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Design and Analysis of a Vented Disc brake Rotor

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ABSTRACT

Brakes are most important safety parts in the vehicles. Generally all of the vehicles have their own safety devices to stop their car. Brakes function to slow and stop the rotation of the wheel. To stop the wheel, braking pads are forced mechanically against the rotor disc on both surfaces. They are compulsory for all of the modern vehicles and the safe operation of vehicles. In short, brakes transform the kinetic energy of the car into heat energy, thus slowing its speed.

The increases in travelling speeds as well as the growing weights of cars have made these improvements essential. The faster a car goes and the heavier it is, the harder it is to stop. An effective braking system is needed to accomplish this task with challenging term where material need to be lighter than before and performance of the brakes must be improved. Today's cars often use a combination of disc brakes and drum brakes. For normal sedan car, normally disc brakes are located on the front two wheels and drum brakes on the back two wheels. Clearly shows that, together with the steering components and tyres represent the most important accident avoidance systems present on a motor vehicle which must reliably operate under various conditions. However, the effectiveness of braking system depends on the design itself and also the right selection of material.

The thesis consists of modeling and analysis of both solid and vented type rotor disc brakes. The main objective of the project is to conduct thermal analysis on the both rotors to study the heat and temperature distribution on disc brake rotor. The results were compared for better rotor and both results provide better understanding on the thermal characteristic of disc brake rotor and assist the automotive industry in developing optimum and effective disc brake rotor.

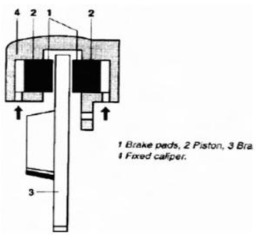
Key words: *Ansys, disc brake, Pro-E, Rotor, AMMS.*

I. INTRODUCTION

1.1 Disc brake rotor description

Overall idea on vehicle brake system and disc brake theories has been described as above. As similar to the type disc brake described above, the author used the disc brake rotor from normal passenger vehicle. The disc brake rotor was taken from normal passenger vehicle which having type of ventilated disc. Basically, disc brake rotor consists of rotating circular plate and cylinder disc (hat) attached and rotated to wheel hub.

The rotating circular plate which also call annular disc has two flat surfaces separated by 32 internal vanes. Figure shows the cross sectional view of ventilated disc brake rotor with outer diameter measured as 250 mm, 4.5 mm thickness of plate and having mass approximately 4 kg



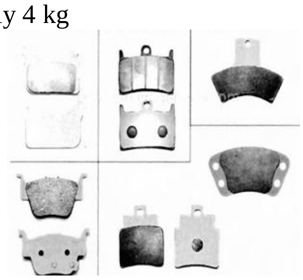


Fig.1 Disc brake rotor   Fig.2 Sample disc pads

1.2 Brake pads

As shown in Figure.2, brake pads consist of steel carrier which the pad are bonded to the steel carrier. According to (Gerschler, 1980), organically bonded pads consist of metallic, ceramic or organic friction materials in a bonded mass such as rubber or synthetic resin. The bonded friction materials can withstand temperatures up to 750°c, with short term peaks-up to 950'~ where the friction coefficient is between 0.25 and 0.5. There is an advantage of brake pads, where most of them are poor to thermal conductivity which protects the hydraulic actuating elements from overheating. It is also ease to manufacture and low cost. However, the pads needs to inspect frequently due to rapid wear as result from higher temperatures and contact pressures associated with the operation of a brake disc.

