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STRUCTURAL AND THERMAL ANALYSIS OF DICS BRAKE BY USING ANSYS ON DIFFERENT ALLOYS

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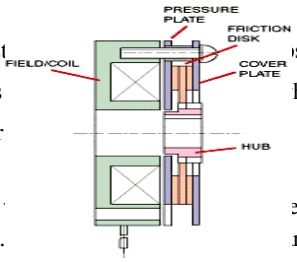
Abstract

The current tendencies in automotive industry need intensive investigation in problems of interaction of active safety systems with brake system equipment's. At the same time, the opportunities to decrease the power take-off of single components, disc brake systems. Disc brakes sometimes spelled as "disk" brakes, use a flat, disc-shaped metal rotor that spins with the wheel. The frictional heat, which is generated on the interface of the disc and pads, can cause high temperature during the braking process. Hence the automobiles generally use disc brakes on the front wheels and drum brakes on the rear wheels. Our main moto is to improve mechanical and physical properties of the disk when compared to the existed one. We use the three different materials those are the AL 6061, AISI 4340 & Titanium alloy. And also, we use three different disk designs those with a slotted& drilled, pure solid, drilled one in the simultaneously so we find out the best design and best material for the disk brake.

Keywords: Disc Brake, Alloys, Thermal Analysis, Structural Analysis.

1 Introduction

A **brake** is a mechanical device which inhibits motion. Most commonly brakes use frictionto convert kinetic energy into heat, though other methods of energy conversion may beemployed. For example, regenerative braking converts much of the energy to electricalenergy, which may be stored for later use. Other methods convert kinetic energy intopotential energy in such stored forms as pressurized air or pressurized oil. Eddy currentbrakes use magnetic fields to convert kinetic energy into electric current in the brake disc,fin, or rail, which is converted into heat. Still other braking methods even transform kineticenergyintodifferentforms,forexamplebytransferringtheenergytoarotatingflywheel.



Brakesaregenerallyappliedtorotatingax- formssuchast sdeployedintowaterorair).Somevehiclesusea sms, such as heel brakes anda parachute, or airplanes with both d into the air dern vehicle ed, ultimately apiston pushes the brake pad against the brake disc which slows the wheel down. r as the cylinder pushes the brake shoes against the drum which alsoslowsthewheeldown.

TheThreeTypes ofDiscBrakesAre:-

- FloatingCaliperDiscBrakes
- FixedCaliperDiscBrakes
- SlidingCaliperDiscCaliper

Literature Review

TING-LONG HO et al. (1974), Investigated on the effect of frictional heating on brake material (Aircraft) [1]. In this paper simplified analysis is conducted to determine most significant factors which affect surface temperature. Where there are size and weight restrictions the specific heat and maintaining the contact area appear a criterion is suggested for determining the number and thickness of brake disks, within the limited space available in a wheel. Frictional variations at high temperature could result from three different phenomenon: softening of the material, formation of oxides and surface melting. Metallographic study approach is been used here. It was found that minimum surface temperature would result under material with minimum value of (1/ρc) and (1/kρc), when there is maximum contact area and by using higher load-lower friction system. Masahiro Kubota et al. (2000), presented paper on development of a lightweight brake disc rotor: a design approach for achieving an optimum thermal, vibration and weight balance

Choi and Lee, et al. (2004) presented a paper on Finite element analysis of transient thermo elastic behaviors in disk brakes A transient analysis for thermo elastic contact problem of disk brakes with frictional heat generation is performed using the finite element method. To analyze the thermo elastic phenomenon occurring in disk brakes, the coupled heat conduction and elastic equations (cylindrical coordinates) are solved with contact problem. Material used is carboncarbon composite and wear is assumed negligible. The numerical simulation for the thermo elastic behavior of disk brake is obtained in the repeated brake condition. The computational results are presented for the distributions of pressure and temperature on each friction surface between the contacting bodies. It is observed that the orthotropic disc brakes can provide better brake performance than the isotropic one because of uniform and mild pressure distribution.

Zaid, et al. (2009) presented a paper on an investigation of disc brake rotor by Finite element analysis. In this paper, the author has conducted a study on ventilated disc brake rotor of normal passenger vehicle with full load of capacity [7]. The study is more likely concern of heat and temperature distribution on disc brake rotor. In this study, finite element analysis approached has been conducted in order to identify the temperature distributions and behaviors of disc brake rotor in transient response. Modeling is done in CATIA & ABAQUS/CAE has been used as finite elements software to perform the thermal analysis on transient response. Material used is Grey cast iron, with maximum permissible temperature 550 C. Result provided during 1 st , 5th and during 10th cycle. Thus, this sure study provide better understanding on the thermal characteristic of disc brake rotor and assist the automotive industry in developing optimum and effective disc brake rotor.

