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"Design Manufacturing and Analysis of Hydraulic Braking System with Floating Disc and Balance Bar"

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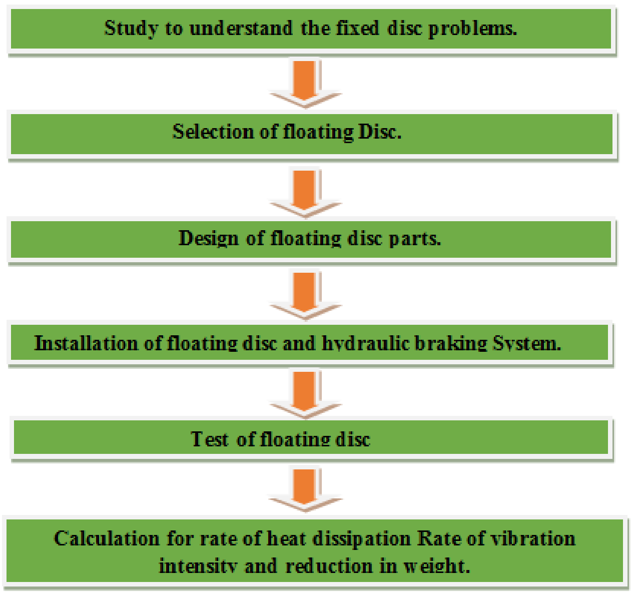
Abstract - *Modern braking systems are wonders of technology. In this project we'll cover the design, analysis, manufacturing, advantages of hydraulic braking system with floating disc and balance bar. Nowadays, most people have realized the necessity and significance of the existence of brakes in vehicles. In order to let drivers, get automobile brake system, the project also discusses about the international market of the brakes with ideas about the future market. As we know, if the brakes fail, the result will be disastrous. Modern automotive disc brake systems can generate extremely high temperature in very short time. One consequence of the high disc and pad temperature is a gradual heating of the break hydraulic fluid which can lead to floating disc avoids distortion and decrease vibration. Having very fast heat dissipation. The plate is fitted with the help of rivets. Middle foundation of disc is made up of alloy ss or high-grade steel. Foundation and disc rotor are connected with the help of rebate. Which avoids transmission of heat from disc to foundation A floating calliper slides on pins, and has pistons only on one side, with the pads on both the side with the pistons and the side of the calliper opposed to the pistons.*

Key Words: **Floating Disc, Breaking system, Heat loss, Friction**

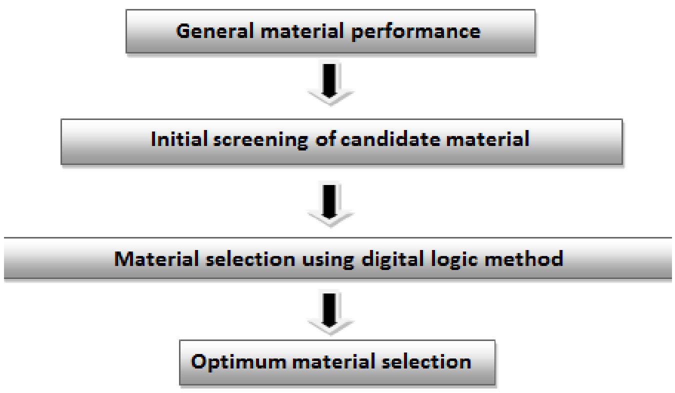
1.INTRODUCTION

In general, the main functions of a brake system are to maintain a vehicle's speed when driving downhill, to reduce a vehicle's speed when necessary and to hold a vehicle when in parking. Today, most passenger vehicles are fitted with disc brake systems. A disc brake of floating caliper design typically consists of two pads, a caliper, a disc, a piston, a carrier bracket and two guide pins. Along with achieving a force mentioned functionalities, the brake caliper also needs to withstand the forces and stresses raised in the components due to high hydraulic pressure and shear forces due to disc rotation and hence avoiding deformations in the caliper and to give maximum life. Also, one of the major requirements of the caliper is to press pads against the disc and it should ideally achieve as uniform interface pressure as possible. It is well known that uniform pad wear and brake temperature, and more even friction coefficient could only be achieved when pressure distributions between the pads and disc are uniform. This project investigates the stresses generated in the caliper components and contact (interface) pressure distributions at the rotor and piston-pad interface taking into consideration dynamic condition of the assembly.

