DESIGN AND ANALYSIS OF DISC BRAKE

Thermal and Static Analysis

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Abstract: - Each single system has been studied and developed in order to meet safety requirement. Instead of having air bag, good suspension systems, good handling and safe cornering, there is one most critical system in the vehicle which is brake systems. Without brake system in the vehicle will put a passenger in unsafe position. Therefore, it is must for all vehicles to have proper brake system. In this paper disc brake material use for calculating normal force, shear force and piston force. And also calculating the brake distance of disc brake. The standard disc brake two wheelers model using in Ansys and done the Thermal analysis and Modal analysis also calculate the deflection and Heat flux, Temperature of disc brake model. This is important to understand action force and friction force on the disc brake new material, how disc brake works more efficiently, which can help to reduce the accident that may happen in each day.

I.INTRODUCTION:-

Now-days technology improved rapidly day to day which changes in vehicle sector surprisingly. On comparison of vehicle production before 20-25 years ago & later, we find abundant difference in aspect of comfort, economy, and function & particularly in Safety. Very careful attention given these days to passive & active safety system for vehicle. Active safety means helpful in avoiding traffic event & passive safety system protect passengers & drivers against injuries in traffic.

In braking system one of most important active safety of vehicle. Brakes continuously improved in various aspects. While braking, most of the kinetic energy are converted into thermal energy and increase the disc temperature. This project deals in disc brake rotor design, disc rotor profile selection, disc rotor material selection & thermal stress analysis on pulsar brake disc rotor for steady state and transient condition. The heat dissipated along the brake disc surface during the periodic braking via conduction, convection and radiation. In order to get the stable and accurate result of element size, time step selection is very important and all of these aspects are discussed in this paper. The findings of this research provide a useful design tool to improve the brake performance of disc brake system.

A) HISTORY OF DISC BRAKE;

Development of disc brake began in England in the 1890s.

The first caliper-type automobile disc brake was patented by **Frederick William lanchester** in his Birmingham factory in1902 and used successfully a lanchester cars.

Successful application began in airplanes and tanks before and during World War 2. In Britain, the Daimler company used disc brakes on its Daimler armoured car of 1939, the disc brakes, made by the girdling company, were necessary because in that four-wheel drive(4*4)vehicle the epicyclic final drive was in the wheel hubs and therefore left no room for conventional hub-mounted drum brake.

At Germany`s Argus motoren, Hermann klaue (1912-2001) had patented disc brakes in 1940. Argus supplied wheel fitted with disc brakes e.g. for the arado Ar 96. The German tiger l heavy tank, was introduced in 1942 with a55 cm Argus-werke disc. On each drive shaft.

Chrysler developed a unique braking system, offered from 1949 to 1953.

FIRST USE IN RACING: The first use of disc brake in racing was in 1951, one the BRM types 15s using a girling -produced set, a first for a formula one car. Reliable caliper-type disc brake later appeared in 1953 on the jaguar c-type racing car.

MASS PRODUCTION: The first mass production use of the modern disc brake was in 1955, on the citroen ds, which featured caliper type front disc brake among its many innovations. This model went on to sell 1.5 million unit over 20 years with the same brake setup.

PROBLEM STATEMENT:

1) A problem in Disc Brake occurs because of uneven stress & heat dissipation during braking of two wheeler as follows:-

2) Scarring, Cracking, Rusting, Poor stopping, noise, Vibration, Pulling, Grabbing, Dragging, Pulsation etc.

B.CAMPARISON BETWEEN DISC AND DRUM BRAKE

DISC BRAKE	DRUM BRAKE
1) Friction pad is flat.	1) Friction pad is semi-circular.
2) Heat dissipated is quick.	2) Heat dissipated is slow.
3) Braking is more effective.	3) Braking is less effective.
4) lighter in weight.	4) Heavier in weight.
5) Friction area is less.	5) Friction area is more.

II. MATERIALS USED FOR DISC BRAKE:

1) Forged steel.
2) Carbon steel.

A) FORGED STEEL:

What is Steel Forging?

Forged steel is an alloy of carbon and iron. Manufactured by a series of compression under an extremely high pressure, steel forgings normally have less surface porosity, finer grain structure, higher tensile strength, better fatigue life/strength, and greater ductility than any other steel processing.

b) CARBON STEEL:

WHAT IS CARBON STEEL?

Most-common types of steel that contains about 0.1 to 0.3 percent carbon. In general, increase in the amount of carbon reduce ductility but increase tensile strength and ability to harden through tempering. As an industry-wide practice, steel that does not contain any specified or standard amount of one or more allying elements(such as chromium, molybdenum, nickel, titanium, vanadium) to be classified as alloy steel is called carbon steel.

