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FINITE ELEMENT ANALYSIS OF DISK PLATE FOR TWO WHEELER AUTOMOTIVE FRONT DISK BRAKE

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ABSTRACT

A Disc brake is a device that retards/halts the rotation of a shaft/ wheel. A disc brake system consists of a brake disc, a brake caliper and brake pad. When the brake pedal is applied, pressurized hydraulic fluid squeezes the brake pad friction material against the surface of the rotating brake disc. The result of this contact produces friction which enables the vehicle to slow down or stop. Due to this friction, heat will be generated and the brake disc gets heated up which affects the performance of the disc brake under different braking conditions. In this paper focus is primarily emphasized on the comparative performance of disc brakes having different profiles, by determining the von-misses stress & Deformation developed in the disc brake for different braking conditions using ANSYS14.5

KEYWORDS: Disk Plate, Stress, Pro-e, Ansys 14.52 and Deformation.

INTRODUCTION

The Drum brake is not sufficient for excessive heat condition, requires more effort from rider and needs to be adjusted frequently. To overcome above problems disc brake is used. A disc brake uses hydraulic pressure to stop the vehicle. It is widely used in motorcycles, cars, trucks, buses, bicycle etc. but here we are focusing only on motorcycle disc brake.

The first caliper-type automobile disc brake was patented by Frederick William in 1902 but it w as failed due to use of copper disc. The first motorcycles to use disc brakes were racing machines. The first mass-produced road-going motorcycle to sport a disc-brake was the 1969 Honda CB750 (A Successful motorcycle launched by Honda.

A Brake is a device used in the machines to inhibit the motion by providing artificial frictional Resistance to a moving member. Brake plate absorbs the kinetic energy and dissipates the heat energy. There are different types of brakes among which disc brakes, drum brakes, air brakes, and vacuum brakes are prominent. The disk brake is a round, flat piece of metal, made usually of cast iron that is attached to the wheel. When braking, the brake discs are squeezed against the wheel on either side by brake pads. Disk brakes last longer and are more effective when wet than drum brakes.

A disk brake works on the principle of Pascal's Law/Principle of transmission of fluid pressure. The fluid enters in to cylinder bore of caliper assembly via brake hosepipes and pushes the caliper piston or pistons. At this time

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the piston ring moves in rolling shape with piston and then the caliper piston pushes brake pad. This movement causes brake pads to stick with brake disc which creates friction and stops the brake disc/rotor to rotate by which the disk brake system stops or slows down the vehicle.

When the brake lever is released the piston ring pushes the caliper piston back to cylinder bore of caliper till both, caliper piston and piston ring come into their original shape. At this time retraction spring pushes the brake pads to their original position. The return spring in master cylinder assembly pushes the master cylinder piston back into its original position and allows the fluid to flow.

Disc brake is usually made of Cast iron, so it is being selected for investigating the effect of strength variations on the predicted stress distribution Gray Cast Iron & SS materials are selected and analyzed. The results are compared with existing disc rotor. The model of Disc brake is developed by using Solid modeling software Pro/E (Creo-Parametric1.0).Further Static Analysis is done by using ANSYS Workbench. Structural Analysis is done to determine the Deflection & Mises stress.

PTC Creo, formerly known as Pro/ENGINEER, is 3D CAD/CAM/CAE feature-based, associative solid modeling software. It is one of a suite of 10 collaborative applications that provide solid modeling, assembly modeling, 2D orthographic views, finite element analysis, direct and parametric modeling, sub-divisional and NURBS surfacing, and NC and tooling functionality for mechanical designers. Creo Elements/Parametric competes directly with Solid works, CATIA, and NX/Solid Edge. It was created by Parametric Technology Corporation (PTC) and was the first of its kind to mark.

ANSYS package 14.5 is a dedicated finite element package used for determining the variation of stresses and deformation across the disc brake profile. In this present work, an attempt has been made to investigate the effect of variations in disc brake rotor design on the predicted stress and Deformation. By identifying the true design features, the extended service life and long term stability is assured.