1.1 Methodology



1.2 Material Selection



1.3 Design

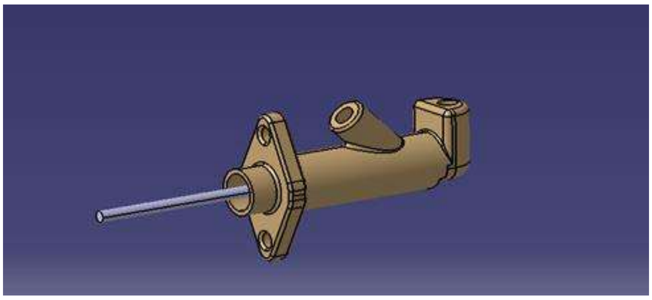


Figure- Part design of Master Cylinder

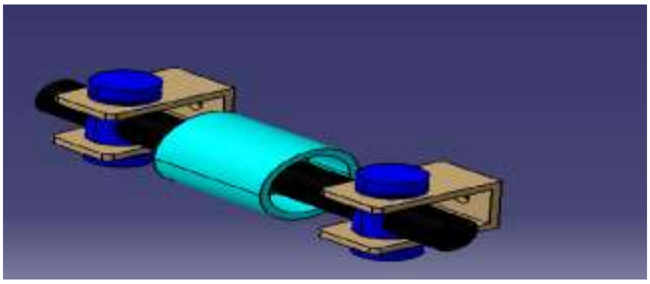


Figure- Part design of Balance bar

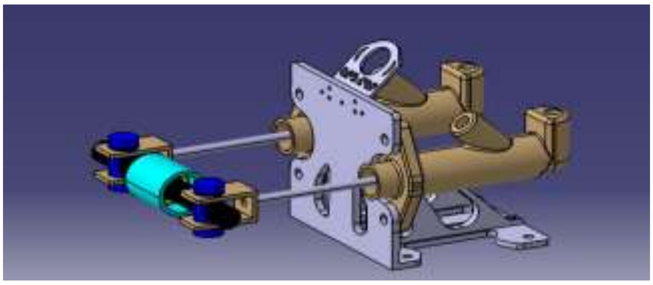


Figure- Part design of Master Cylinder and Balance Bar Assembly

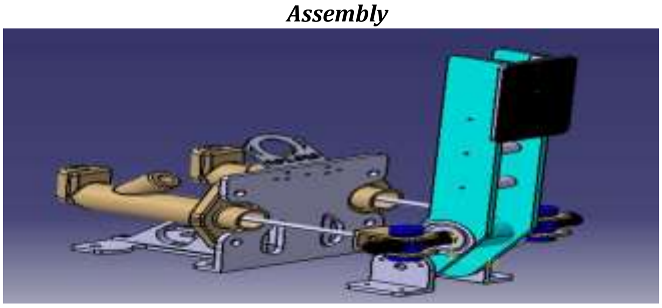


Figure- Part design of Brake Pedal Assembly

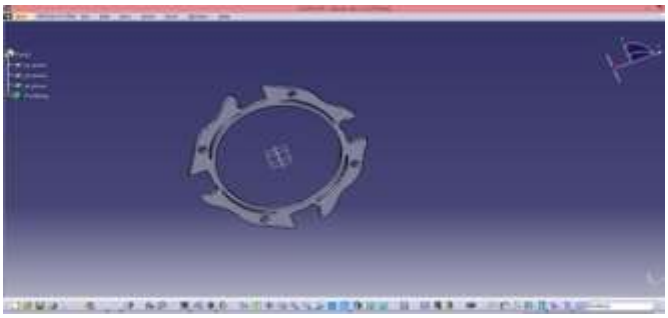


Figure- Part design of Inner Disc Assembly

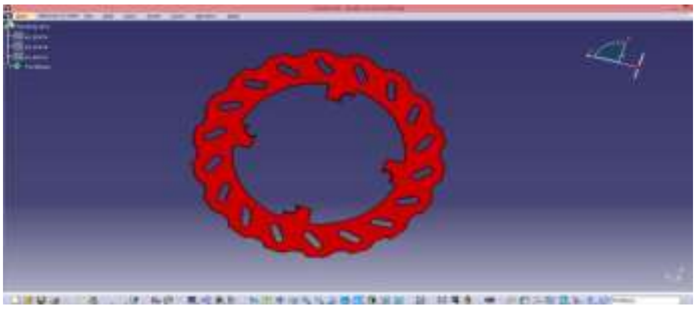


Figure- Part design of Outer Disc Assembly

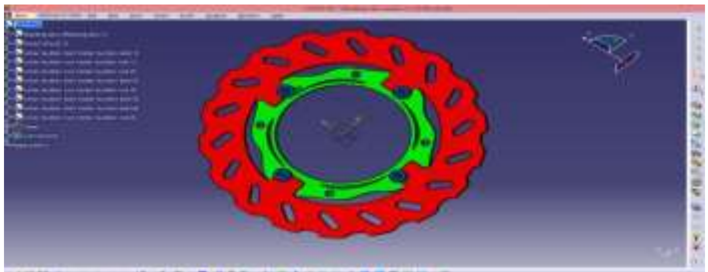


Figure- Part design of Floating Disc Assembly

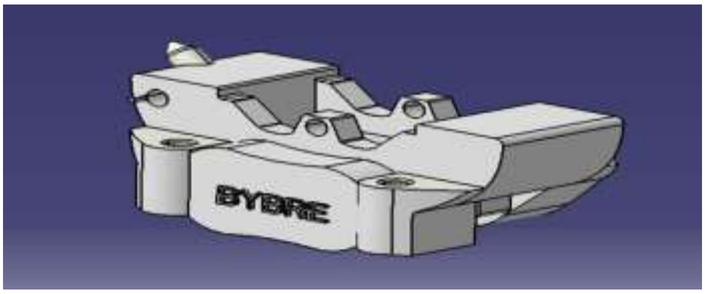


Figure- Part design of Brake Caliper Assembly

CALCULATION:

Given Data:

1) Tyre Diameter =540mm
2) Coefficient of friction of Brake Pads = 0.6
3) Caliper Piston Diameter = 30mm
4) Disc Diameter =190mm
5) Master Cylinder Bore Diameter = 19.05mm
6) No of Piston in Caliper = 4
7) Pedal Ratio = 5
8) Force applied by driver =250N

Calculations:

Pedal Force (F_P)

1) Force applied by the driver =250N
2) Force magnification due to pedal ratio:

$F_P = h \times F_d$

$= 5 \times 250$

$F_P = 1250$ N