II. MODELING BY USING PRO-E

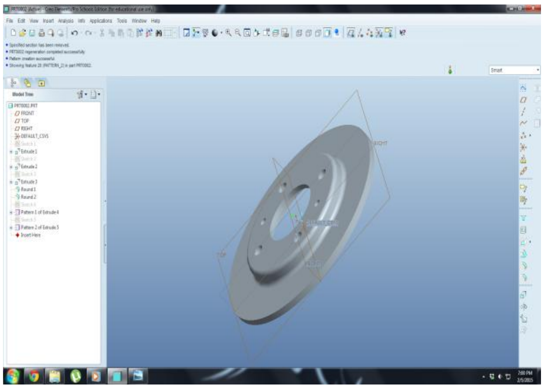


Fig.3 Solid model

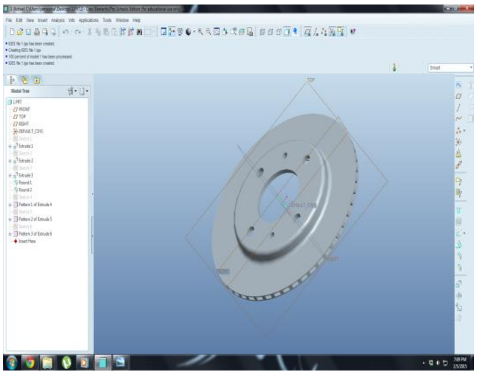


Fig.4 Vented model

2.1 Parts under analysis

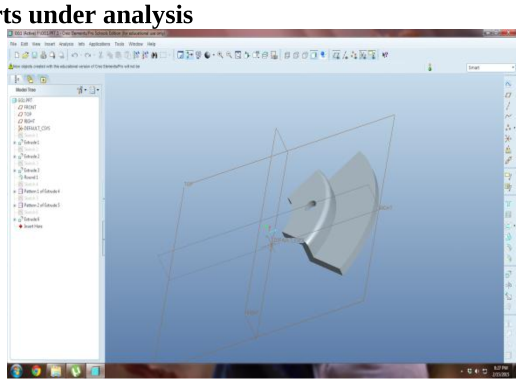


Fig.5 Solid type

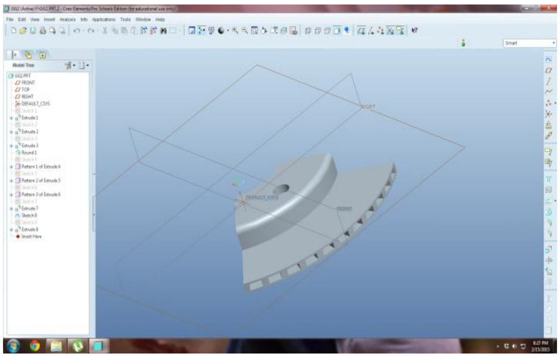


Fig.6 Vented type

III. ANALYSIS BY USING ANSYS

3.1 Imported models

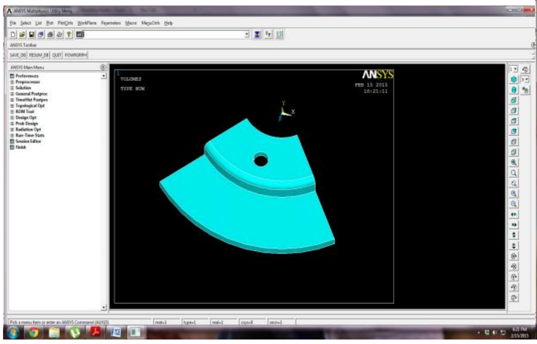


Fig.7 Solid type

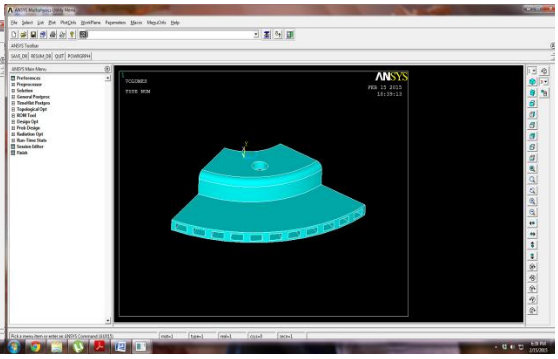


Fig.8 Vented type