MATERIALS AND METHODS

Properties of Gray Cast Iron:

DESCRIPTION	VALUE	UNITS
Density	7.2e-006	In kg /mm^{-3}
Compressive Ultimate Strength	820	In MPa
Tensile Ultimate Strength	240	In MPa
Poisson's Ratio	0.28	

Properties of SS (Structure Steel):

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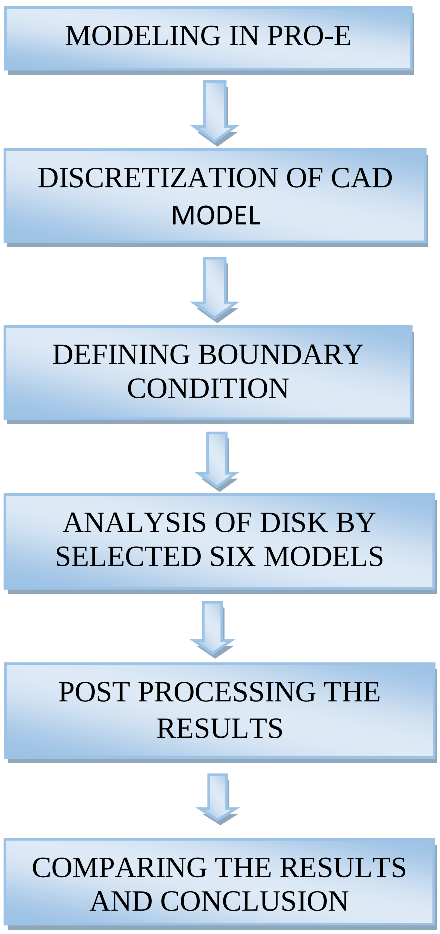
DESCRIPTION	VALUE	UNITS
Density	7.85e-006	In kg /mm^{-3}
Compressive Yield Strength	250	In MPa
Tensile Ultimate Strength	460	In MPa
Poisson's Ratio	0.3	

METHODOLOGY



INPUT PARAMETER FOR DISC BRAKE

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In this project, be study about stress & deformation analysis on rotor disc under condition of static equation. After completion of the finite element model it has to constrain and load has to be applied to the model. User can define constraints and loads in various ways.

Rotor disc dimension = 240 mm

Rotor disc Thickness = 10 mm

Rotor disc material = Gray cast iron & SS

Tangential Force = 1000 N

LITERATURE REVIEW

A few papers were discussed about developing and validating procedures for predicting the analysis of Disk Plate for different Profile.

Design Modification & Optimization of Disc Brake Rotor IJREAT, P.K.Zaware1 et. al., Volume 2, Issue 3, June-July, 2014 –

This paper This work is presented with “Design modification & optimization in stress, deformation & weight of Disc brake rotor” which studies about on disc brake rotor by modeling & analysis of different shapes of slots of different vehicle’s disc brake rotor with same outer diameter & inner mounting position of holes on wheel hub as like Bajaj Pulsar 150.Analysis done on real model of disc brake rotor of Bajaj pulsar 150cc and disc brake Rotor of different shapes of slots of different vehicle’s in one Disc brake rotor.

Structure Optimization of Disc Brake (IJSEAS) Vaibhav A. Ajmire Issue-7, October 2015

In the present work in Structural Analysis of the Rotor of Disc Brake is aimed at evaluating the performance of disc brake rotor of a bike under severe braking conditions and there by assist in disc rotor design and analysis. An investigation into usage of new materials is required which improve braking efficiency and provide greater stability to vehicle. This investigation can be done using ANSYS software along with the modeling software CATIA V5.