III. DESIGN CALCULATION:

Tangential force between pad and rotor (Inner face), FTRI

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FTFI = µ1.FRI

Were;

FTRI = Normal force between pad brake and rotor (inner).

µ1 = coefficient of friction = 0.5

FRI = Pmax/2 ×A Pad brake area.

FTRI = (0.5) (0.5) $(1\times10^{6}\ N/m^{2})$ $(2000\times10^{6}\ m^{2})$.

=500N.

Brake Torque:

TB = FT.R

Where: TB = Brake torque.

µ= co efficient of friction

FT = FTRI ± FTRO

= 1000N.

TB = 120 N.m

A) CARBON STEEL

HEAT GENERATED THROUGH BRAKING

Heat Generated in disc rotor (J/s)

$$Q = m\, C_p\, \Delta T$$

Heat Flux (W/m^2)

Q=q/a

Where, mass of disc is 0.848 kg, specific heat capacity of disc is 486J/kg K, time taken stopping the vehicle is 5sec, developed temperature difference (ΔT) is 15 °C and area of disc is 0.06328 m^2

Q = 0.848 * 486 * 15= 6181J

Heat flux= heat generated/second

Area of disc

Heat flux = (6181 /5) / 0.03828 =32293 W/m^2

Thermal gradient = heat flux

Thermal conductivity

Thermal gradient =32293/41=787 K/m

2) FORGED STEEL

HEAT GENERATED THROUGH BRAKING

Heat Generated in disc rotor (J/s)

$$Q = m\, C_p\, \Delta T$$

Heat Flux (W/m^2)

Q=q/a

Where, mass of disc is 0.848 kg, specific heat capacity of disc is 486J/kg K, time taken stopping the vehicle is 5sec, developed temperature difference (ΔT) is 15 °C and area of disc is 0.06328 m^2

Q = 0.848 * 464 * 15= 5902J

Heat flux= heat generated/second

Area of disc

Heat flux = (5902/5) / 0.03828 =30835 W/m^2

Thermal gradient = heat flux

Thermal conductivity

Thermal gradient =30835/43=717 K/m

IV. SOLID TYPE DISC IN CATIA;

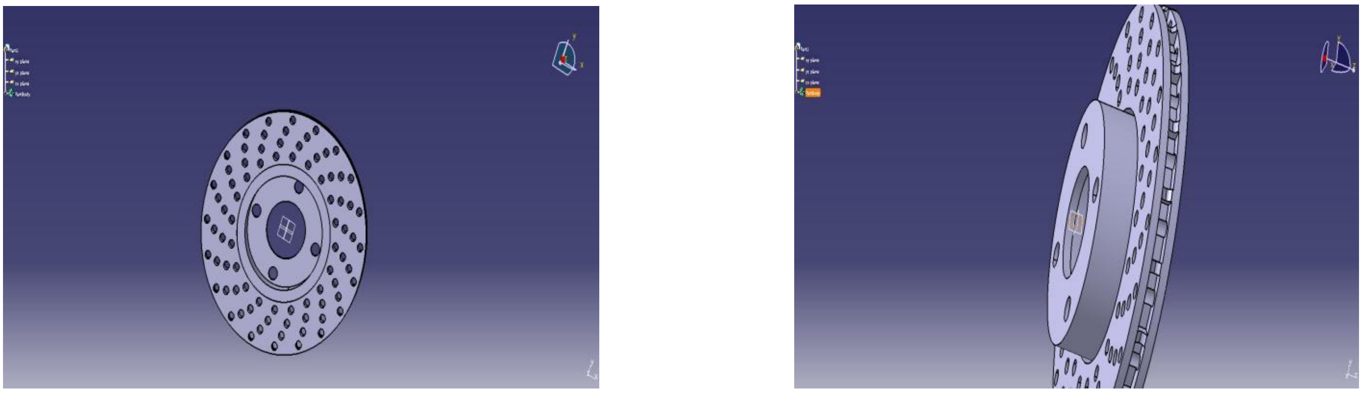


Fig.1 solid model

V. ANALYSIS RESULTS OF DISC

A) THERMAL ANALYSIA IN DISC

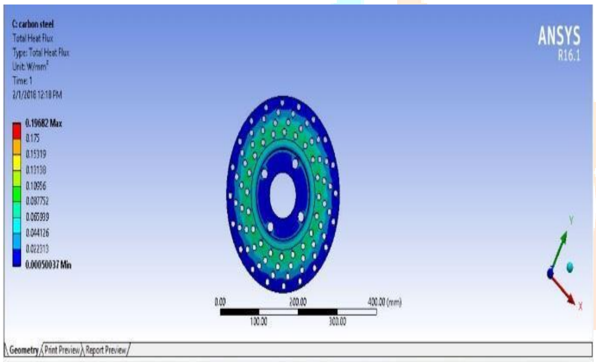


Fig.2 carbon steel (heat flux)

