BRAKING SYSTEM DESIGNING AND ANALYSIS OF ATV

A PROJECT REPORT

Submitted By

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in partial fulfillment for the award of the degree
of

BACHELOR OF ENGINEERING

IN

AUTOMOBILE ENGINEERING

DEPARTMENT OF AUTOMOBILE ENGINEERING
RAJALAKSHMI ENGINEERING COLLEGE
ANNA UNIVERSITY, CHENNAI

APRIL 2023

RAJALAKSHMI ENGINEERING COLLEGE, THANDALAM, CHENNAI – 602 105

BONAFIDE CERTIFICATE

Certified that this Thesis titled **"BRAKING SYSTEM DESIGNING AND ANALYSIS OF ATV" is the bonafide work of RAKESHKUMARAN.G (190201024)**, **RESMAN.AK (190201025), NETHAJI.T (190201021)** who carried out the work under my supervision. Certified further that to thesis or dissertation based on which a degree or award was conferred on an earlier occasion on this or any other candidate.

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This project is submitted for VIVA-VOICE Examination held on 21.4.2023 at Rajalakshmi Engineering College, Chennai.

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ACKNOWLEDGEMENT

Initially, we thank the almighty for being with us through every walk of life it is our privilegeto express our sincerest thanks to our respected Chairman **MR. S. MEGANATHAN, B.E., F.I.E.,** and beloved Chairperson **DR.(MRS.) THANGAM MEGANATHAN, M.A., M.Phil., Ph.D.** for providing us with the requisite infrastructure and extending support in all endeavors. Our heartfelt thanks to **DR. S. N. MURUGESAN, Ph.D.,** our principal for his kind support and resources provided to complete our work on time.

We gratefully acknowledge and thank **DR. K. BHASKAR, Ph.D.,** Professor & Head, Department of Automobile Engineering for giving his constant Encouragement.

We thank our project coordinators **MR.K. MOHANRAJ, M.E.,** Assistant Professor, and **DR. B. MULLAI SUDAROLI, Ph.D.,** Assistant Professor, Department of Automobile Engineering, for their timely support and suggestion throughout this phase.

We thank our project guide **DR.PN.SELVARAJU, Ph.D.,** Associate professor, Departmentof Automobile Engineering, for his valuable guidance throughout this phase of the project.

We also express our profound thanks to all the faculty members and lab technicians of the Automobile Engineering department who helped us to make this project successful. We also sincerely thank all our family members and friends for their help in completing this project.

ABSTRACT

A disc brake is a type of brake that uses the calipers to squeeze pairs of pads against a disc or a "rotor" to create friction. This action slows the rotation of a shaft, such as a vehicle axle, to reduce its rotational speed or to hold it stationary. The most modern vehicle uses disc brakes for braking. We aim to design disc brakes with hydraulic systems for All-terrain vehicles (ATVs) & to select material for the disc rotor which has minimal pin wear and plot graph and fabricate the braking system. The formula necessary for braking force at the start of braking is derived. Required braking force is calculated and applied.

CHAPTER-1
1. INTRODUCTION

1.1 GENERAL

Our cars need brakes, which are an essential part of them. They are used to either slow down or stop the vehicle. Braking pads are pressed up against the rotor or disc on both surfaces to stop the wheel. For the safe functioning of all vehicles, they are necessary. In essence, brakes reduce a car's speed by converting the kinetic energy of the vehicle into thermal energy. The loss of stopping force that can happen after using the brakes repeatedly or continuously, particularly under situations of high load, is known as brake fade. Both drum brakes and disc brakes can undergo brake fade, which is brought on by a build-up of heat in the braking surfaces and the ensuing changes and responses in the brake system components. Brake fade can be significantly reduced by appropriate equipment and materials design and selection, as well as good cooling. It is more prevalent in drum brakes due to their configuration.

1.2 PROBLEM STATEMENT

Brakes are such a crucial part of the braking system in stopping the vehicle on all moving stages including braking during high speed, sharp cornering, traffic jam, and downhill. All of those braking moments give a different value of temperature distribution and thermal stress. Most passenger cars today have disc brake rotors that are made of grey cast iron. Grey cast iron is chosen for its relatively high thermal conductivity, high thermal diffusivity, and low cost. Due to the application of brakes on the car disc brake rotor, heat generation takes place due tofriction and this thermal flux has to be conducted and dispersed across the disk rotor cross-section. All the brake disc has a limited wear and tear period of the cycle, this project involves the changing of brake disc materials and analyzing it to see how the efficiency of the brake disc increases and what else can be done to increase its efficiency and reduce braking wear and tear.High temperature during braking will cause:

- Brake fade
- Premature wear
- Brake fluid vaporization
- Bearing failure
- Thermal cracks
- Thermally-excited vibration

1.3 PURPOSE OF BRAKING SYSTEM

- To Stop the vehicle
- Heat energy is created by friction between disc rotor and disc pad.
- Disc and drum brakes are the most common type of braking systems used.

1.4 FACTORS AFFECTING BRAKING

- Number of wheels braking.
- Weight of vehicle.
- Type of friction material.
- Surface area of friction material.
- Size of discs or drums

1.5 CLASSIFICATION OF BRAKES

Classification of brakes (based on the transformation of energy):

- Hydraulic brakes
- Electric brakes
- Mechanical brakes

1.5.1 MECHANICAL BRAKE

Mechanical brakes are assemblies consisting of mechanical elements for the slowing or stopping of rotor. They use levers or various leverage to transmit force from the applied place to the brake. Mechanical brakes according to the direction of acting force may be sub-divided into two groups:

- Radial brake
- Axial brake

1. RADIAL BRAKE:

In these brakes, the force acting on the brake drum is in the radial direction. The radial brakemay be subdivided into the external brake and internal brake.

2. AXIAL BRAKE:

In these brakes, the force acting on the brake drum is only in the axial direction eg. Disc brake Cone brake.

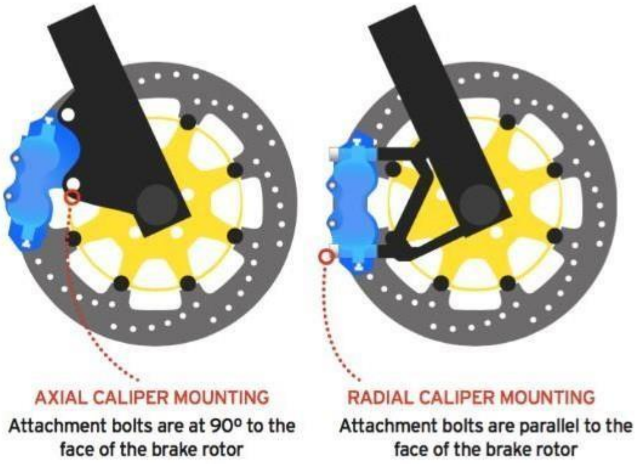


Fig.1.1 Axial& Radial Caliper Mounting

1.5.2 ELECTRIC BRAKE:

Electric brakes are assemblies of electrical elements for the slowing or stopping of rotating objects. Electrical power is required to activate the brake.

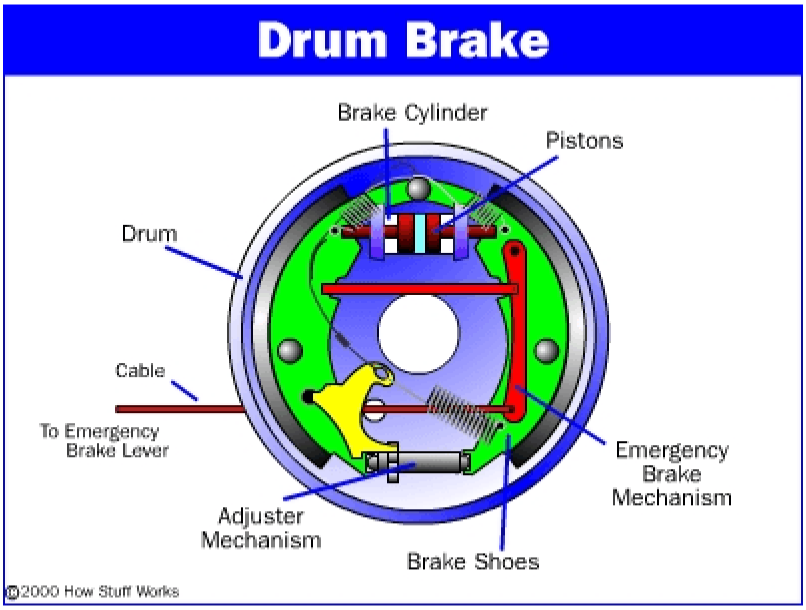


Fig.1.2 Electric Braking

1.5.3 HYDRAULIC BRAKE:

Hydraulic brakes use fluid to transfer pressure and actuate the braking mechanism.

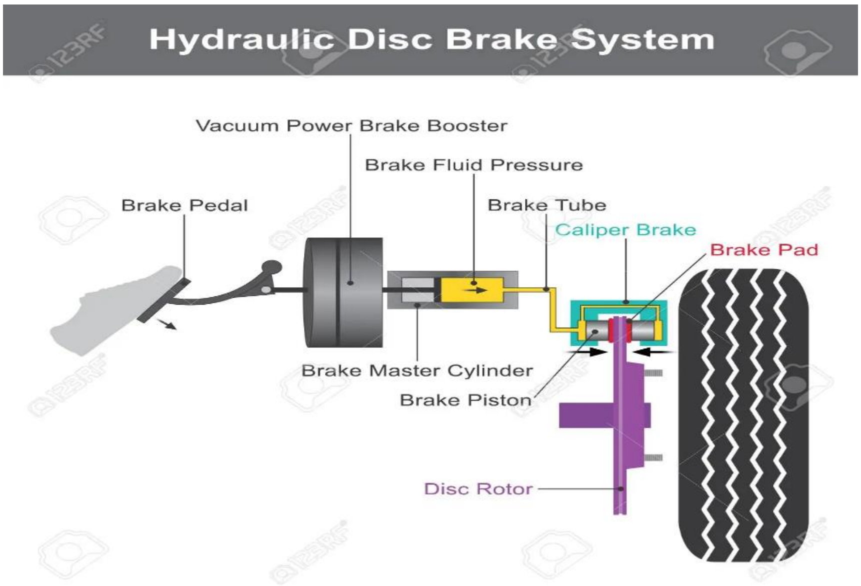


Fig.1.3 Hydraulic Brake

1.6 DISC BRAKE:

A disc brake consists of a cast iron disc bolted to the wheel hub and a stationary housing called Caliper. The caliper is connected to the stationary part (knuckle) of the vehicle, like the axle casing or the stub axle, and is cast in two parts, each part containing a piston. In between each piston and the disc, there is a friction pad held in position by retaining pins, spring plates, etc. passages are drilled in the caliper for the fluid to enter or leave each housing. These passages are also connected to another one for bleeding. Each cylinder contains a rubber sealing ring between the cylinderand the piston.