Methodology and Experimental Work

Element	Content (%)
Iron, Fe	95.195 - 96.33
Nickel, Ni	1.65 - 2.00
Chromium, Cr	0.700 - 0.900
Manganese, Mn	0.600 - 0.800
Carbon, C	0.370 - 0.430
Molybdenum, Mo	0.200 - 0.300
Silicon, Si	0.150 - 0.300
Sulfur, S	0.0400
Phosphorous, P	0.0350

Density (ρ)	2.70 g/cm
Young's modulus (E)	68 GPa
Tensile strength (σ_t)	124–290 MPa
Poisson's ratio (ν)	0.33
Melting temperature (T_m)	585 °C
Thermal conductivity (k)	151–202 W/(m·K)
Linear thermal expansion coefficient (α)	2.32×10^{-5} K^{-}
Specific heat capacity (c)	897 J/(kg·K)

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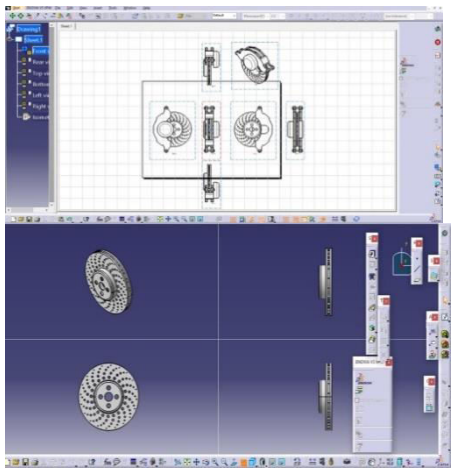
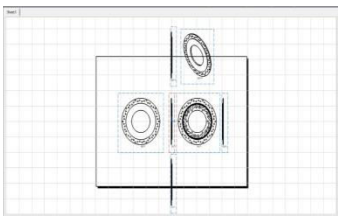
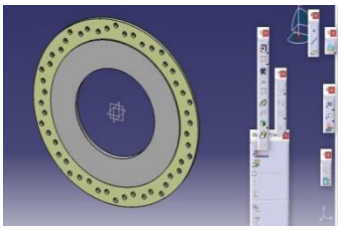
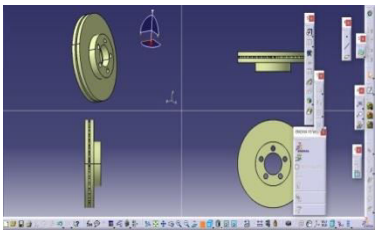