3) Magnified force = Force applied on the master cylinder

F at master cylinder = 1250N

Area of master cylinder = $\frac{\pi}{4} \times d^2$

$= \frac{\pi}{4} \times 19.05^2$

$= 285.025 mm^2$

Pressure of Master Cylinder = $\frac{F}{A}$

$= \frac{1250}{285.025}$

$= 4.38562 \ N/mm^2$

Force on Caliper

Pressure at Master Cylinder = Pressure at Caliper

Pressure at Caliper $= 4.38562 \ N/mm^2$

Area of Caliper Piston = $\frac{\pi}{4} \times d^2$

$= \frac{\pi}{4} \times 28^2$

$= 615.75 mm^2$

Force at Caliper of Single Piston = Pressure at Caliper x Area of Caliper Piston

= 4.38562 x 615.75

= 2700.45 N

Force at Caliper = Force at Single Piston x Number of Piston

= 2700.45 x 4

= 10801.8N

Force at disc by the Caliper

Force of disc =μ x force applied by the caliper

= 0.6 x10801.8

= 6481.08 N

Torque at Disc =Force at disc x mean radius of disc

= 6481.08 x 95

= 615703N-mm

Torque at Disc = Torque at Tyre

Torque at Tyre = 615703N-mm

T at Tyre = Force on Tyre x Radius of Tyre

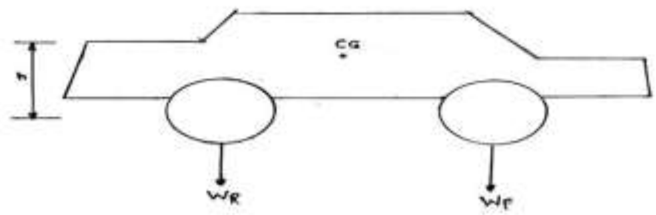
Force on Tyre = $\frac{\text{T at Tyre}}{\text{Radius of Tyre}}$

$= \frac{615703}{540}$

= 2280.38N

Normal Force on Tyre < Force at Tyre by Caliper

T_{Stop} the car.