1.6.1 ELEMENTS OF DISC BRAKE:

There are major four elements of the brake disc

1. Master Cylinder – usually accessible by the user. it is an actuating device.
2. Brake Caliper - It is the end part of effort transmission in brakes which retards the motion of rotor.
3. Hose – is for transmission of Oil from the Master Cylinder to the Brake caliper

1.6.1.1 CALIPER:

The wheel cylinder and two brake pads are part of the brake caliper. Disc calipers can be divided into two categories: floating calipers and fixed calipers. To squeeze the brake pad against the rotor, this sort of brake uses just one piston. (BOSCH 1992). The braking pad's opposing side is pressed up against the rotor by the reactive force, which also causes the caliper housing to shift. When the brake is applied to the left of the piston, the brake fluid pulls the piston, pushing the inner pads and pressing them against the rotor disc. The sliding caliper housing then shifts and pushes the left pad on the disc in response. Vacuum Caliper (as shown in Fig.1.4) Design (Source: BOSCH Automobile Handbook, 1992) A fixed caliper is a different kind of disc caliper and is an example of a fixed caliper. (as shown in Fig.1.4). These brakes use two or more pistons on either side of the rotor and have a fixed caliper body. The fixed caliper has pistons in each of its two halves.

Fig.1.4 Floating Caliper Piston Operation

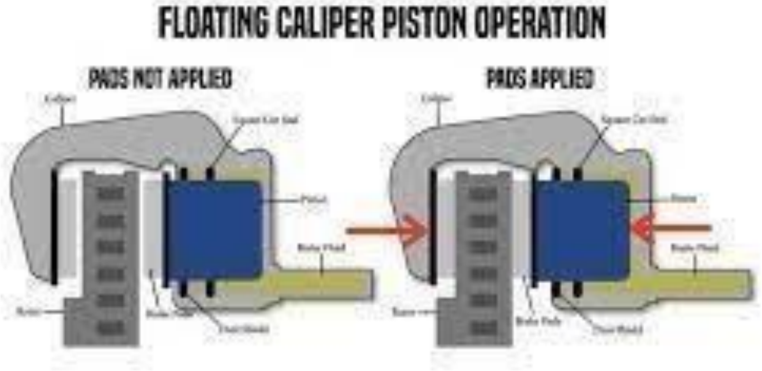
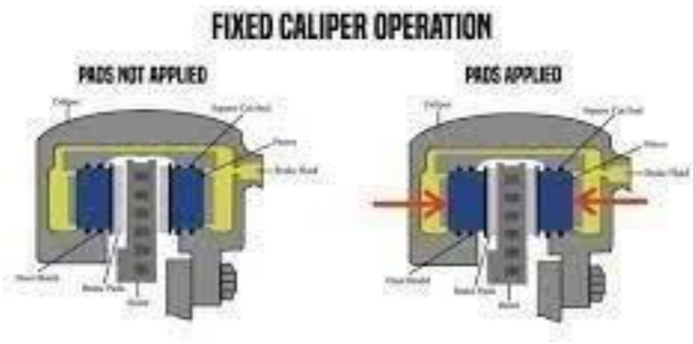


Fig.1.4 Floating Caliper Piston Operation



1.6.1.1 BRAKE PAD:

The majority of the materials used to make the pad are non-metallic, including ceramic. Steel carriers serve as the basis for brake pads, which are bonded to the carriers. (as shown in Fig.1.5) claims that organically bonded pads are made up of organic, metallic, or ceramic friction components that are bonded together in a mass like rubber or synthetic resin. The materials used for bonded friction can tolerate temperatures of up to 750 °C, with short-term maxima reaching 950 °C when the friction coefficient is between 0.25 and 0.5. The fact that most brake pads have weak thermal conductivity, which guards against overheating of the hydraulic actuating elements, is a benefit of brake pads.

Fig.1.5 Brake pad

BRAKE PAD LINING MATERIAL:

- Non-metallic-Made from synthetic fibers (used to be asbestos)
- Semi-metallic
  - Made from iron and synthetic fibers
  - More fade resistant - harder pad
  - More prone to squealing
- Full-metallic
  - Made from sintered metals
  - Very hard pad

1.6.1.2 PISTON:

It is used to push the brake pad by the flow of brake fluid.

1.6.1.3 ROTOR OR DISC:

It provides a smooth surface against which to face the brake pads, to slow or stop the vehicle. The heat is generated on the surfaces of the disc brake rotor when the brake is applied. Materials of disc brake rotor usually are made from cast iron, spheroidal-graphite cast iron, or cast steel. It is chosen as a rotor material due to the low cost of the material and performs high thermal resistance. This type of material normally suits normal passenger vehicles but not high-performance cars. Once brake pads contact the rotating rotor, there will be a huge amount of heat generated to stop or slow down the vehicle. The rotor temperature can exceed 350°c for normalcars and 1500°c for race cars.

1.6.1.4 MASTER CYLINDER:

The first part of a car's braking system, the brake master cylinder, is triggered by pressing the brake pedal. Brake fluid is forced through brake lines to slave cylinders at each wheel by a piston pushed through this cylinder by the pedal.

which in turn activates the pistons that apply pressure to the friction material and cause the wheel to stop. Although the master cylinder is intended to last the lifetime of the vehicle, like brake calipers, it occasionally develops leaks or experiences other failures, necessitating rebuilding or replacement. The brake-fluid reservoir, which needs to be kept full, sits on top of the master cylinder (Fig. 1.6.1 and Fig 1.6.2).

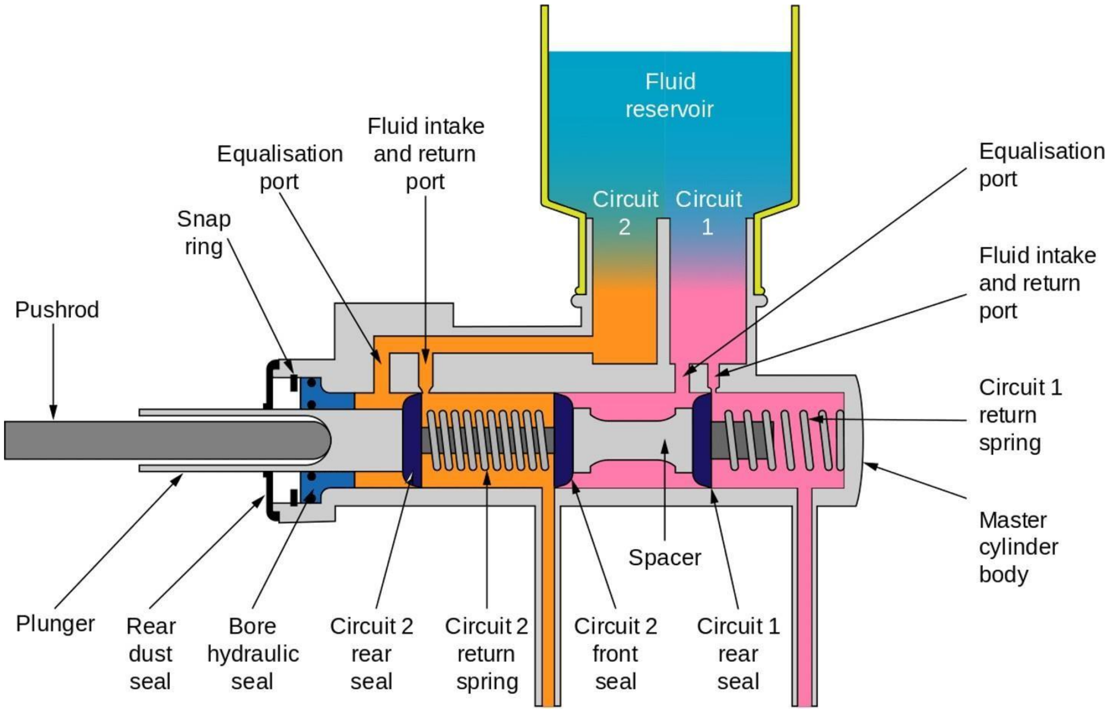


Fig.1.6.1 Master cylinder

Fig.1.6.2 Tandem Master Cylinder

1.7 ADVANTAGES AND DISADVANTAGES

1.7.1 ADVANTAGES:

- Greater amounts of heat in the atmosphere
- Cooling more rapid
- Rotors scrape off the water more efficiently
- Self-adjusting
- Don’t need periodic maintenance
- Easier to service

1.7.2 DISADVANTAGES:

- Prone to noise (squeals and squeaks)
- Rotors warp more easier
- Not self-energizing
- Hard to use as a parking brake

CHAPTER 2

METHODOLOGY

- The first step would be, selection of the vehicle to which brake disc is to be designed.
- The next step in this project will be design Calculation for designing the braking system.
- The next step would be study of various materials for disc.
- Based on study, Disc material are tested and wear is obtained.
- The next step would be modelling the disc rotor based on the design calculation result using modelling software **(CATIA V5).**
- The fourth step would be "ANALYSIS" meaning, analyzing the disc rotor with different materials adding to it and finding out their thermal properties, mechanical properties & structural properties.
- At the last, the material with less pin wear is used for disc rotor and entire brake system is fabricated.
- The vehicle is tested.