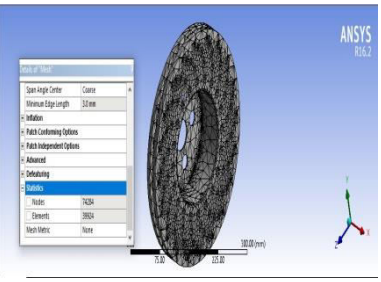
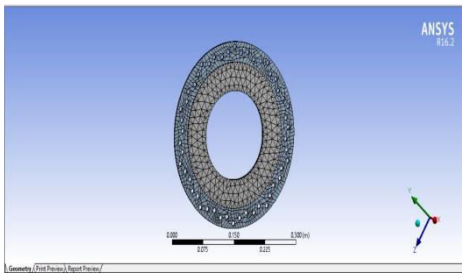
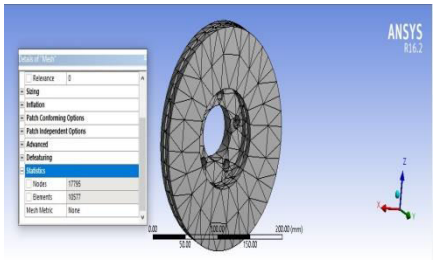
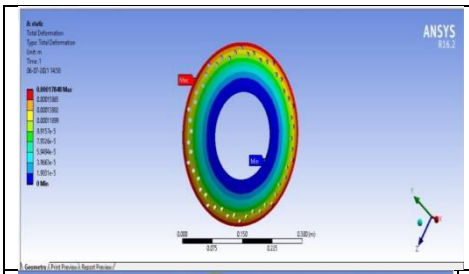
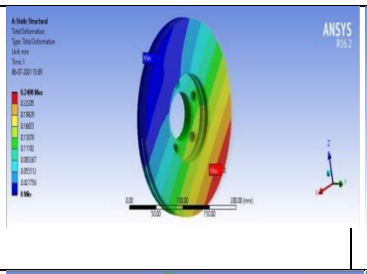
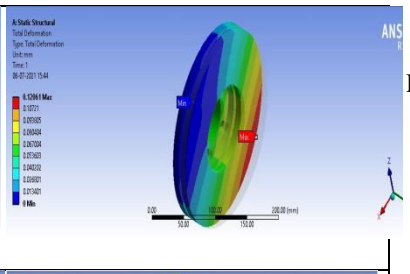
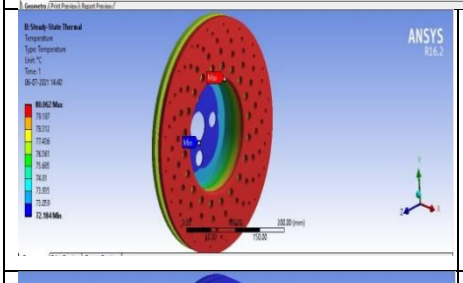
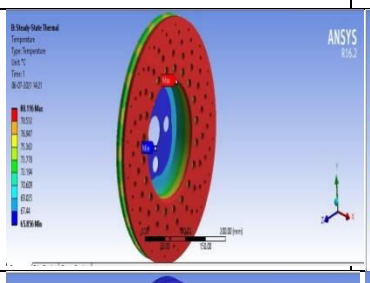
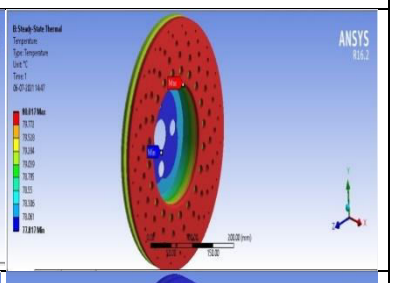
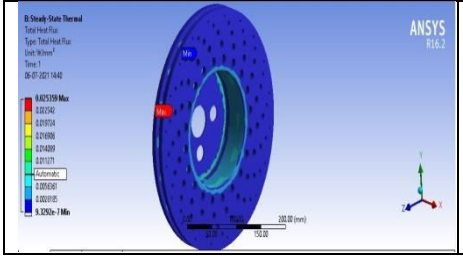
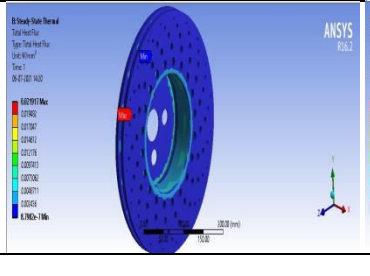
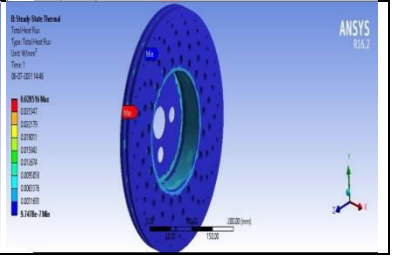



Results

AISI	TITANIUM	ALUMINIUM	
			Deformation
			Temperature
			Heat Flux

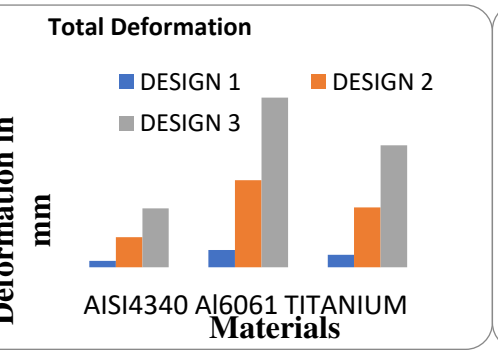
Deformation/Material	AISI4340	Al6061	Titanium Alloy
Design 1	0.01334	0.035819	0.0258
Design 2	0.061917	0.17848	0.12262
Design 3	0.12061	0.34784	0.24989