MODELING & ANALYSIS

* Modeling of Modified disc brake rotor 1 done in Pro-E

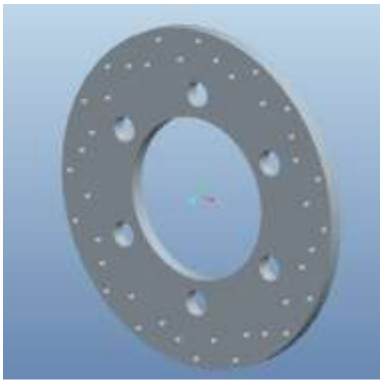

Fig.1.1 shows Modeling of Modified disc brake rotor 1 done in Pro-E

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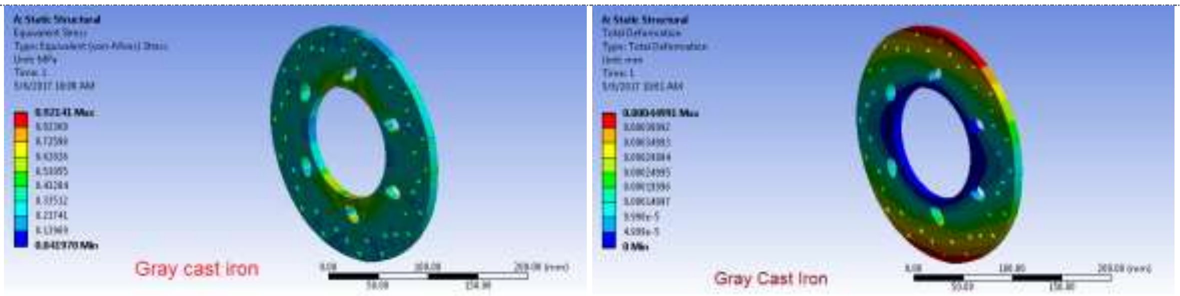

Fig. 1.2 Stress & Deformation Analysis in Disc Brake Rotor 1 Material in Gray cast iron