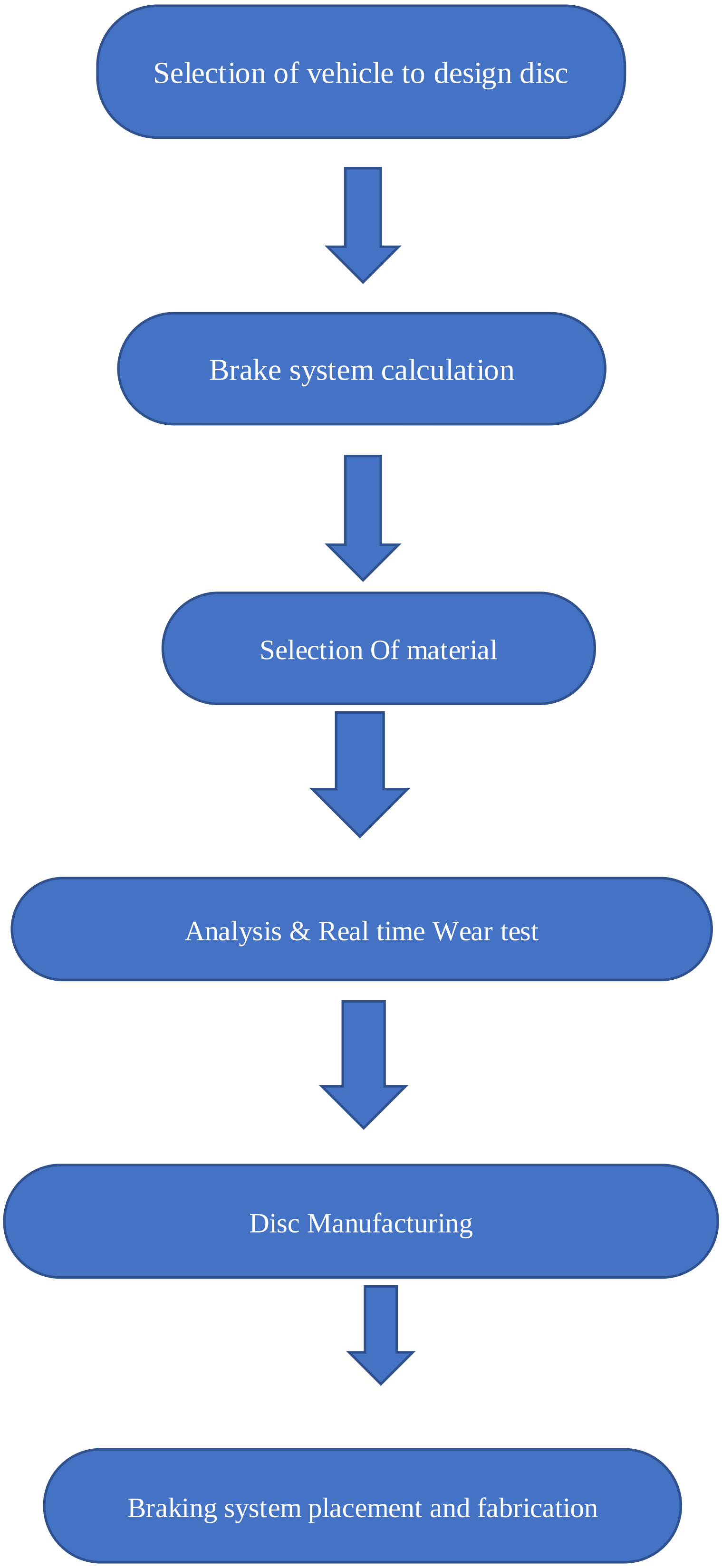


Fig .2.1 Methodology Flow Chart

CHAPTER 3
3.1 DESIGN CALCULATION OF BRAKE DISC

Fig.3.1.1Electric All-Terrain Vehicle (V7)

- Vehicle: Electric ATV (as shown in Fig.4.1.1)
- Gross vehicle weight: 350kg (including driver)
- Driver weight: 75 kg
- Kerb weight: 280 kg
- Sprung mass: 250 kg
- Un-sprung mass: 40 kg
- Ground clearance: 330 mm
- Maximum speed: 54 km/hr
- Maximum acceleration: 4.05m/s^2
- Max-power: 4.5 kw @ 4500 rpm
- Max-torque: 38 Nm @ 1150 rpm

- Master cylinder bore =19.05
- Wheel base =1.53m
- Center of Gravity height = 0.500m
- Center of Gravity to real axle =0.330m
- Caliper Bore = 25.4mm
- Coefficient of friction = 0.7
- Coefficient of pads & Disc = 0.4
- Pedal ratio = 8.1
- Vehicle weight = 350 kg. 3433.5N

Required Calculation: -

STEP 1: (Relative C.G)

Center of Gravity (h) = 0.500m
b=1.53m
X=h/b =0.500/1.53
X=0.326

STEP 2: (Dynamic load on front) Rf

X' = Rear axle to Center of gravity = 0.530m
W=350×9.81
W=3433.5 N
Rf=W× (x +x'×h)/b
Rf= 3433.5 × (0.530 +(0.7×0.500))/1.53
Rf= 1974.82 N

STEP 3: (Dynamic Load On Rear)

Rr= W× (b−x'− (m× h))/b
Rr= 3433.5 × (1.53 – 0.530 - (0.7×0.500) / 1.53
Rr = 1458.67 N

STEP 4: (Dynamic Weight Transfer)

Rf = 1974.82 N; Rr= 1458.67 N
Front = 1974.82 / 3433.5 × 100
= 57.5 %
≈60 %
Rear = 1458.67 / 3433.5×100
= 42.4
≈40 %

STEP 5: (Deaccelerate of Vehicle)

(w/g) × a = μ × (Rf + Rr)
(3433.5 / 9.81) ×a =0.7 × (1974.82 ± 1458.67)
a= 6.86 m/s^2 or 0.69 g

STEP 6: (Total Braking Force)

Fb= μ×a×g
M= 350 kg
a=9.81 m/s^2
g=0.69 g
Fb = 350 ×9.81×0.69
Fb = 2369.1 N

STEP 7: (Braking Force on Front Wheel)

Rf= 1974.82 N
Fbf = Rf×N
Fbf = 1974.82 ×0.7
=1382.37 N

STEP 8: (Braking Force on Rear wheel)

Rr= 1458.67 N
F br =Rr ×μ
F br = 1459.67 × 0.7
=1021

STEP 9: Torque on front wheel

wheel ratio - 11.5 inch =0.2921m
F b s = 1382.37
T f = Wheel radius ×F b f
=0.2921×1382.37
T f= 403.79

On Each Wheel = T f /2 = 403.79 /2
= 201.89 N mm

STEP 10: (Torque on Rear Wheel)

Tr = Wheel Radius × F br
F br = 1021.06 N
Tr = 1021.06 ×0.2921
Tr = 298.25
On Each Wheel = Tr/Z = 298.25 /2 =149.12 Nm
(Front Disc)

STEP 11: (Force on Master Cylinder)

Aera Of Master Cylinder = $\pi D^2 / 4$
$= \pi \times (19.05)^2 / 4$
$= 285.02\ mm^2$

Pedal Force by Drum = 300 N
Pedal ratio = 8
Force = 8×300
=2400 N

Actuation Force at Master Cylinder on Front Brakes
= 2400×0.6 →Brake bias
= 1440 N
Pressure Generated Inside Master Cylinder
Force / Area = $1440 / 2855.02 \times 10^6$
= 5.05 M pa

STEP 12: (**Area of Piston Cylinder Bore)**

Area of Piston Cylinder Bore = $\pi D^2 / 4$
$= \pi \times (25.4)^2 / 4$
$= 506.70\ mm^2$

Due to Dual Piston = 506.70 ×2
$= 1013.4\ mm^2$

Force Applied by Caliper
$= 2 \times \mu d \times p \times A$
$= 2 \times 0.4 \times 5.05 \times 10^6 \times 1013.4 \times 10^{-6}$
= 4094.13 N → Frictional Force

FRONT DISC

Outer diameter = 185 mm
Inner diameter = 110 mm

Effective radius (Re) = $1/3\ [\ (o^3 - d^3) / (o^2 - d^2)$
$= 1/3\ [\ (185^3 - 110^3) / (185^2 - 110^2)]$
= 75.3 mm
= 0.0753 m

TORQUE (Affected) = 0.0753 × 4094.13
= 308.28 N
= 0.0753×3413.13
= 257 N

REAR DISC

Force on Master Cylinder
Area of Master Cylinder = 285.02 mm^2
Pedal force by Driver = 300 N
Pedal ratio: 8:1
Force = 8×300 = 2400 N
Actuation Force a t Master Cylinder on Rear Brakes
= 2400 ×0.4 → 60 N
Pressure Generated Inside Master Cylinder
Force/ Area = 60 / 286.02 ×10^6 = 3.36 M pa
Area of Caliper Piston = 163.4 m^2
=10134×10^-6 m^2
Force Applied by Caliper
=2×μd× ƿ × A
=2×0.4 ×3.36 ×10^6 ×1013.4 ×10^-6
= 2724.01 N

REAR DISC
Outer diameter = 185 mm
Inner diameter = 110 mm
Effective Radius = 0.0753
Torque (Affected) = 0.0753 × 2724.01
= 205.1 N

STEP 13: Stopping Distance

Sdv = (Vv)^2 / 2×av
Vv = Velocity in m/s
Av= deaccleration
SDv = (11.11) ^2 / 2× (6.86) [40 Km / hr = 13.88 m/s]
Sdv = 8.9 m @40 Km / hr
SDv = (13.88) ^2 / 2× (6.86) [50 Km /hr = 13.88 m/s]

SDv = 14 m @50 Km / hr

STEP 14:

STOPPING DISTANCE
St = V v / a v
St = (11.11) / 6.86
St = 1.61 sec @40 Km / h

St = 13.88 / 6.86
St = 2.02 Sec @50 Km / h

STEP 15:

STATIC FRONT AXLE LOAD

Vf = Vehicle Weight × X' / b (Center Of Gravity)

Vf = 3433.5 × 0.53 / 1.53

Vf = 1189.3 N

STATIC REAR AXLE LOAD

Vr = Vehicle Weight × x'' / b (Center Of Gravity)

Vr = 3433.5 × 1 / 1.53

Vr = 2244.1 N

STEP 16:

DYNAMIC WIEGHT TRANSFER @40 – 0

WT = (av /g) × (bv /b) × Vv

= (6.86 / 9.81) × (0.500/ 1.53) × (11.11)

= 2.538

In Front Axel

Vf1d = Vf + WT

= 2062.63

In Rear Axel

Vrd = V r + WT

= 1375.93

STEP 17:

FORCE REQUIRED BY CALLIFER CYLINDER

Pressure P = 5.05 × 10^6 N /m^2

= 5.05 M pa

Bore Diameter of Caliper = 25.4 mm

IN FRONT

P = 5.05 M pa

F= p×π× (r^2 /4)

F= 5.05 ×π × [(25.4) ^2 / 4]

Force required by Front Caliper = 2558.8 N

IN REAR

p=3.36 M pa

F=p×π× (r^2 / 4)

F=3.36×π× (25.4) ^2 / 4

Force required by Rear Caliper = 1702.53 N

BRAKES

PERFORMANCE	
Pedal force	300 mm
Pedal travel	35 mm
Slopping Distance	8.9 m @ 40 km /hr 14 m @ 50 km hr

All Wheels Lock Simulation	
Braking Circuit	
Split Cycle	Front (60) / rear (40)
Master cylinder (bore/Stroke)	19.05 / 31 mm
Disc / Drum	Disc
Caliper Cylinder	25.4 × 2
Brake Pad Area	325.6 mm^2
Brake Fluid	DOT 3

Brake Calculation	Front	Rear
Static Weight Spilt	1190 N	2244 N
Weight Transfer From 40 Kmph	2062 N	1375 N
Brake Torque Required for Wheel	201 N	150 N
Disc Diameter	185 mm	155 mm
Force Required by Caliper Cylinder	2558 N	1702 N
Disc Effect Radius	75 mm	75 mm
Coefficient Of Friction	0.7	0.7
Rolling Radius of Tire	292.1 mm	292.1 mm

CHAPTER 4:

4. MATERIAL SELECTION & PROPERTIES OF MATERIALS

5.