3.2 meshed models

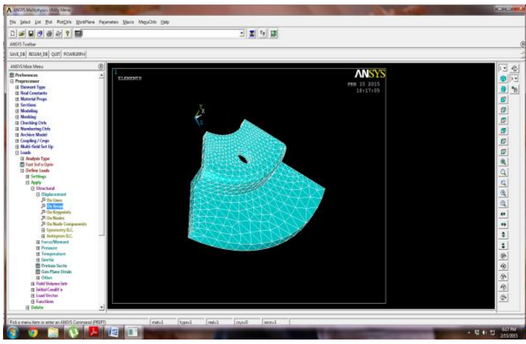
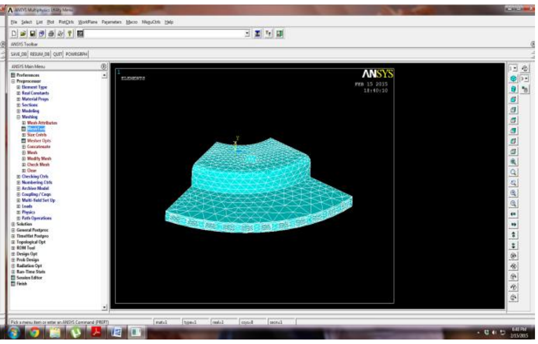



Fig.9 Solid type Fig.10 Vented type

IV. RESULTS & DISCUSSION

4.1 structural analysis results

4.1.1 Solid type

a) cast iron

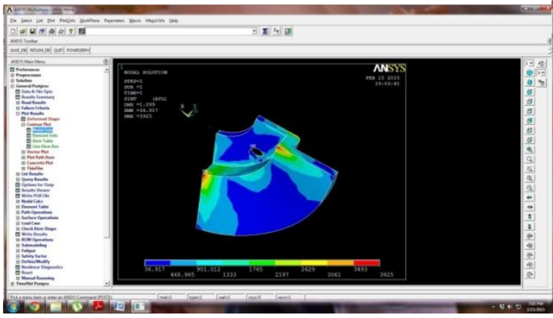
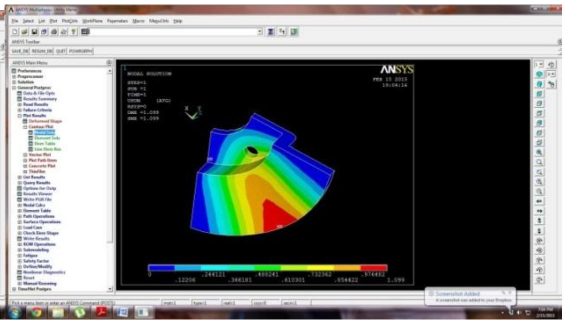



Fig.11 Stress intensity Fig.12 Deformed shape

b) Steel

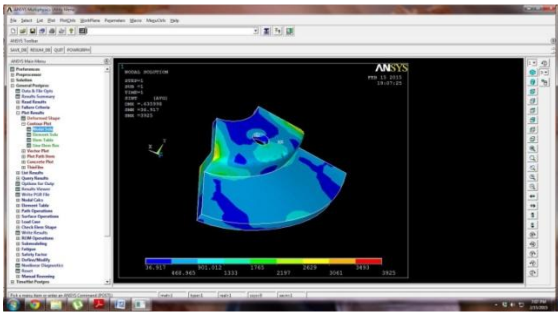
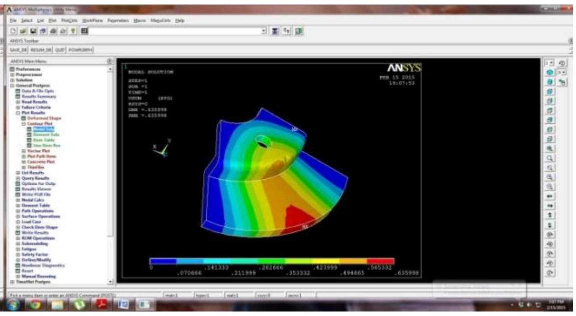