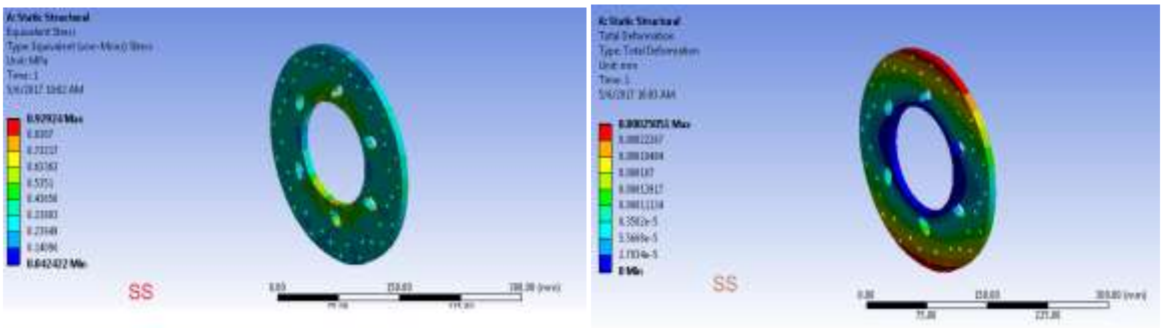

Fig. 1.3 Stress & Deformation Analysis in Disc Brake Rotor 1 Material in SS

*Modeling of Modified disc brake rotor 2 done in Pro-E

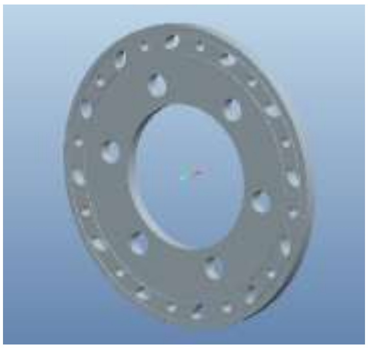

Fig.2.1 shows Modeling of Modified disc brake rotor 2 done in Pro-E

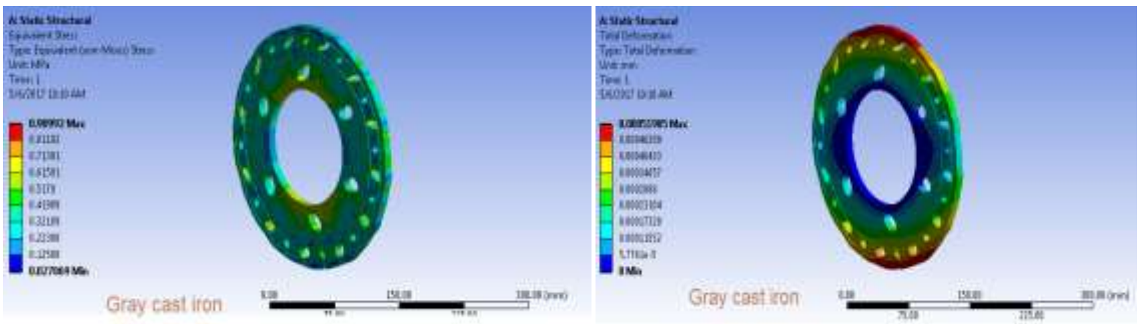

Fig. 2.2 Stress & Deformation Analysis in Disc Brake Rotor 2 Material in Gray Cast Iron

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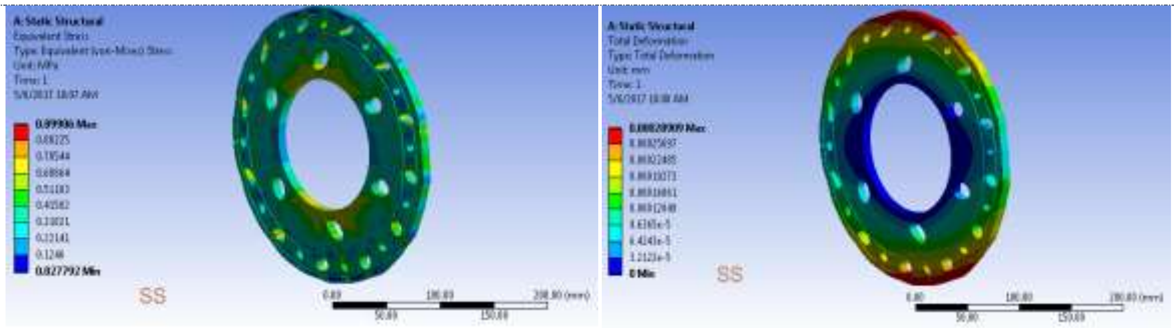

Fig. 2.3 Stress & Deformation Analysis in Disc Brake Rotor 2 Material in SS

*Modeling of Modified disc brake rotor 3 done in Pro-E

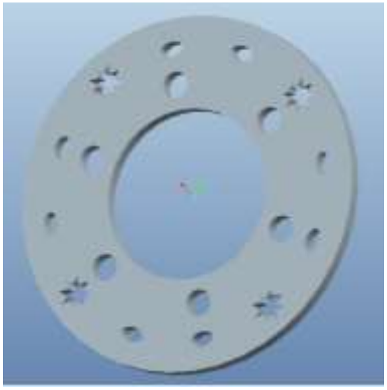

Fig.3.1 shows Modeling of Modified disc brake rotor 3 done in Pro-E

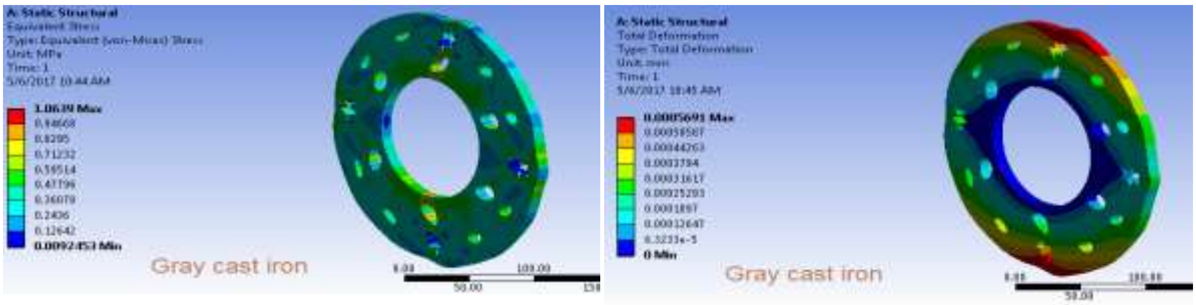

Fig. 3.2 Stress & Deformation Analysis in Disc Brake Rotor 3 Material in Gray Cast Iron