5.1 GENERAL MATERIAL REQUIREMENTS

Disc braking systems generate braking force by clamping brake pads onto a rotor that is mounted to the hub. The force given in brake pedal is transferred to master cylinder using a leverage mechanism thus results in building up of brake pressure and it results in locking of calipers against the rotor. The pressure build is transferred through steel hose. This large force stops the rotor with friction material pads and generates brake power. The higher the coefficient of friction for the pad, the more brake power will be generated. Coefficient of friction can vary depending on the type of material used for the brake rotor. Typically, service brakes are concerned with the coefficient of frictionmeasured while the vehicle is moving. In order to create rolling resistance and slow the automobile down, all contemporary disc brake systems rely on brake pads rubbing on the braking rotor on both sides. By dividing the force pushing the pad into the rotor by the pad's coefficient of friction, the quantity of frictional force may be calculated. Ground-based transportation systems' braking systems are essential safety features, so the structural materials used in brakes should have a variety of qualities, including good compressive strength, a higher friction coefficient, wear resistance, light weight, good thermal capacity, and economic variability.

The materials considered for disc rotor:

1. Aluminum
2. Mild steel
3. Phosphor Bronze
4. Stainless Steel

5.2 Mild steel:

Mild steel is a low carbon content kind of carbon steel; it is often referred to as "low carbon steel." The average quantity of carbon in mild steel is between 0.05% and 0.25% by weight, though ranges might vary depending on the source, whereas higher carbon steels are often defined as having a carbon content between 0.30% and 2.0%. Cast iron would be the category for the steel if any more carbon were added.

Since mild steel is not an alloy steel, it does not contain significant levels of any other elements besides iron. For example, mild steel does not contain significant concentrations of chromium, molybdenum, or any other alloying elements. Similar to other carbon steels, mild steel is fabricated. Iron ore and coal are frequently combined to accomplish this. After being taken from the earth, coal and iron ore are combined and melted in a blast furnace. Once melted, the material is transferred to a different furnace to burn out any impurities and make any necessary alterations to the chemical make-up of mild steel.

Fig 4.2 Mild Steel

5.3 Phosphor Bronze:

Alloys of copper, tin, and phosphorous are known as phosphor bronzes. Between 0.01 and 0.35 percent phosphorous and 0.5 to 11% tin are both present in phosphor bronzes. Tin boosts the alloy's strength and ability to resist corrosion. The addition of phosphorous improves the alloy's stiffness and wear resistance. Exceptional spring properties, strong fatigue resistance, outstanding formability and solderability, and high corrosion resistance are all characteristics of phosphor bronzes. They are mainly used for electrical items, but they can also be used to make bellows, diaphragms, and spring washers that are resistant to corrosion. The UNS codes for the phosphor bronzes are C50100 through C54200. Leaded phosphor bronzes have strong wear resistance, corrosion resistance, good machinability, and good strength and fatigue resistance. They are utilized in sleeve bearings, thrust washers, and cam followers, among other things.

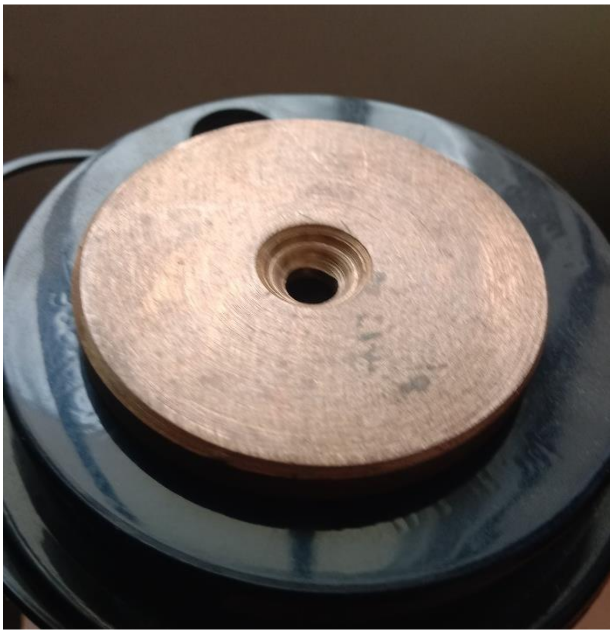


Fig 5.3 Phosphor Bronze

5.4 Stainless Steel (AISI 304):

Any member of the family of alloy steels known as stainless steel, typically having 10 to 30 percent chromium. In combination with low carbon content, chromium offers exceptional heat and corrosion resistance. It is possible to add other elements, such as nickel, molybdenum, titanium, aluminum, niobium, copper, nitrogen, Sulphur, or selenium, to improve corrosion resistance in a certain environment, boost oxidation resistance, or give something special.

The majority of stainless steels are initially melted in electric-arc or basic oxygen furnaces and then refined, mostly to reduce the carbon content, in another steelmaking vessel. In the argon-oxygen decarburization procedure, liquid steel is injected with a mixture of oxygen and argon gas.

It is feasible to reduce carbon to predetermined levels by oxidizing it to carbon monoxide by changing the oxygen to argon ratio without simultaneously oxidizing and losing costly chromium. In the initial melting process, less expensive raw materials, including high-carbon ferrochromium, may be employed. Stainless steel comes in more than 100 different grades. In the family of stainless steels, the majority are divided into austenitic, ferritic, martensitic, duplex, and precipitation-hardening. The steels with the best corrosion resistance are typically austenitic steels, which range in chromium content from 16 to 26 percent to up to 35 percent nickel. They are nonmagnetic and cannot be heat-treated to become harder.

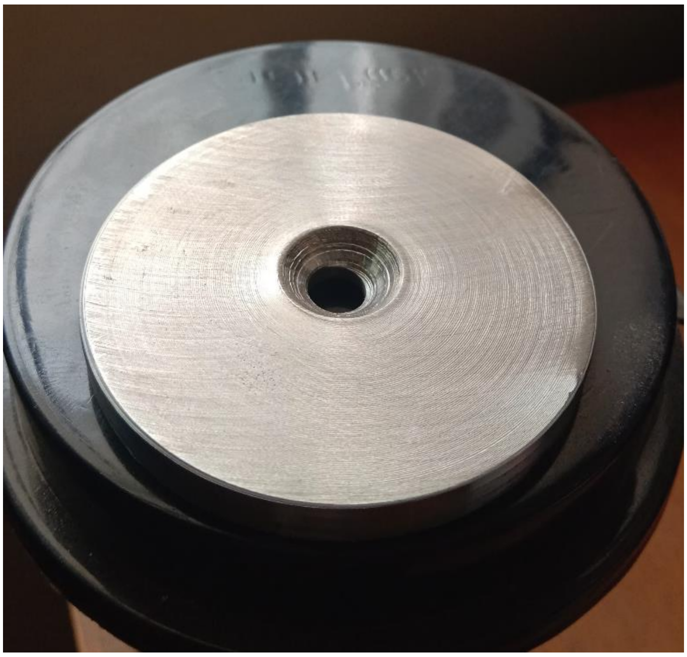


Fig 5.4 Stainless Steel

5.5 ALUMINIUM 6061 (Al):

Aluminum is considered for rotor due to its thermal property of high heat dissipation and structural property of light weight compared to other materials for consideration. It can be combined with many materials to form alloys. It is Silver white in colour. The main disadvantage is at high temperature it losses its property.

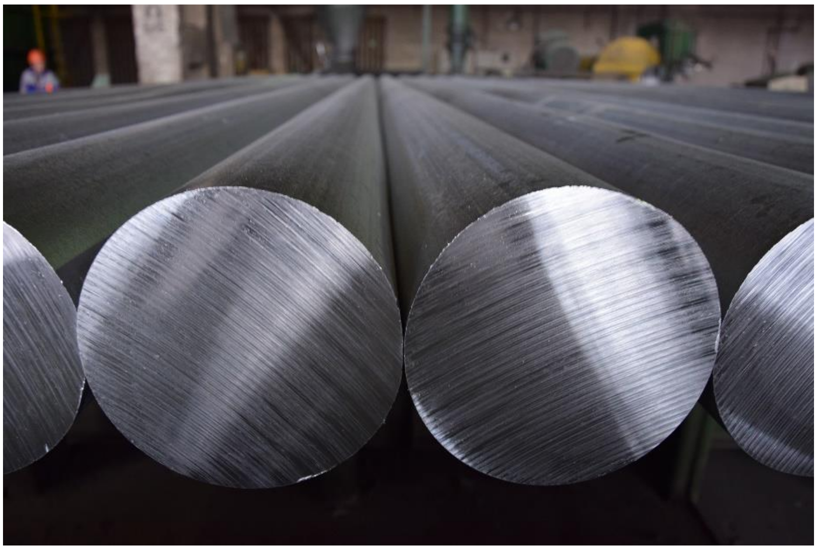


Fig 4.1 Aluminum

APPLICATIONS:

- aerospace,
- aircrafts,
- underwater,
- automobile,
- substrate in electronics,
- golf clubs,
- turbine blades
- brake pads

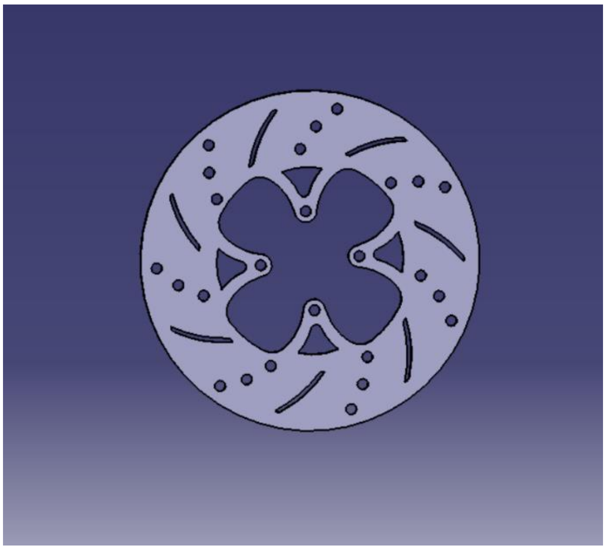
5.6 MATERIAL PROPERTIES:

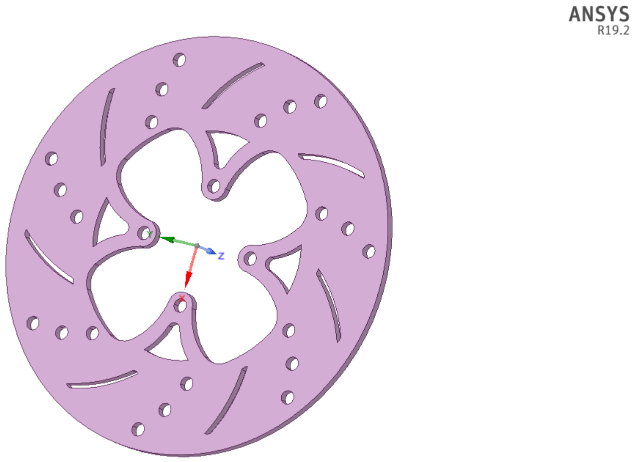
PROPERTIES	ALUMINIUM	MILD STEEL	PHOSPHOR BRONZE	STAINLESS STEEL
Density (kg/m^3)	2710	7850	8800	7500
Young's Modulus GPA	69	200	110	190
Poisson Ratio	0.33	0.3	0.34	0.265
Tensile Yield Strength Mpa	240	250	450	510
Tensile Ultimate Strength Mpa	290	460	550	621
Thermal Conductivity W/m-k	167	46	69.2	15
Specific Heat J/ (kg.k)	500	420	380	502.41
Melting point $^{\circ}C$	660	1530	1049	2550

CHAPTER 5

DESIGN & ANALYSIS

5.1 DESIGN:





The design is done using CATIA V5, with disc radius as 185mm and strut hole diameter as 4mm. and slots are provided for heat dissipation.

5.2 ANALYSIS TESTING:

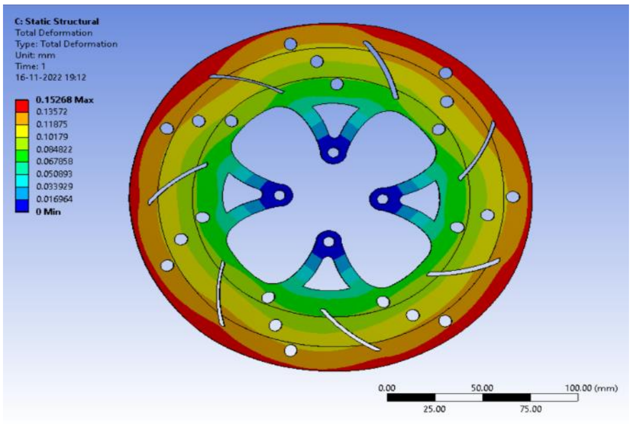
Our rotor is tested in Ansys 2021 R2, we have done ANSYS using four different materials.

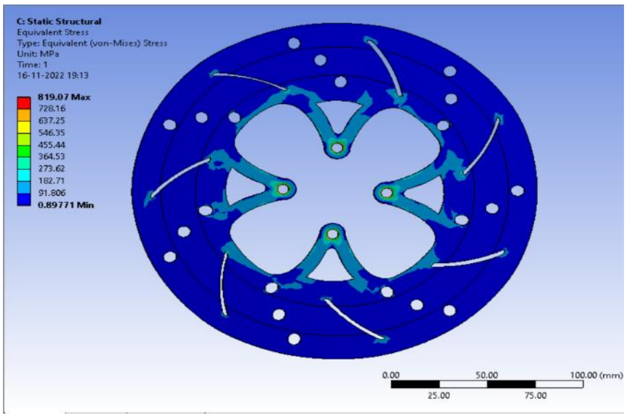
The boundary conditions are,

1. load experienced by the disc rotor while braking, while braking the load of the vehicle and braking pressure and vehicle acceleration are taken into account.

2. After the result obtained from the load is given to thermal analysis and heat flux, and temperature are obtained.

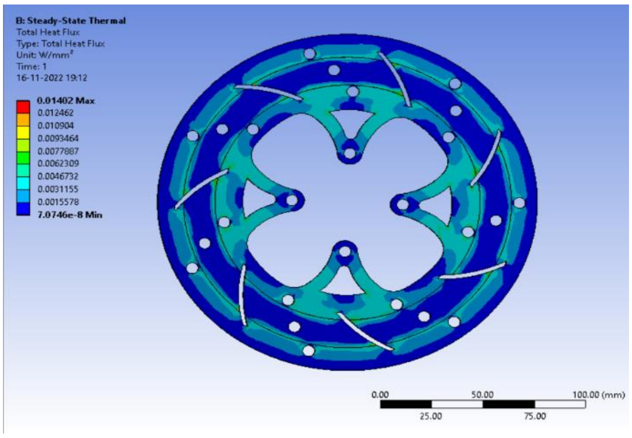
5.2.1 STAINLESS STEEL

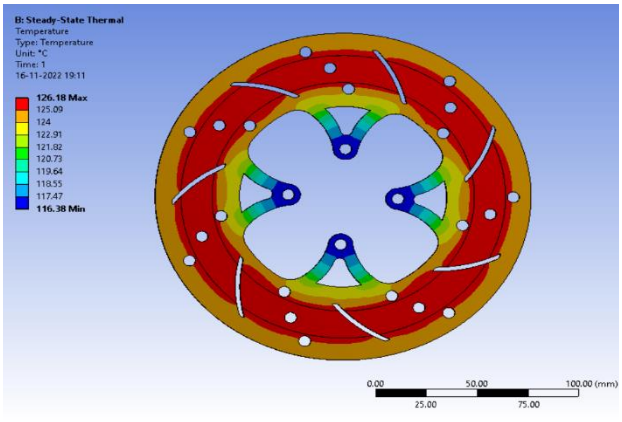




TOTAL DEFORMATION

STRESS





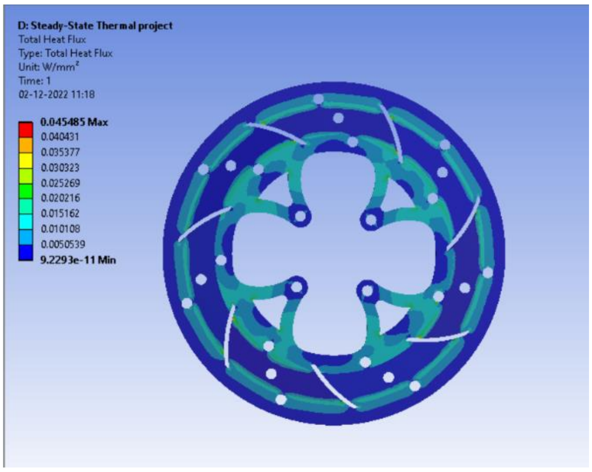
TOTAL HEAT FLUX

TEMPERATURE

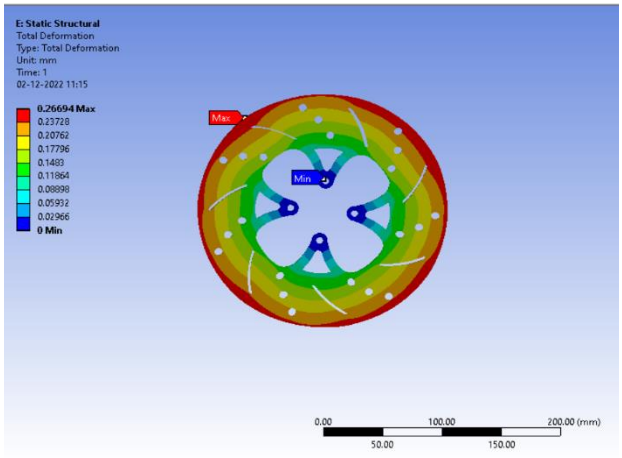
STAINLESS STEEL:

TOTAL DEFORMATION	0.15268mm
TOTAL HEAT FLUX	0.0142 W/mm^2
TEMPERATURE	126.18°C

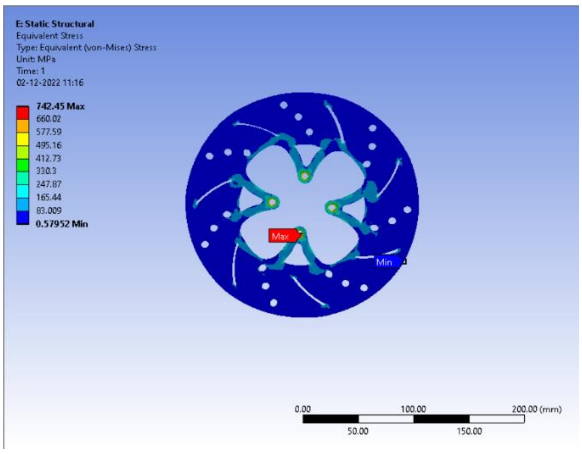
5.2.2 MILD STEEL:



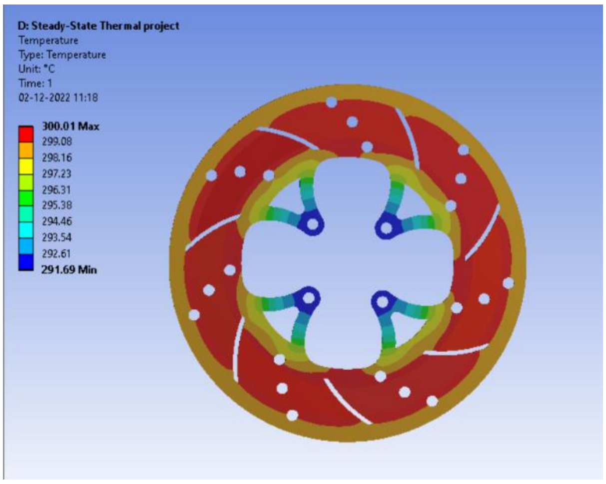
TOTAL HEAT FLUX



TOTAL DEFORMATION



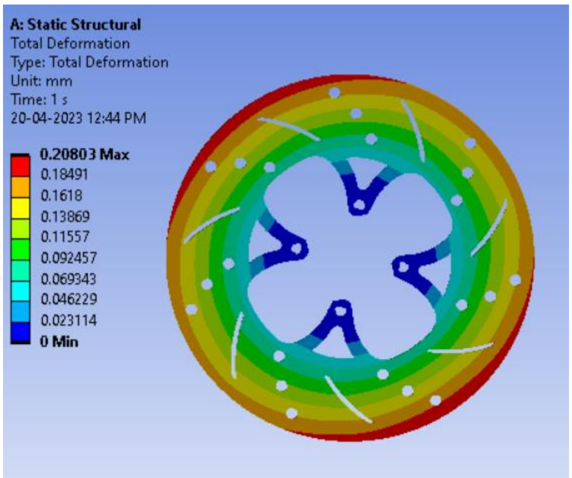
STRESS

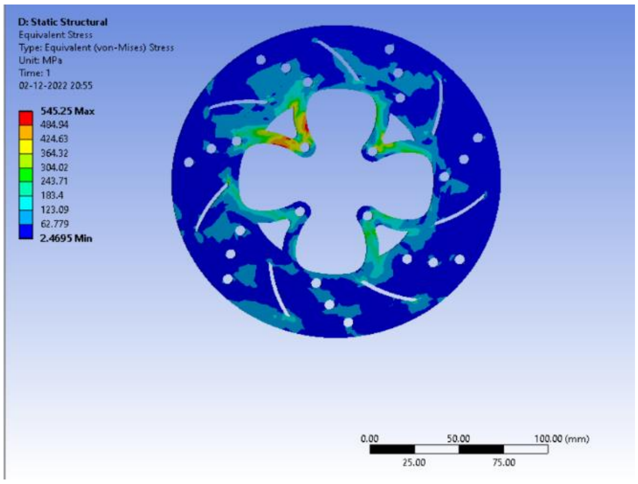


TEMPERATURE

TOTAL HEATFLUX	1.8 W/mm^2
TOTAL DEFORMATION	0.26694mm
TEMPERATURE	300.01℃

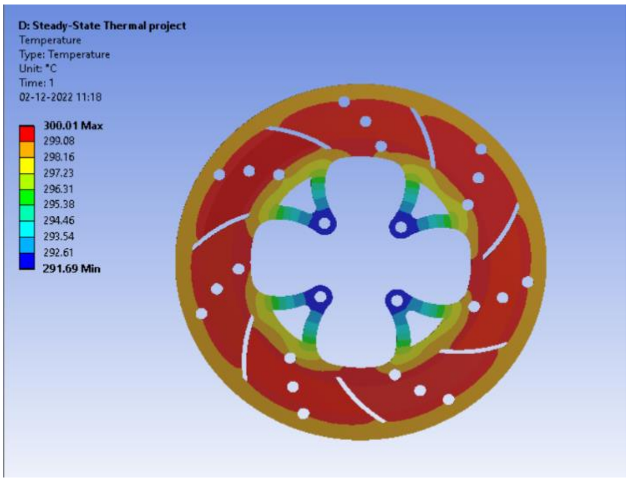
5.2.3 ALUMINIUM:

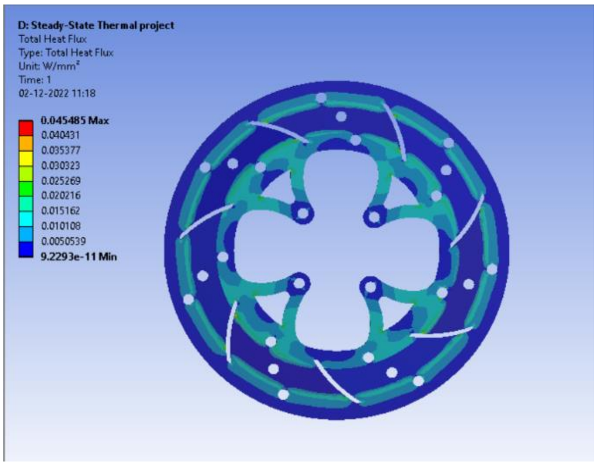




DEFORMATION

STRESS



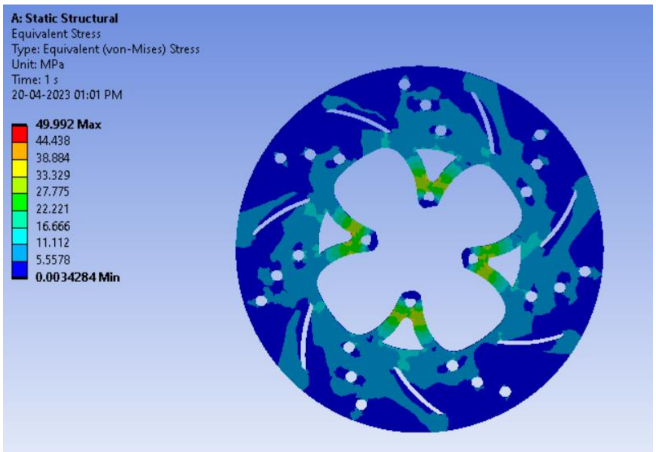


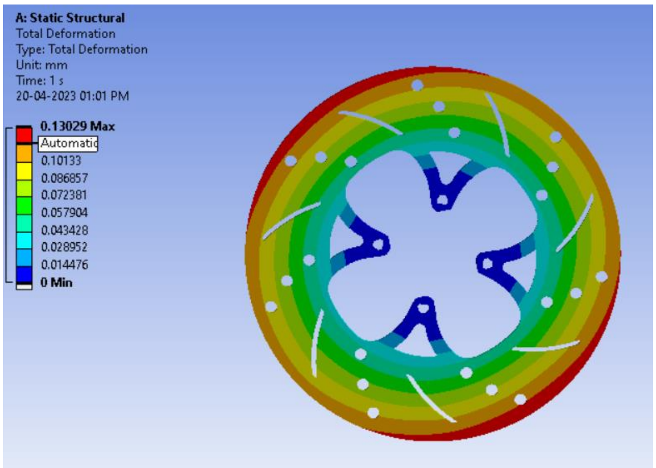
TEMPERATURE

HEAT FLUX

TOTAL HEATFLUX	0.045W/mm^2
TOTAL DEFORMATION	0.2mm
TEMPERATURE	291°C

5.2.4 PHOSPHOR BRONZE:





STRESS DEFORMATION

STRESS	49.992 Mpa
TOTAL DEFORMATION	0.13 mm
TEMPERATURE	291℃

Analysis Setting:

1. Modules used:

    1. Static Structural

    2. Transient Thermal

2. Element Size: 4mm

3. Method: Tetrahedron

4. Braking force applied on brake pad area: 200N

5. Temperature: 290℃ - 350℃

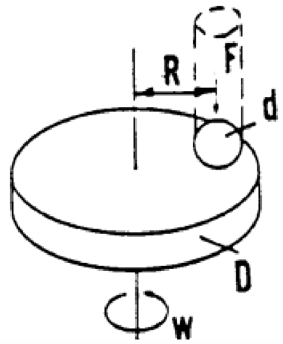
CHAPTER 6
TESTING OF DISC ROTOR

Aim:

To find the wear of the disc and pin (Brake pad) using Pin-On-Disc method

Apparatus:

Pin-On-Disc apparatus, disc, pin



Materials used for disc:

1. Stainless Steel
2. Phosphor Bronze
3. Mild steel

Material used for pin:

Friction Lining material.

Description:

Disc:

A disc is manufactured with 55mm of diameter with desired material and CSK (countersunk) of 6mm hole is given at the center for the mounting of M6 Screw.

Pin:

The material which contacts the disc during test is called as pin and it is manufactured using desired friction material.

Procedure:

Initially, the weight of disc and pin are measured separately using weighing machine.

The disc is mounted to the testing rig at csk 6mm hole, and the pin is placed idle where it makes a constant contact with the disc. The disc is the rotating component and pin is idle component.

Now, a load of 50N is applied to the disc against the pin to resemble the braking nature of vehicle, and the disc is allowed to spin at a speed of 955 RPM. The duration for disc rotation is specified in the testing rig. After the completion of the time the disc and pin are removed and the weight is checked again, it is considered as final value. The difference between initial and final value taken and thus the wear is found. The values such as frictional force, and wear are obtained.

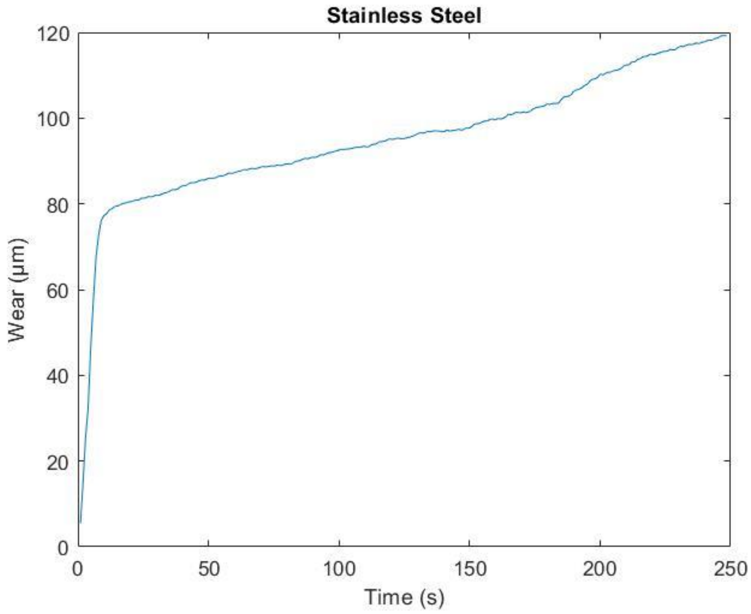
The above process is repeated for different material and compared.

