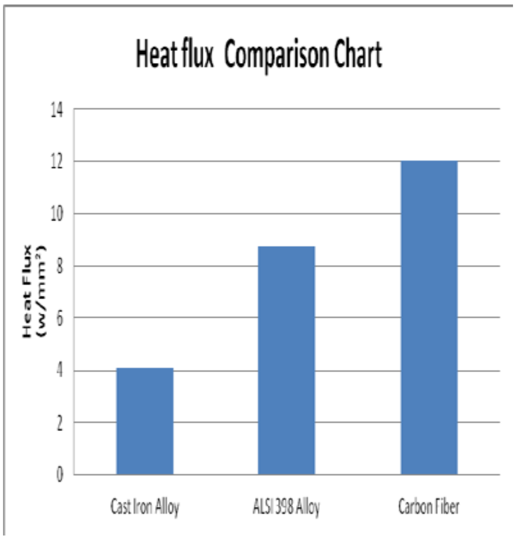

Figure 6.3Thermal Heat Flux Comparison Chart

VII. RESULT & DISCUSSION

We take different three materials and seen that the maximum von misses stress value for All material like Cast Iron Alloy , AL SI 398 ,and Carbon Fiber respectively are 4.09 w/mm^2 , 8.77 w/mm^2 and 12.04 w/mm^2. Here we can clearly observe that Carbon Fiber materials have very high value of heat flux temperature compare to other materials. So it is safe for future design.

So we can suggest Carbon Fiber materials for Low budget car's brake rotor in future, whereas Carbon fiber best material specially for Luxury and sports car's. Because it is light weight and durable materials.

Discussion

- Carbon Fiber properties will be decreased fairly while the steel and cast iron properties will remain basically the same. High dampness with warmth will have a significantly more prominent impact.
- You can see that the Carbon Fiber is the lightest and the most minimal thickness and has moderate stiffness.
- Carbon Fiber layer have most uniform properties. , you can get up to about a 30% weight investment funds over Cast Iron.
-

VIII. CONCLUSION & FUTURE SCOPE

8.1 Conclusion

The disc brake is a gadget for decelerating or halting the revolution of a wheel. Slowing down is a procedure which changes over the motor vitality of the vehicle into mechanical vitality which must be dispersed as warmth. This paper presents the examination of the contact pressure dispersions at the plate interfaces utilizing a ANSYS 19.3 -dimensional model of a genuine vehicle circle brake. Assurance of the slowing down power is the most pivotal perspective to be thought of while planning any stopping mechanism. The created slowing down power ought to consistently be more noteworthy than the required slowing down power. The estimation of required cinching power causes us to choose the boundaries of the circle brake rotor. Displaying and examination o plate brake rotor is done to choose the best material which is progressively sturdy. Space and get together imperatives are likewise a significant factor while structuring the rotor body. Discover the estimation of distortions and worries because of reason for pressure. We take nine unique materials Cast Iron Alloy, AL-Si 398, and Carbon fiber . Investigation is done on these materials and presumes that Carbon Fiber shows the base pressure and twisting qualities in limit conditions. So we can recommend though Carbon fiber best material extraordinarily for Luxury and sports car's.

8.2 Future Scope

In future this work can be extended by

- Using different composite materials
- We can do thermal CFD analysis in dick brake rotor with different boundary condition like fluid pressure temperature etc.
- The modular design will be analyzed without considering the effects of thermal expansion.
- Vibration analysis can be done.
- Discrete analysis can be done by using UTM machine and other Hardness test.

REFERENCES

1. **Ting-Long Ho.,** "Effect of frictional heating on brake materials", Wear, 30(1974) 73-91
2. **Masahiro Kubota**. "Development of lightweight brake disc rotor: A design approach for achieving an optimum thermal, vibration and weight balance." JASE review 21 (2000) 349-355.
3. **JIANG Lan, ,** "Thermal analysis for brake disk of Sci/6061 Al. Alloy co-continuous composite for CRH3 during emergency braking considering air flow cooling" ,Trans. Nonferrous Met. Soc. China 22(2012) 2783-2791.
4. **PiotrGrzes and Adam Adamowicz,**"Analysis of disc brake temperature distribution during single braking under non-axisymmetric load", Apllied thermal engineering 31(2011) 1003-1012.
5. **Zhang Jian,** "Research of the transient temperature field and friction properties on disc brakes", Preceeding of the 2012 2nd

© 2020 Copyright IRJEAS. All Rights Reserved

International conference on computer and information application (ICCIA 2012).

6. **K. Sowjanya,**"Structural analysis of disk brake rotor", International Journal of computer trends and technology (IJCTT)- volume 4 , Issue 7- July 2013
7. **K. M. Muniswamy**, "Heat transfer enhancement on ventilated brake disk with blade inclination angle variation", international journal of automotive technology, vol. 14, No. 4, PP.569-575, 2013
8. **Yugesh Anil Kharche and Prof. DheerajVerma**" Design And Fem Based Analysis Of Disc Brake For Four Wheeler" International Journal of Mechanical Engineering Research & Technology, vol.1 July 2015
9. **Pravin Mohan and Patel Sudheendra S ,"** Design and Analysis of Titanium Caliper Disc Brake" International Journal of Engineering Development and Research, Volume 5, Issue 1 | ISSN: 2321-9939, PP 144 – 158, 2017
10. **S.ArvinRao,MuhamadAnuwarJusoh, Abd Rahim Abu Bakar* 2017**,"REDUCTION OF DISC BRAKE SQUEAL NOISE USING CONSTRAINEDLAYERDAMPERS"JurnalTeknologi(Sciences&Engineering),4(2017)83–87

© 2020 Copyright IRJEAS. All Rights Reserved