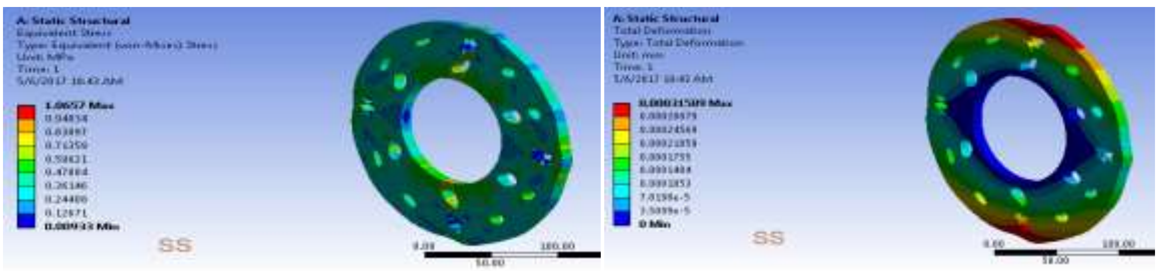

Fig. 3.3 Stress & Deformation Analysis in Disc Brake Rotor 3 Material in SS

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*Modeling of Modified disc brake rotor 4 done in Pro-E

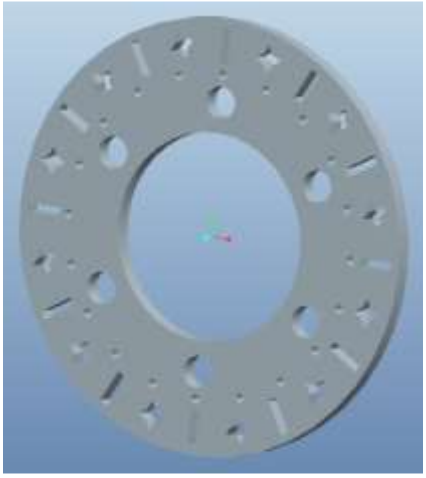

Fig.4.1 shows Modeling of Modified disc brake rotor 4 done in Pro-E

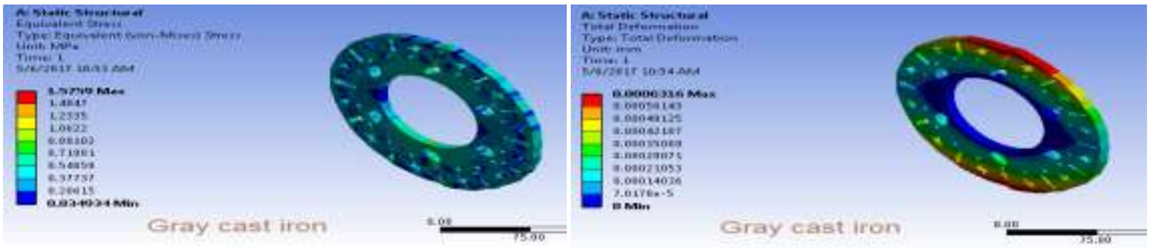

Fig. 4.2 Stress & Deformation Analysis in Disc Brake Rotor 4 Material in Gray Cast Iron

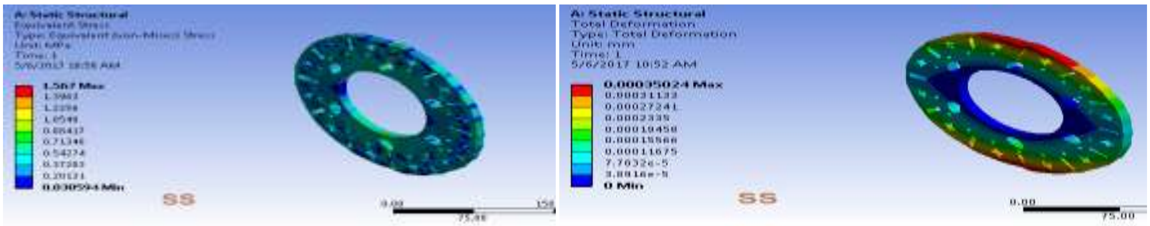

Fig. 4.3 Stress & Deformation Analysis in Disc Brake Rotor 4 Material in SS

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*Modeling of Modified disc brake rotor 5 done in Pro-E