Test parameters				Machine setting			
Expt. No.	Applied Load (N)	Sliding velocity (m/sec)	Sliding Distance (m)	Sliding dia in mm	r.p.m	Time in secs	Time in min:secs
1	50	2	500	40	955	250	4.166
2	50	2	500	40	955	250	4.166
3	50	2	500	40	955	250	4.166

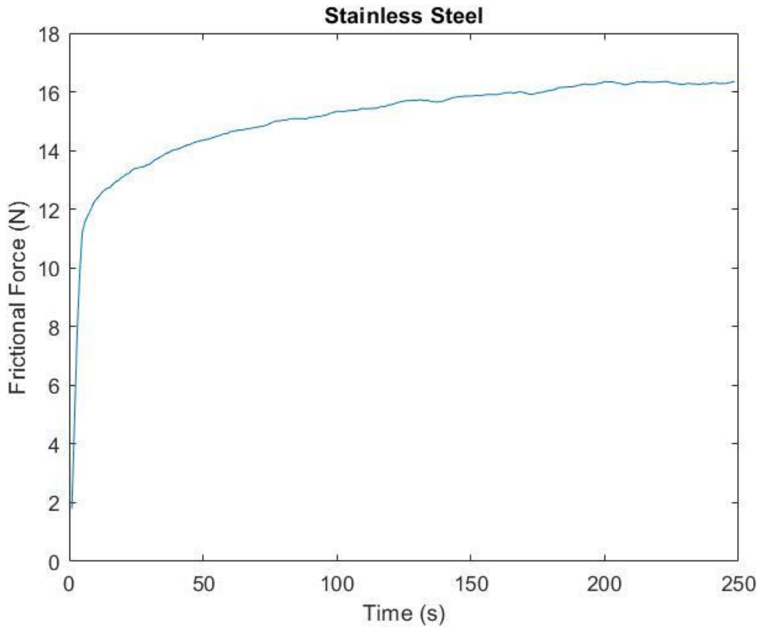
PLOTTED GRAPH:

1. Stainless Steel:

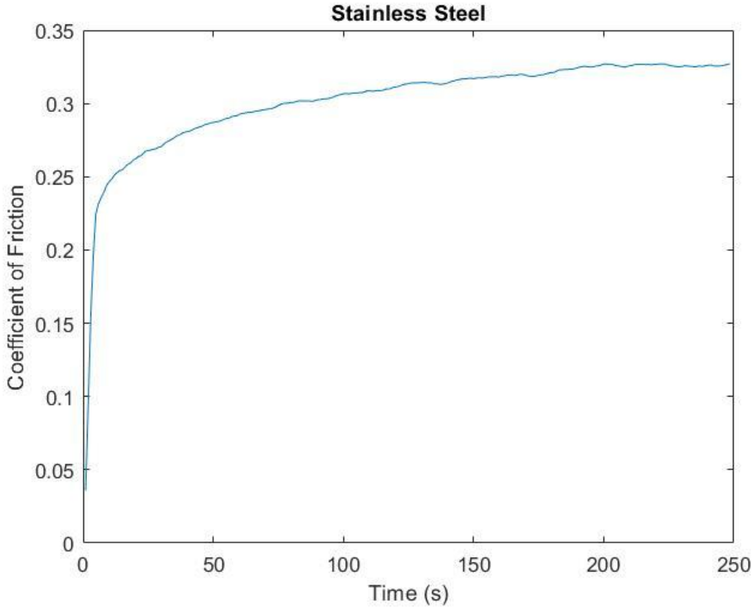
1.1. Time(s) vs Wear (µm)



1.2. Time(s) Vs Frictional Force (N)

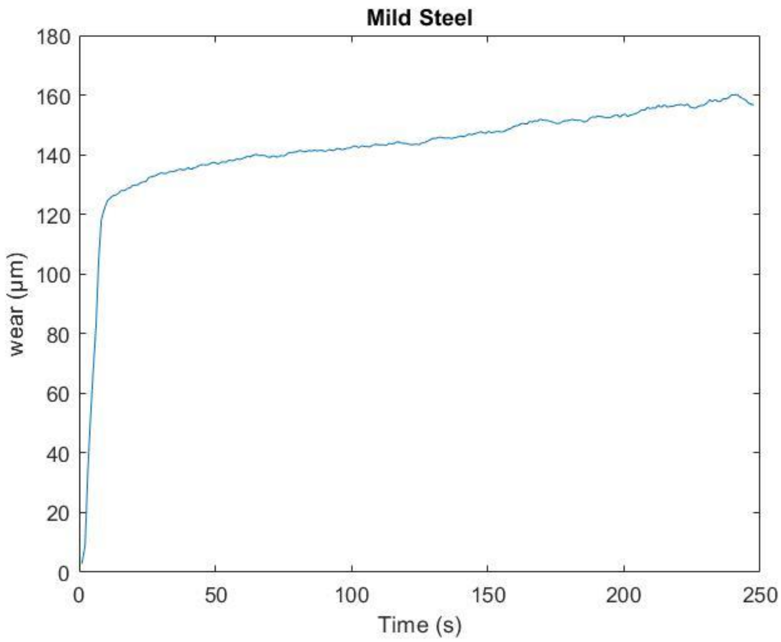


1.3 Time Vs Coefficient of Friction

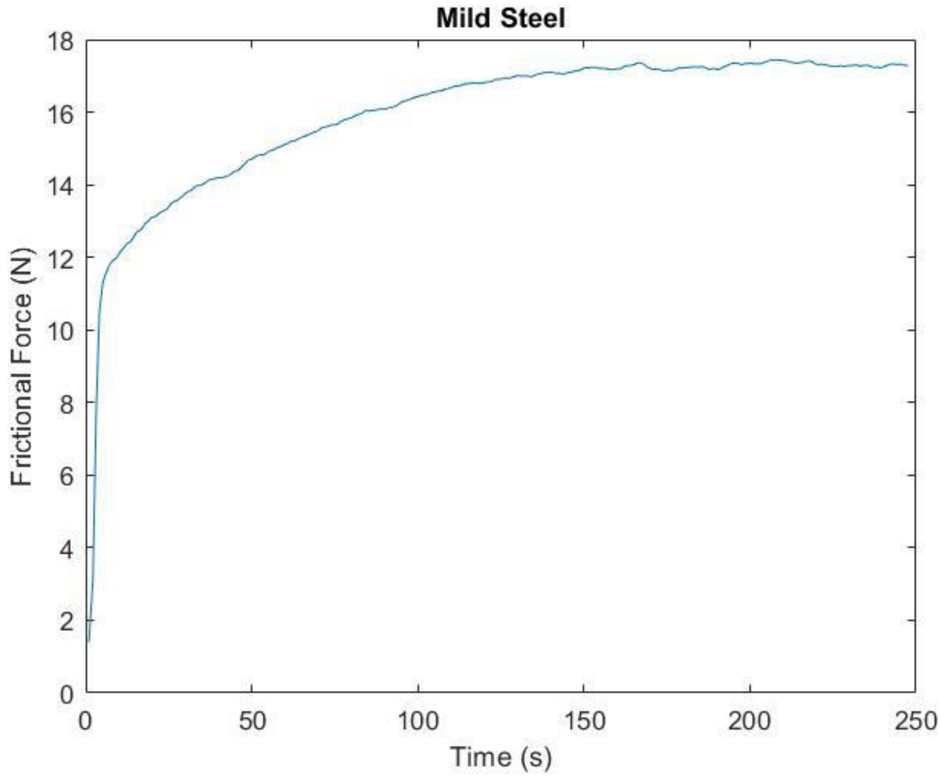


2. Mild Steel:

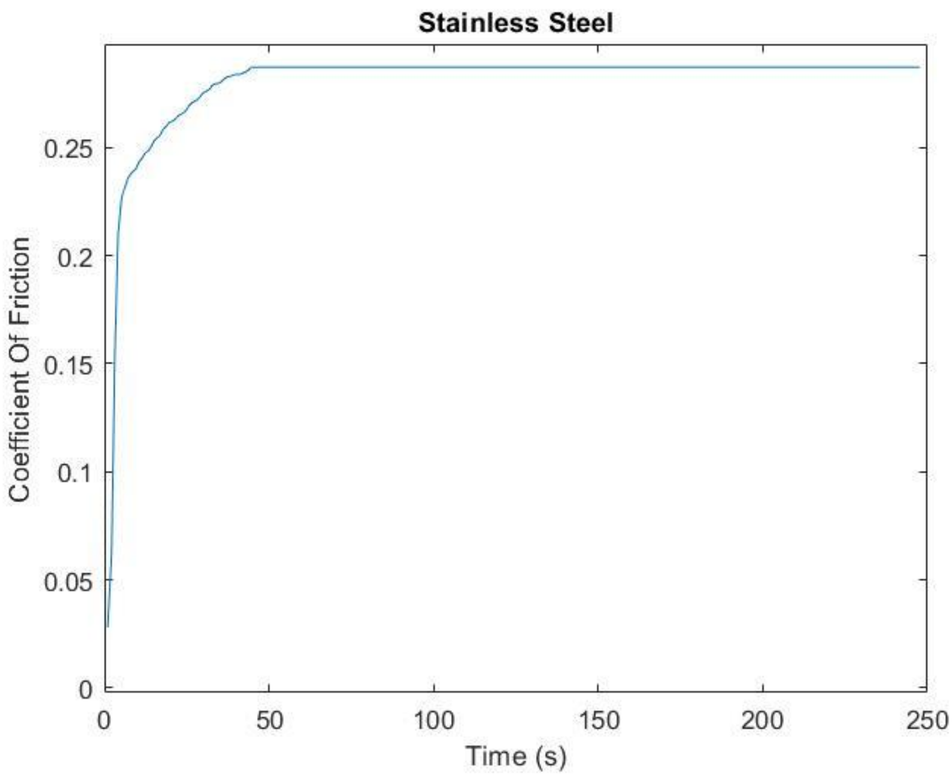
2.1 Time(s) vs Wear (μm):