Vehicle force Layout

W= Weight of Vehicle

W_R = Weight on Rear Wheel

W_F = Weight on Front Wheel

C.G. = Centre of Gravity (Centre of Mass)

H= Height of C.G.

$\sum y = 0$

$W = W_R + W_F$

Moment at A = W x a - W_F x (a+ b)

$W_F = \frac{W \times a}{(a+b)}$

$W_R = W - W_F$

Weight distribution of vehicle at static condition = $\frac{W_R}{W_F}$

Thermal Calculation of Disc:

Total Energy that vehicle has = K.E. energy of car

K.E. = $\frac{1}{2} MV^2$

To stop the vehicle K.E. of the car should be = 0

i.e. All of the K.E. should be converted to heat

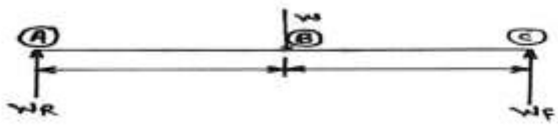
K.E. = $\frac{1}{2} MV^2$

To calculate disc temp = V = u + at

Breaking Power = $\frac{K.E.}{t}$

Heat Flux = $\frac{K.E.}{t} \times \frac{1}{A}$

$\frac{K.E.}{t} = \frac{\text{Heat Flux}}{A}$



Force Distribution Diagram

2. ANALYSIS

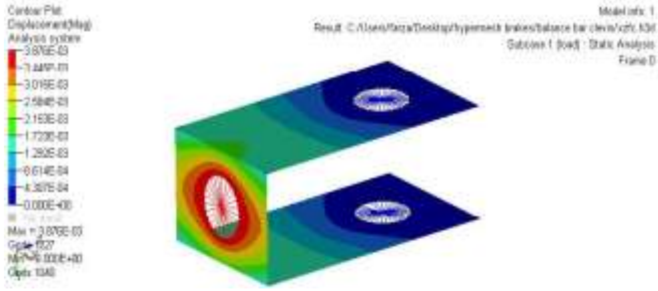


Figure- Displacement Result of Clevis

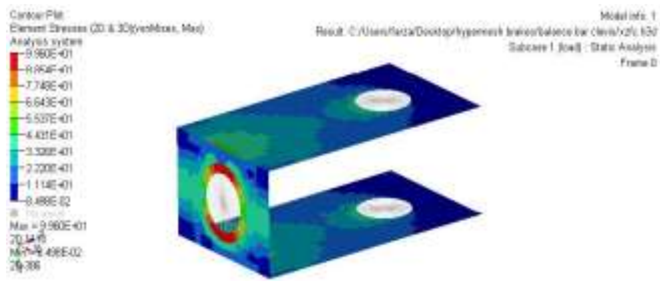


Figure- Elemental Stress Result of Clevis

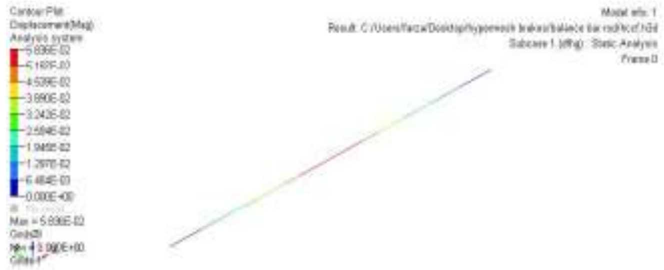


Figure- Displacement Result of Balance Road

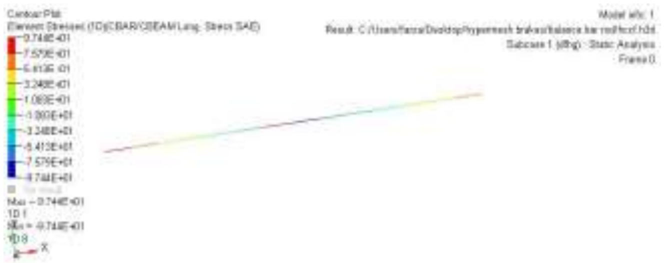


Figure- Elemental Stress Result of Balance Road

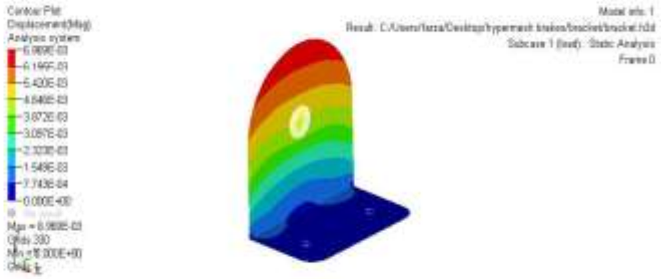


Figure- Displacement Result of Bracket of Pedal

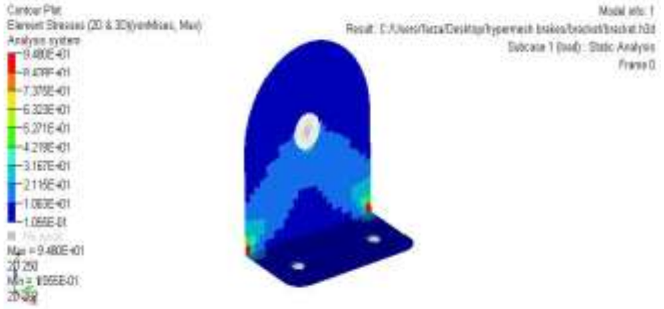


Figure- Elemental Stress Result of Bracket of Pedal

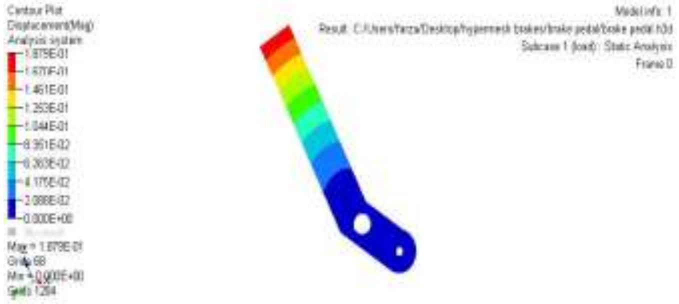


Figure- Displacement Result of Brake Pedal

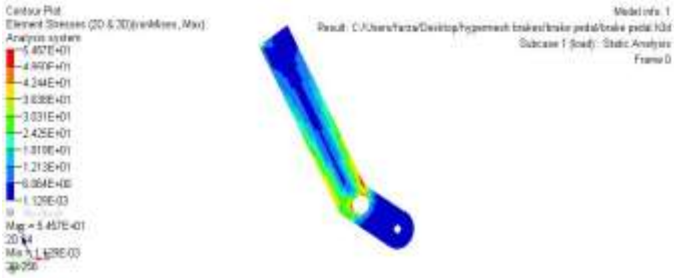