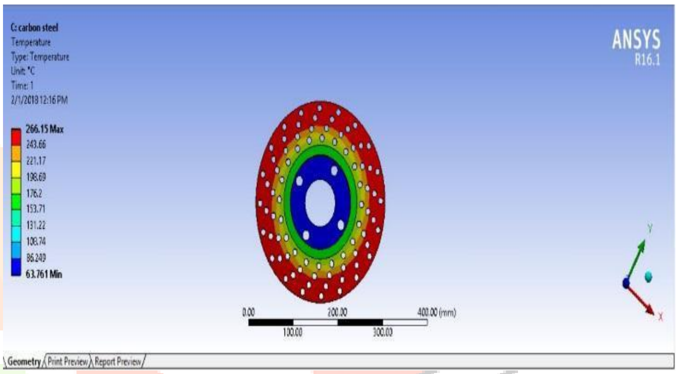


fig.3 carbon steel (temperature)

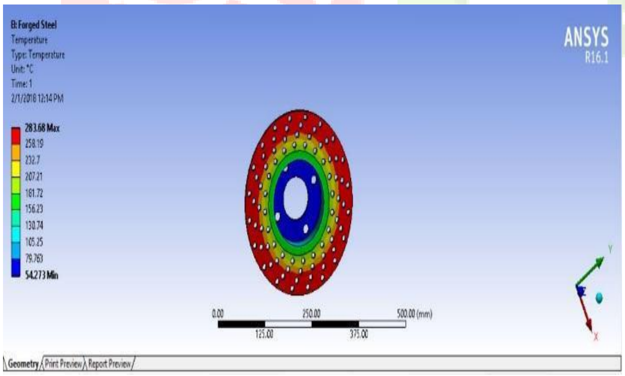


Fig.4 gorged steel (temperature)

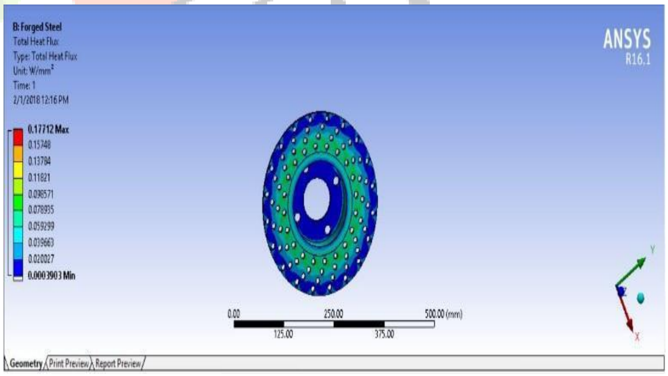
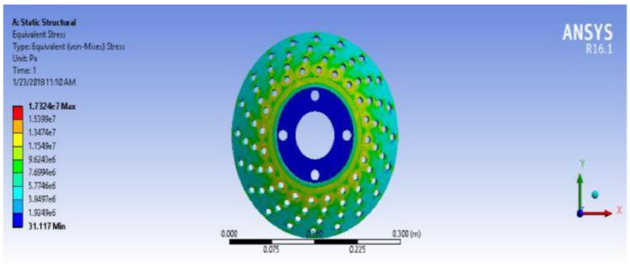


fig.5 forged steel (heat flux)