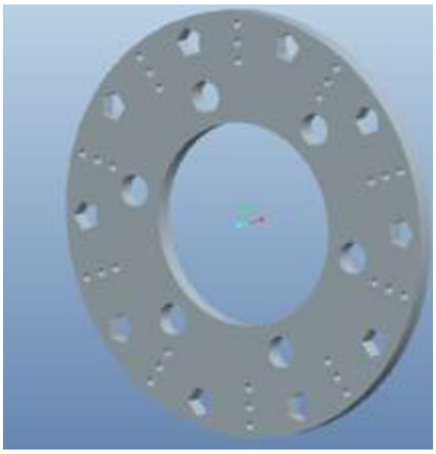

Fig.5.1 shows Modeling of Modified disc brake rotor 5 done in Pro-E

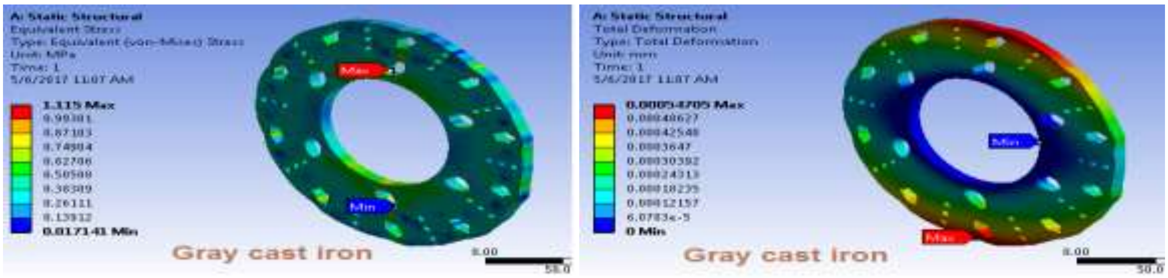

Fig. 5.2 Stress & Deformation Analysis in Disc Brake Rotor 5 Material in Gray Cast Iron

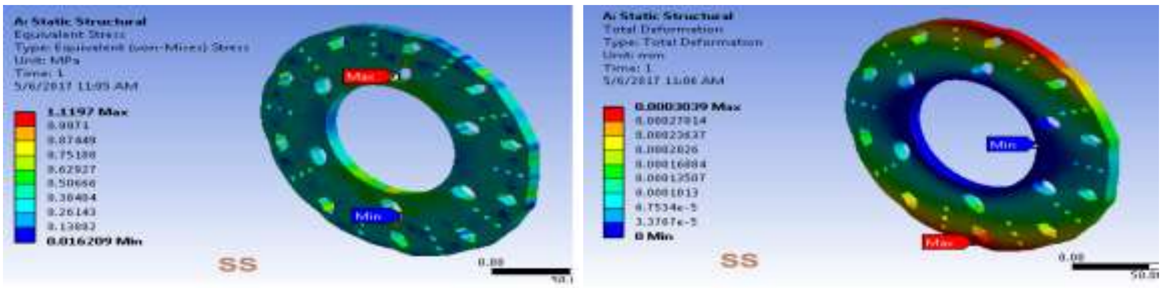

Fig. 5.3 Stress & Deformation Analysis in Disc Brake Rotor 5 Material in SS

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*Modeling of Modified disc brake rotor 6 done in Pro-E