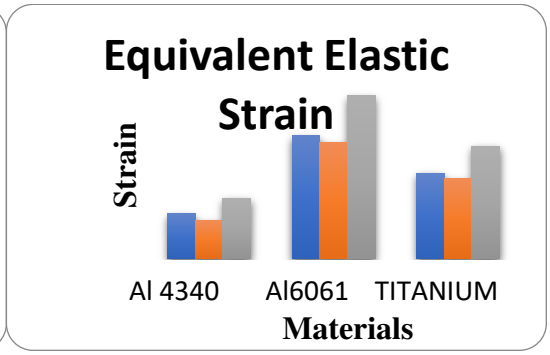
Strain/Material	AISI4340	Al6061	Titanium Alloy
Design 1	0.0002367	0.00065523	0.00045366
Design 2	0.00020066	0.00061748	0.00042596
Design 3	0.0003199	0.00086945	0.0005973

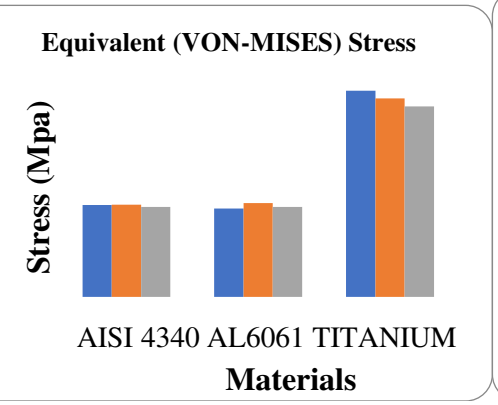
Stress/Material	AISI4340	Al6061	Titanium Alloy
Design 1	41.595	40.0627	93.477
Design 2	41.801	42.462	89.974
Design 3	40.777	40.807	86.264

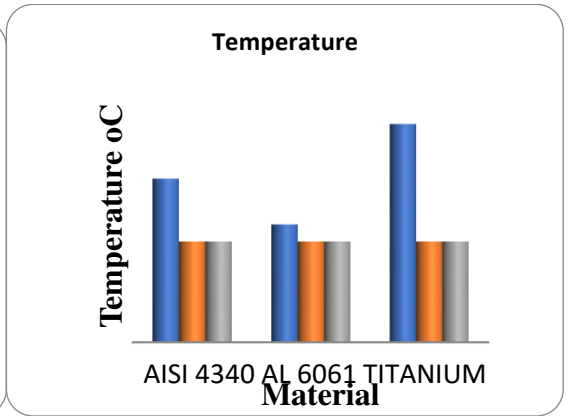
Temperature/Material	AISI4340	Al6061	Titanium Alloy
Design 1	80.062	80.017	80.116
Design 2	80	80	80
Design 3	80	80	80

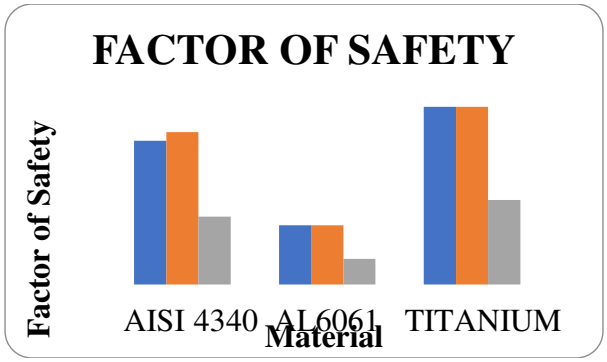
Factor of safety	AISI4340	Al6061	Titanium Alloy
Design 1	17	7	21
Design 2	18	7	21
Design 3	8	3	10











Conclusion

- Many trucks and buses and present days' bikes are also equipped with hydraulic actuated disc brakes. The highcontact-forcesare transmittedmechanicallyvianeedle mountedactuatingdevice.
- In view of the fact that the air can circulate freely between the disc and the brakeshoe, disc brakes are cooled much better, especially since it is possible to do so ventilateddiscs extra holes. The gases resulting from friction, dust, dirt, do not stay on the workingsurfaces. Thesebrakes arenotsticky.
- The disc brakes have been widely used in cars and trucks, especially in the premiumsedan. The disc brakes on the new mine hoist brake. The disc brake inertia is small, fastaction, high sensitivityandadjustablebrakingtorque.
- From the above analysis on the different disc designs and by taking different materials (AISI 4340, Aluminum 6061, Titanium Alloy).
- Under the above boundary conditions AISI 4340 and Titanium alloy is best suited material for manufacturing the Disc brakes and design1 is the best suited.
- The suited material and design is taken by consideration of Total deformation, Strain, Stress and Temperature.

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