B) STATIC ANALYSIS IN DISC



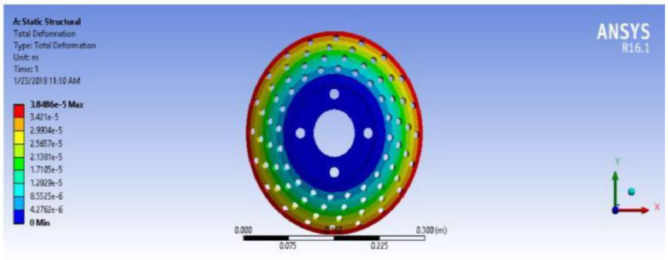


Fig.6 carbon steel (stress) **Fig.7 carbon steel (total deformation)**

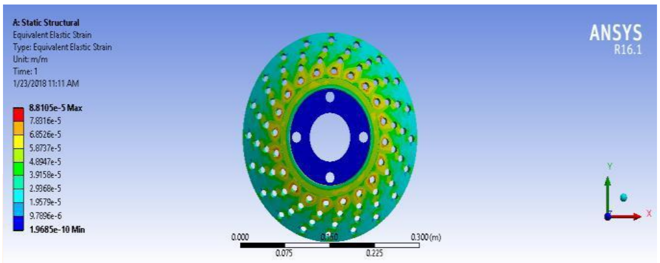
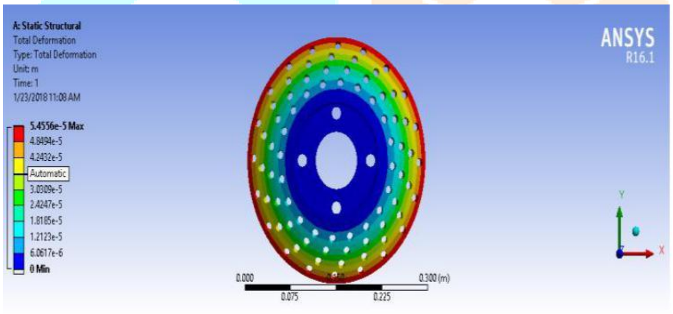


Fig.8 carbon steel (strain)



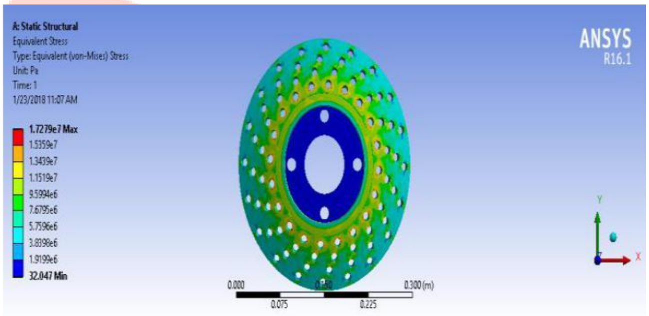


Fig .9 forged steel (total deformation) **Fig.10 forged steel (stress**

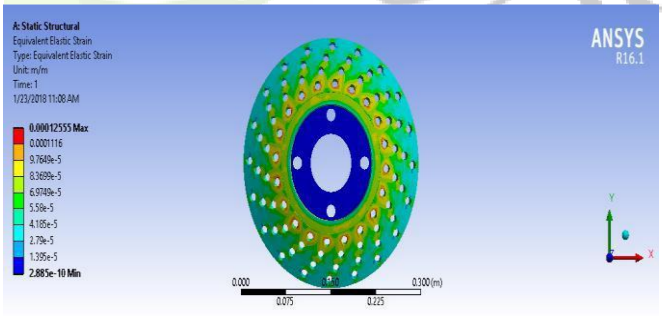


Fig.11 forged steel (strain)

VI .RESULT:

A) STATIC FOR FORGED STEEL:

MATERIAL	MIN.	MAX.
EQUIVALENT STRESS	1.72×10^{7}	32.047
TOTAL DEFORMATION	5.45×10^{-5}	0
EQUIVALENT STRAIN	0.0001255	2.885×10^{-10}

FOR CARBON STEEL:

MATERIAL	MIN.	MAX.
EQUIVALENT STRESS	1.703×10^{7}	31.117
TOTAL DEFORMATION	3.84×10^{-5}	0
EQUIVALENT STRAIN	8.810×10^{-5}	1.968×10^{-6}

B) THERMAL FOR CARBON STEEL

MATERIAL	MIN.	MAX.
TEMPERATURE	63.76	266
TOTAL HEAT FLUX	0.000500	0.19682

FOR FORGED STEEL:

MATERIAL	MIN.	MAX.
TEMPERATURE	54.273	283.68
TOTAL HEAT FLUX	0.0003903	0.17712

VI. CONCLUSION:

Using forged steel and carbon steel disc brake material calculating normal force, shear force and caliper piston force and also calculating the brake distance of disc brake. The standard disc brake two wheelers model using in Ansys, done the Thermal and Modal Analysis calculate the deflection, total heat flux, Frequency and temperature of disc brake model. This is important to understand action force and friction force on the disc brake new material, which use disc brake works more efficiently, which can help to reduce the accident that may happen in each day. when compared to the above two material forged steel is more efficient.

.VII. REFEREENCE

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