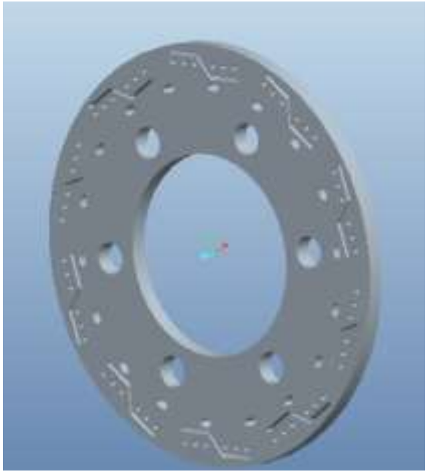

Fig.6.1 shows Modeling of Modified disc brake rotor 6 done in Pro-E

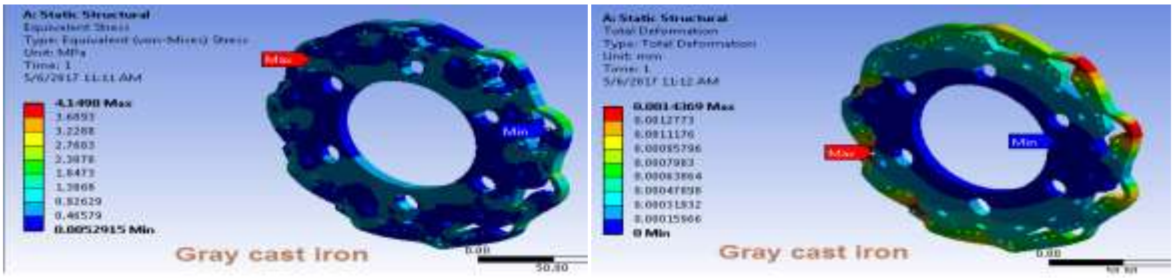

Fig. 6.2 Stress & Deformation Analysis in Disc Brake Rotor 6 Material in Gray Cast Iron

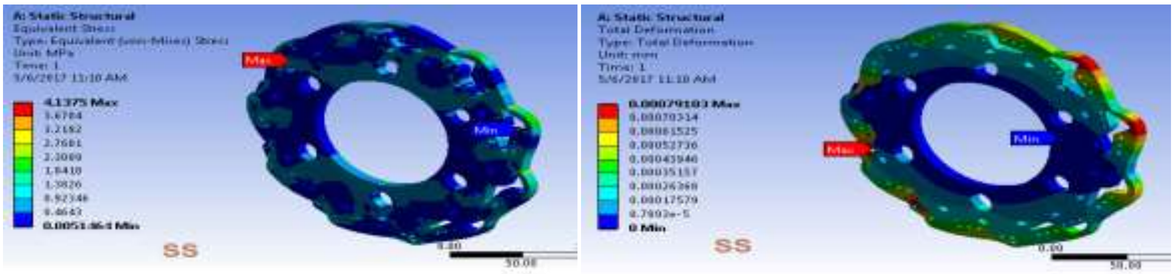

Fig. 6.3 Stress & Deformation Analysis in Disc Brake Rotor 6 Material in SS

RESULTS AND DISCUSSION

By observing the Structural analysis results using SS (Structure Steel) the stress values 0.89906are Minimum for Model Shape Disk No 2 & Mini Deformation 0.00025051 in SS (Structure Steel) for Model Shape Disk No 1.

Difference of Stress

Disk No.	Gary Cast Iron	Structure Steel
	Stress (MPa)	Stress (MPa)
Disk 1	0.92141	0.92924
Disk 2	0.90992	0.89906
Disk 3	1.0639	1.0657
Disk 4	1.5759	1.567
Disk 5	1.115	1.1197