Fig.13 Stress intensity Fig.14 Deformed shape

c) AMMS

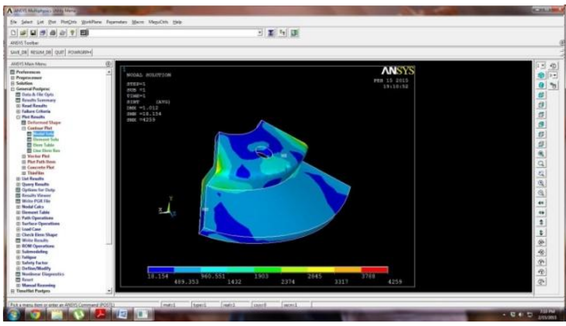
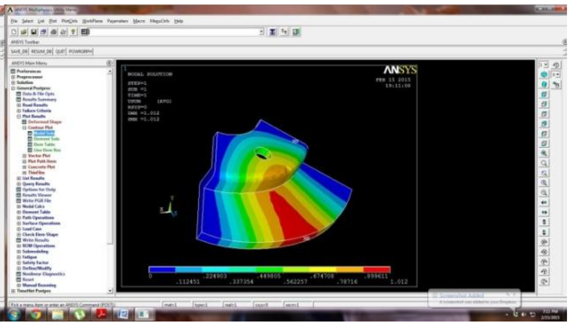



Fig.15 Stress intensity Fig.16 Deformed shape

4.1.2 Vented type

a) Cast iron

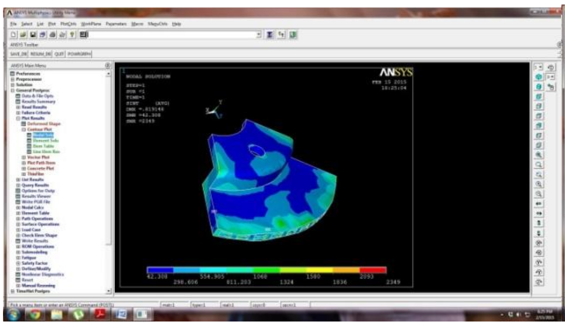
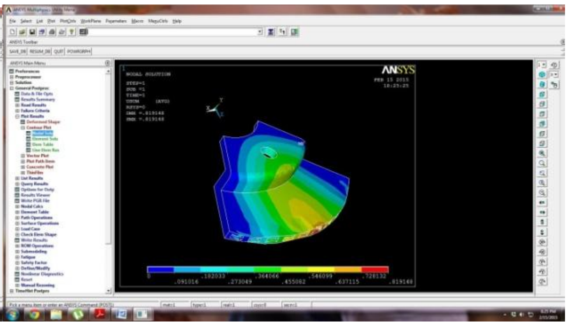



Fig.17 Stress intensity Fig.18 Deformed shape

b) Steel

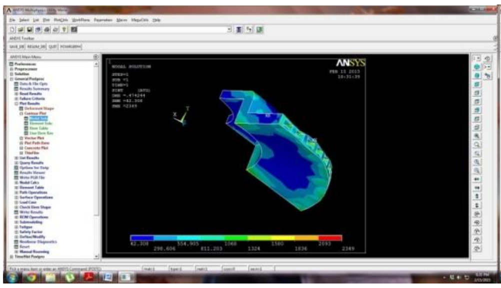
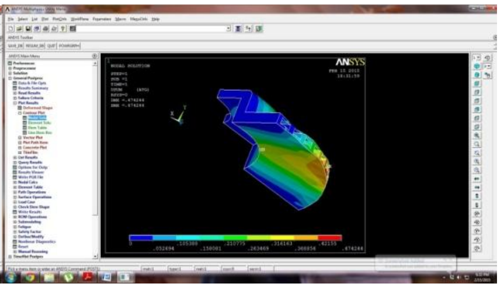



Fig.19 Stress intensity Fig.20 Deformed shape

c) AMMS

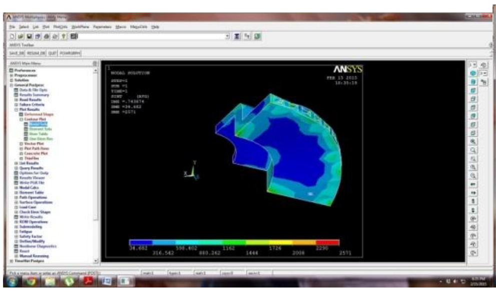
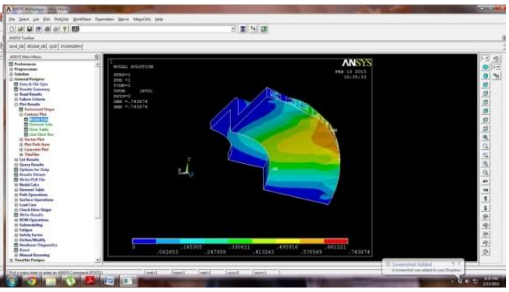