Figure- Elemental Stress Result of Brake Pedal

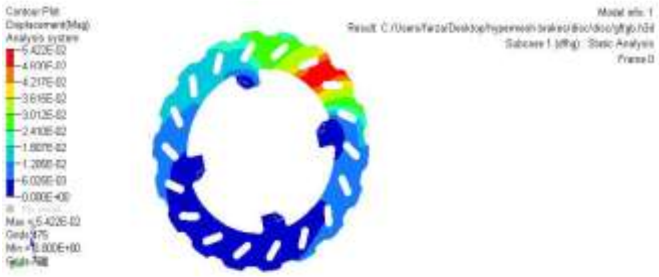


Figure- Displacement Result of Outer Disc

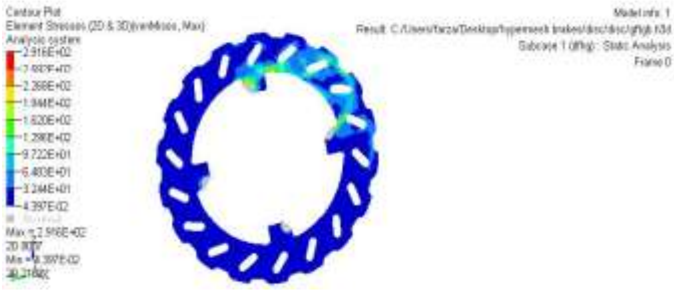


Figure- Elemental Stress Result of Outer Disc

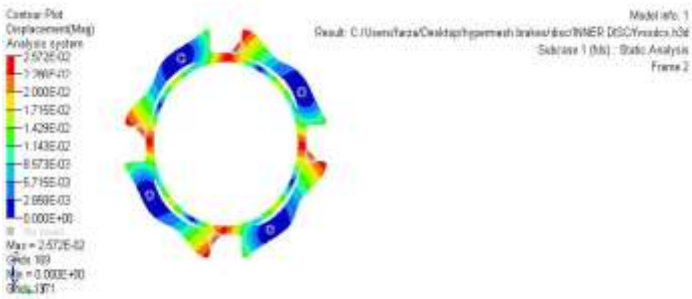


Figure- Displacement Result of Inner Disc

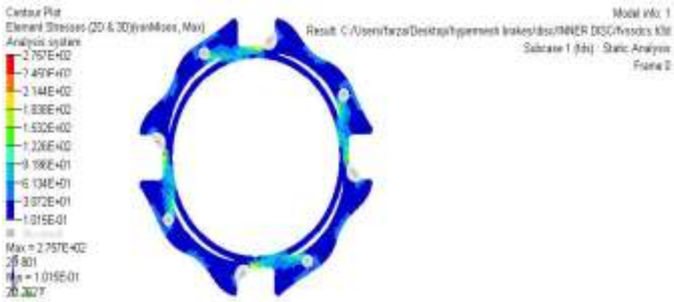


Figure- Elemental Stress Result of Inner Disc

FUTURE SCOPE

The thesis also discusses about the international market of the brakes with ideas about the future market. As it will reduce the vibration in the disc the rate of distortion will get decrease. It will also reduce the time for heat dissipation. And due to rivets, it stops transfer of heat from outer surface to inner surface it will easily replace the fixed disc to avoid above issues. So overall market cost and market demand will be higher for this product.

3. CONCLUSION

Today's brake actuation systems are highly sophisticated and the applications are many and varied. Numerous factors affect the design of these systems, of these operator safeties is the most important. To achieve maximum safety the designer must have a thorough understanding of the components and circuitry. The operating parameters and performance specifications must be carefully analyzed. The reliability of the brake actuation system depends directly upon the quality of the data and the accuracy of the system designer. We want our vehicle's brake system to offer smooth, quiet braking capabilities under a wide range of temperature and road conditions. We don't want brake-generated noise and dust annoying us during our daily driving. To accommodate this, brake friction materials have evolved significantly over the years. They've gone from asbestos to organic to semi-metallic formulations. Each of these materials has proven to have advantages and disadvantages regarding environmental friendliness, wear, and noise and stopping capability. Since they were first used on a few original equipment applications in 1985, friction materials that contain ceramic formulations have become recognized for their desirable blend of traits. These pads use ceramic compounds and copper fibers in place of the semi-metallic pad's steel fibers. This allows the ceramic pads to handle high brake temperatures with less heat fade, provide faster recovery after the stop, and generate less dust and wear on both the pads and rotors. And from a comfort standpoint, ceramic compounds provide much quieter braking because the ceramic compound helps dampen noise by generating a frequency beyond the human hearing range. Another characteristic that makes ceramic materials attractive is the absence of noticeable dust. All brake pads produce dust as they wear. The ingredients in ceramic compounds produce a light colored dust that is much less noticeable and less likely to stick to the wheels. Consequently, wheels and tires maintain a cleaner appearance longer.

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