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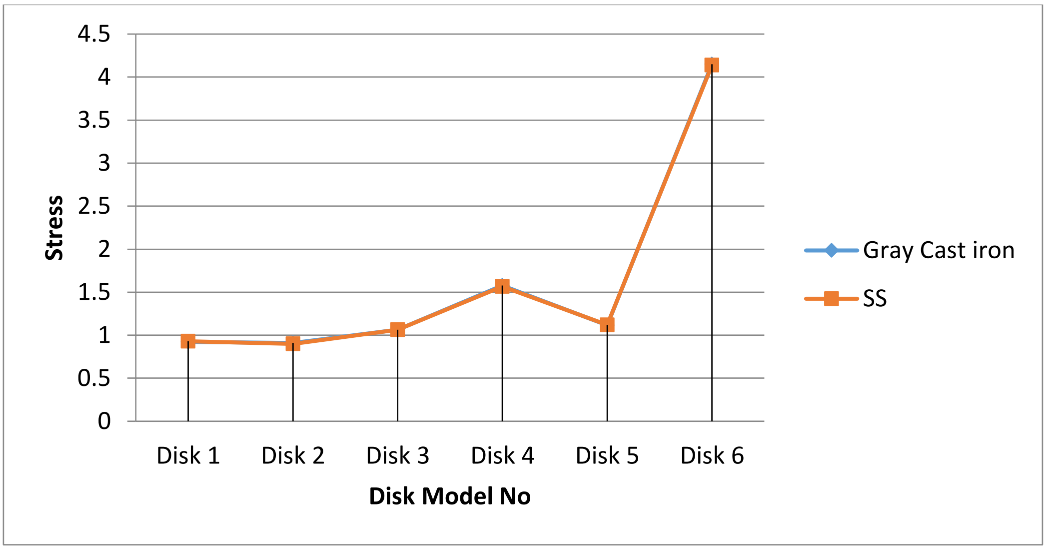
Disk 6	4.1498	4.1375

Fig. Difference of Stress in Gray Cast Iron & Structure Steel

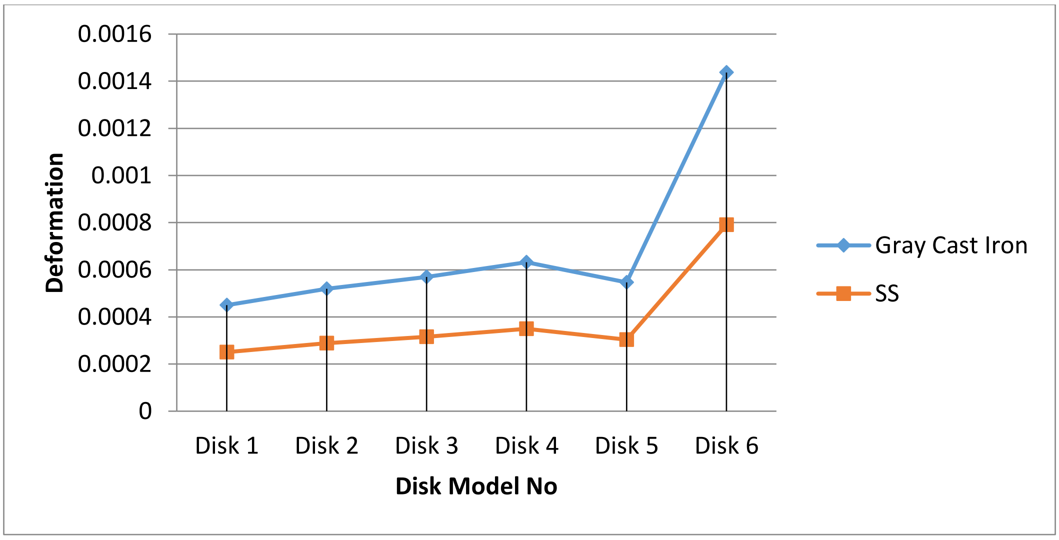


Graph between Stress versus Disk Model for Gray Cast iron & Structure Steel

Difference of Deformation

	Gary Cast Iron	SS
Disk No.	Deformation (MM)	Deformation (MM)
Disk 1	0.00044991	0.00025051
Disk 2	0.00051985	0.00028909
Disk 3	0.0005691	0.00031589
Disk 4	0.0006316	0.00035024
Disk 5	0.00054705	0.0003039
Disk 6	0.0014369	0.00079103

Fig .Difference of Deformation in Gray Cast Iron & Structure Steel



Graph between Deformation versus Disk Model for Gray Cast iron & Structure Steel

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CONCLUSION

From comparing the different results obtained from Analysis, it is concluded that For SS (Structure Steel), Von Mises stress obtained in Modified Shape 2 disc brake rotor is minimum as compare to others disc brake rotor & Deformation obtained in Modified Shape 1 disc brake rotor is minimum as compare to others disc brake rotor.

Disc brake rotor Model Shape No 2 is best possible shape modification for the Different Disk Profile application.

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