Fig.21 Stress intensity Fig.22 Deformed shape

4.2 Thermal analysis results

4.2.1 Solid type

a) Cast iron

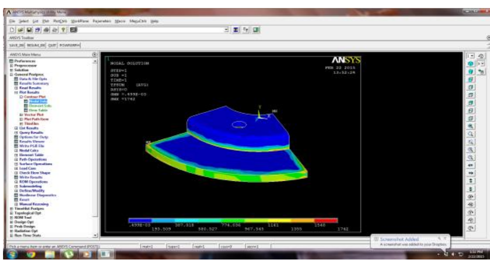
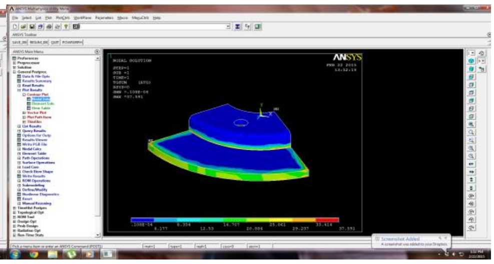



Fig.23 Thermal flux Fig.24 Thermal gradient

b) Steel

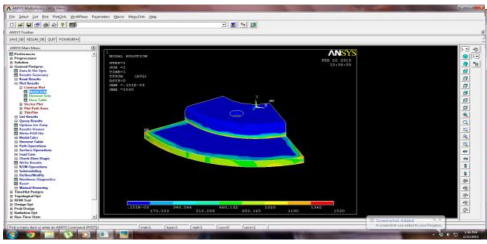
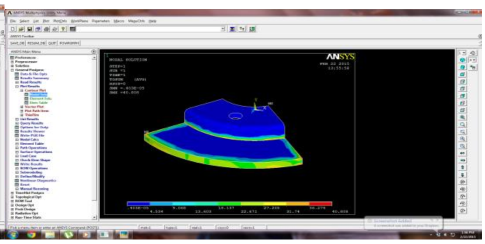



Fig.25 Thermal flux Fig.26 Thermal gradient

c) AMMS

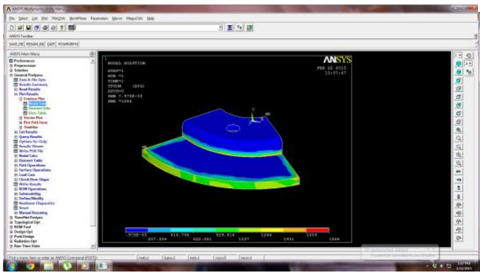
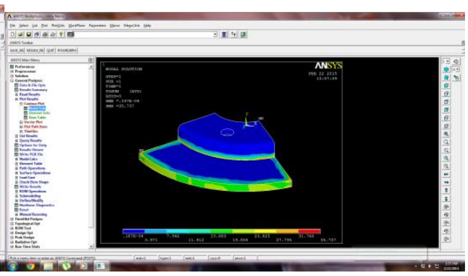



Fig.27 Thermal flux Fig.28 Thermal gradient

4.2.2 Vented type

a) Cast iron

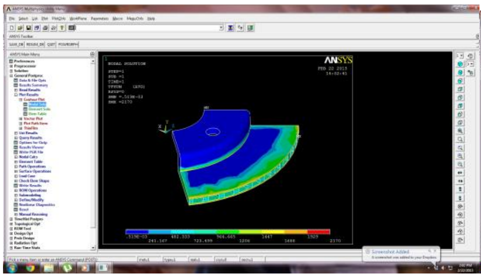
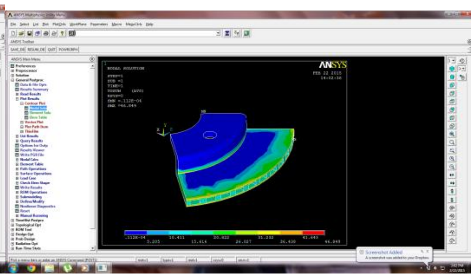