2.2 Time(s) Vs Frictional Force (N)

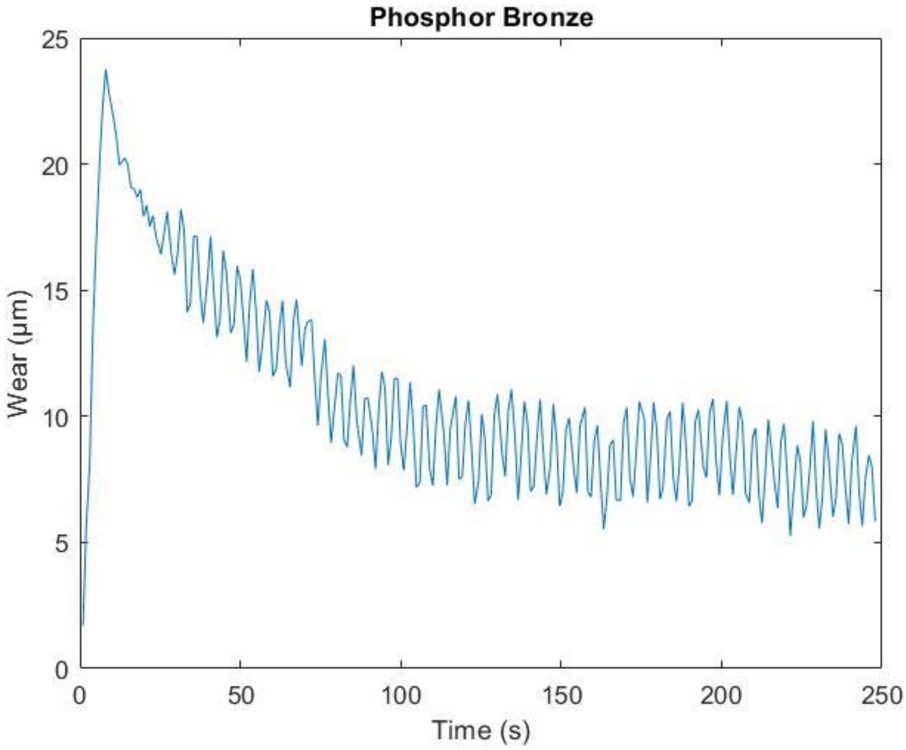


2.3 Time Vs Coefficient of Friction

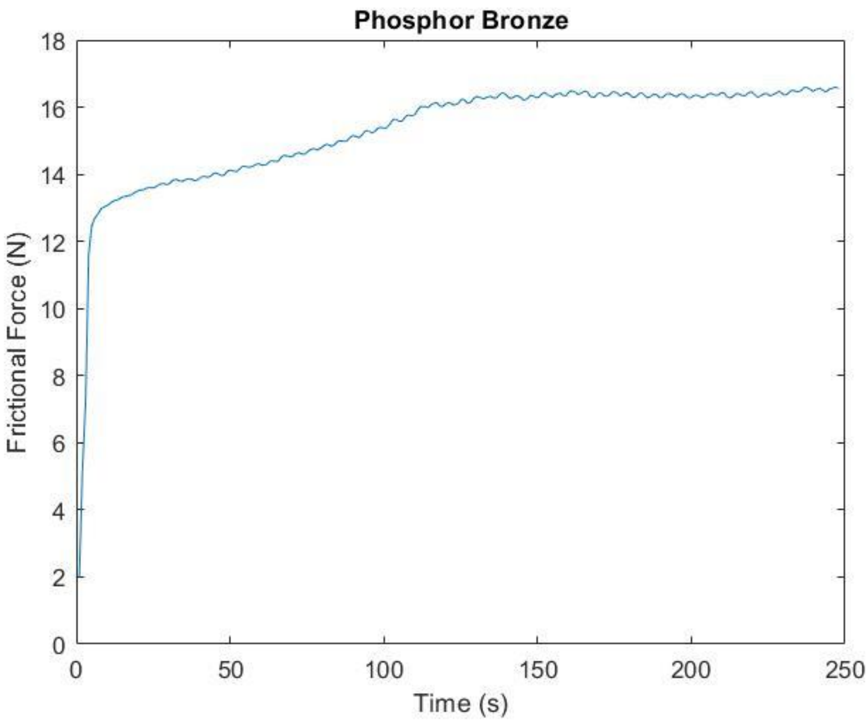


3. Phosphor Bronze:

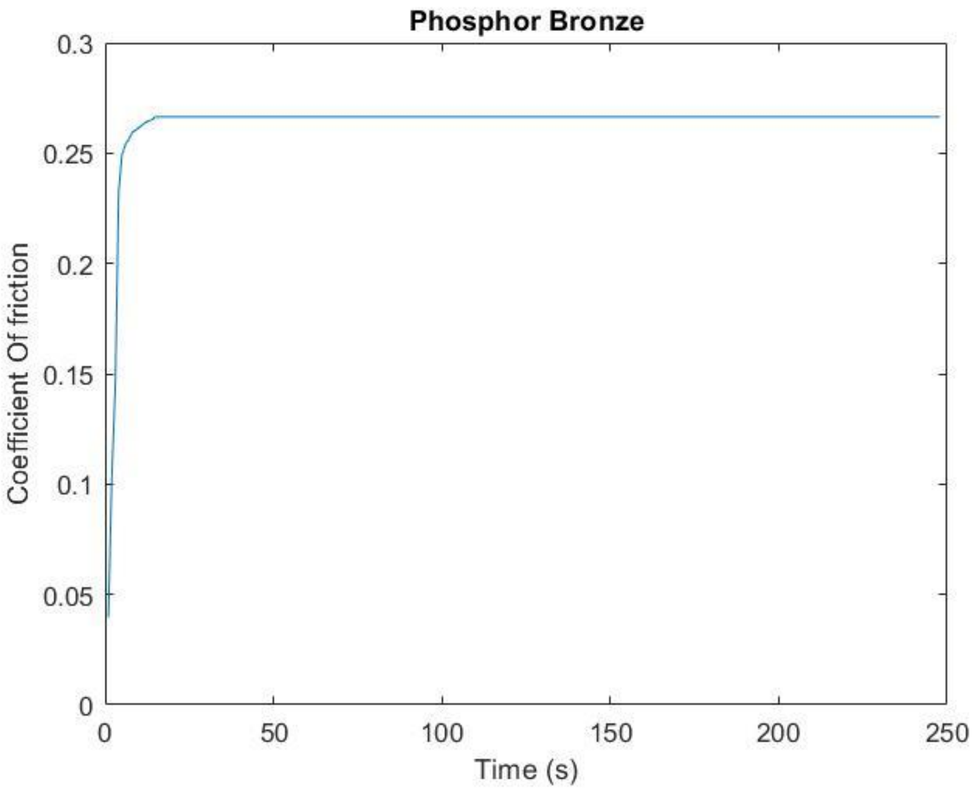
3.1 Time(s) vs Wear (μm):



3.2 Time(s) Vs Frictional Force (N)



3.3 Time Vs Coefficient of Friction



Result:

Thus, the wear of the disc and pin (Brake pad) using Pin-On-Disc method is found.

Disc:

Samples	Initial weight g	Final weight g	Wear loss in g
1	81.628	81.613	0.015
2	77.724	77.719	0.005
3	86.241	86.232	0.009

Pin:

Samples	Initial weight g	Final weight g	Wear loss in g
1	0.858	0.848	0.01
2	0.908	0.9	0.008
3	0.83	0.828	0.002

CHAPTER 7
ESTABLISHING BRAKE LINE IN ATV

7.1 CONSTRUCTION:

The master cylinder is mounted rigidly on a cross member and the leverage mechanism is connected to the brake pedal. The brake fluid reservoir is connected to the master cylinder. The brake lines are connected between master cylinder and Splitter. A Splitter divides the pressure build to two and supplies to the wheel calipers through steel braided lines. Two splitters are used to facilitate front and rear wheels. The calipers are mounted rigidly against the disc rotor with help of knuckle. The knuckle and calipers are connected by brackets.

PARTS USED:

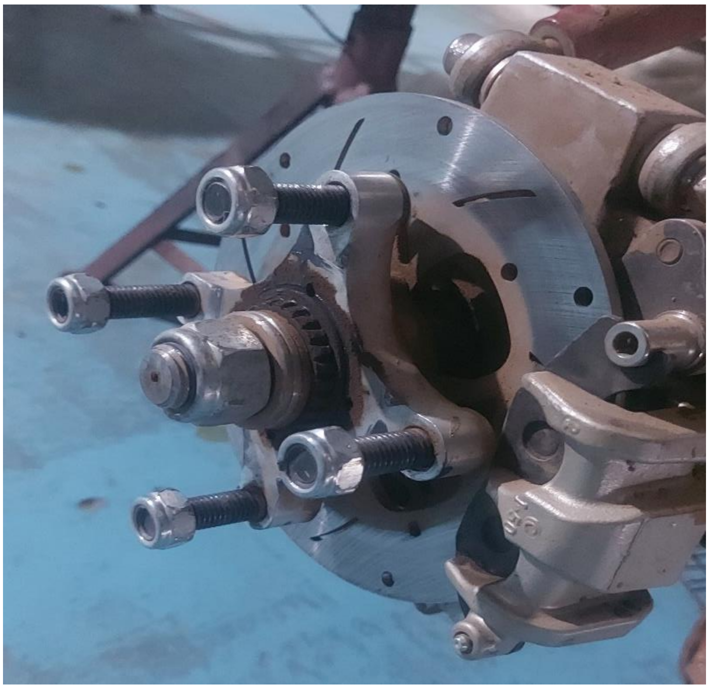
Master cylinder: Maruthi Suzuki 800 (Bosch and KIT)

Calipers: Honda Hornet 160r (Nissin Calipers)

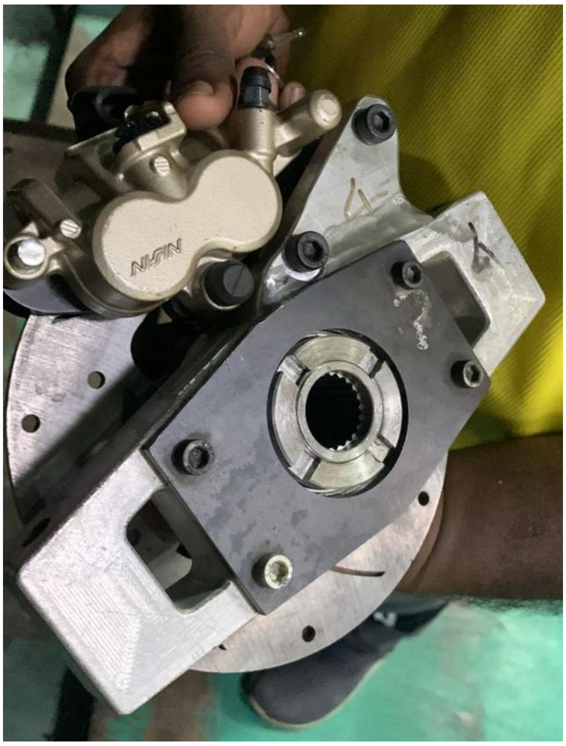
Disc rotor: Own design (GM engineering)

CHAPTER 8
FABRICATED PARTS

1. DISC:



2. BRACKET AND KNUCKLE:



CHAPTER 9
CONCLUSION

Thus, the complete brake system is designed and fabricated.

In this project we have calculated the required brake pressure. We have designed the Disc rotor. Four materials have been selected and tested and the obtained results have been attached. From the results we have identified that during wear test the disc which is worn out is mild steel followed by phosphor bronze and stainless steel. With respect to wear done in pin (Friction lining material) is high in stainless steel followed by mild steel and phosphor bronze. Stainless Steel is chosen for Fabrication and disc rotor is manufactured. Mild steel has rust issues so it is not considered. Phosphor bronze though it has less wear it has high density which results in high unspring mass. Complete brake system has been fabricated in the vehicle and tested.

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2. **"Tribological investigation of titanium-based materials for brakes" Peter J. Blau ∗, Brian C. Jolly, Jun Qu, William H. Peter, Craig A. Blue,2007.**
3. **V. M. Thilak, R. Krishnara Deepan & R.Palani,**

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4. **"Finete element analysis of Disc brake rotor", 2015. M.A.Maleque, S.Dyut**
5. **https://drive.google.com/file/d/1Im53YqCMXSLJZlAy-RM9g1zk_jfaRx-g/view?usp=share_link**