Fig.29 Thermal flux Fig.30 Thermal gradient

b) Steel

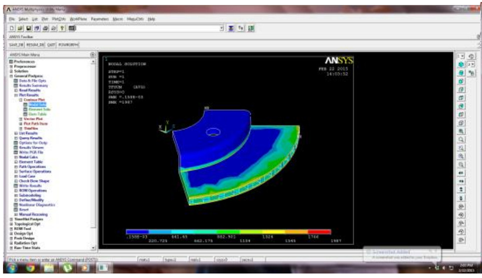
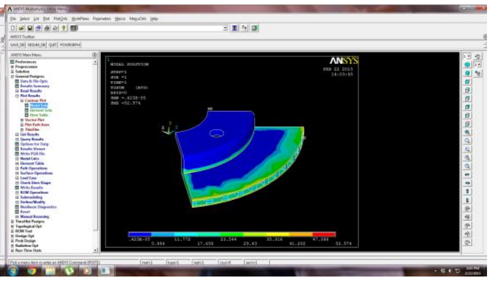



Fig.31 Thermal flux Fig.32 Thermal gradient

c) AMMS

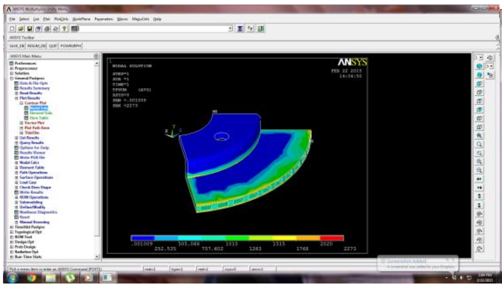
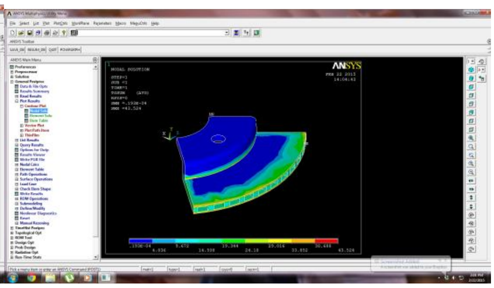



Fig.33 Thermal flux Fig.34 Thermal gradient

4.3 Results comparisons

4.3.1 Structural

Material	Stress intensity	
	Solid type	Vented type
Cast iron	3925	2349
steel	3925	2349
AMMS	4259	2571

Table.1 Stress intensity

material	Total deformation	
	Solid type	Vented type
Cast iron	1.099	0.819148
steel	0.635998	0.474244
AMMS	1.012	0.743874

Table.2 Total deformation

4.3.2 Thermal

material	Thermal gradient	
	Solid type	Vented type
Cast iron	37.591	46.849
steel	40.808	52.974
AMMS	35.737	43.524

Table.3 Thermal gradient

material	Thermal flux	
	Solid type	Vented type
Cast iron	1742	2170
steel	1530	1987
AMMS	1866	2273

Table.4 Thermal Flux

V. CONCLUSION

The modeling of the disc brake is done by using pro-e and the analysis is performed by Ansys. The project consists of two types of analysis structural and thermal. Structural analysis is done to find the strength of the model and the thermal analysis is done to check the thermal resistance of the model. Here we modeled two types of disc brakes one is solid and the other one id vented type. We did analysis on the both models by changing the materials, for this we take three different materials and done analysis on the respective model and the results were compared.

By comparing the results :

- **Structural**

The stress intensity of the vented type disc brake is lower than the solid type and the deformed values of the vented are better than the solid model. If we compare the results in the consideration of change of materials, AMMs have better results than the other two materials so by this we conclude that vented type disc brake with AMMS material is may be used in the place of solid type disc brake.

- **Thermal**

if we compare the thermal results of both solid and vented type model vented model producing better results compared to solid in the both cases of thermal gradient and thermal flux and the AMMS material is best suitable compared to the other two materials.

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