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Design of Disc Brake System for an E-ATV

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Abstract*—In an automobile system, the braking system is arrangement of various linkage and components such as brake lines and or mechanical linkages, brake drum or brake disc, master cylinder etc. that are arranged in such a way that it converts the vehicle's kinetic energy into the heat energy which in turn de-accelerate the vehicle and thereby stopping it.In a typical braking system, brake pads produce friction with the brake rotors to slow or stop the vehicle. Additional friction is produced between the slowed wheels and the surface of the road. This friction is what turns the car's kinetic energy into heat and causes wear.Disc brakes do a better job of managing heat than drum brakes. This causes them to experience less brake wear, which results in more consistent performance.A disc brake is a type of brake that uses calipers to squeeze pairs of pads against a disc or rotor to create friction and stopping the vehicle.The brake system of any vehicle is the most important safety system which helps to slow down or stop at a moment where it will help to avoid an incident or accident.The aim of this project is to design a disc brake system for an ATV by using basic engineering knowledge and constraints of braking.The paper includes designing of vital parameters which are required for braking such as forces, pedal design, brake disc, master cylinder etc. And thereby modelling it into CAD software.*

Keywords*—*ATV, Brake System, Disc Brake, Design, Pedal Design.

I. INTRODUCTION

The braking system is designed to decrease the velocity of the vehicle by converting kinetic energy to heat energy to ensure maximum safety. The vehicle's braking system is designed to be robust and provide better stability by locking four wheels simultaneously. The braking system is purely mechanical type. The disc is designed considering weight and also different dynamic factors which is imposed on the vehicle.Disc brake system has many advantages compared to drum brake system as it provides better cooling and is easy to service. Disc brake system is also compact and can be adjusted as per the space available in wheel assembly.

1.1 Project objective: -

In order to achieve maximum performance from the braking system, the brakes have been designed to lock up all four wheels, while minimizing the cost and weight.
The main objective of the braking system is to stop the ATV within a patch of 5 meters.
The brake pedal must multiply the drivers input sufficiently to increase the braking performance.

1.2 Braking system

By mounting the master cylinders on the top of the nose, we ensured easy maintenance. The master cylinder we have used is of Bosch Tandem master cylinder which has an advantage that it is pre-biased.Caliper selected is KBX Fixed type and has an advantage that it can be mirrored so as to keep the bleeding valve facing upward to ensure easy and effective bleeding.The material we have selected for the brake disc is SS420 as it is easily available and has appropriate yield strength and can sustain

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high temperature.The pedal ratio of 6:1 for maximum leverage and power multiplication. Brake circuit is well balanced by varying the size of disc and using different types of fluid lines. The mounting for pedals were designed considering the space availability inside nose of ATV.

II. PROBLEM DEFINITION

The main objective is to stop the ATV within a patch of 5 meters with all the four wheels locked at once. The design of disc is done by considering various factors involved while the vehicle is in running condition. The ATV is supposedto stop at maximum velocity of 60kpmh. Also the weight is important factor affecting the braking performance and also affects the life of brake component.

III. METHODOLOGY

The braking system for our ATV can be improved by reducing the weight and the cost but keeping the reliability and performance of the system. The main objective for the brake team is to design and fabricate a system which is effective as brakes are important. Since there is no differential the rear braking system is inboard type and is attached at the output shaft of the gearbox, this will eliminate a lot of weight by using less part. The main goals were to reduce weight, cost, ease of maintenance. This was kept in mind while designing the brake disc. Weight is the main factor which affects the performance of the vehicle even if the braking system does not weigh much but we can lose some weight without affecting the performance of the ATV.

IV. DESIGN CALCULATIONS

TABLE 1
DESIGN PARAMETERS USED IN CALCULATIONS

Sr. No	Design parameters	Data
01.	Weight of the ATV (w)	250kg
02.	Velocity of the ATV	40kmph
03.	C.G Height (h)	450mm
04.	Stopping time (t)	1.5sec
05.	Wheel base (l)	1422mm
06.	Weight distribution	40:60

Tyre radius,
Front = 10” = 0.26m
Rear = 11.5” = 0.29m

Co-efficient of friction = 0.7

Weight of ATV at front
$W_f = W*0.4$

Weight of ATV at rear

$W_r = W*0.6$

Dynamic Weight
$W_d = (h/l)*(w/g)*d$

Dynamic Weight at Front
$W_{fd} = W_d + W_f$

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Dynamic Weight of Rear

Wrd= Wd + Wr

Brake Torque,

Front

Tf = Ff * Rf

= 208.95Nm

Rear

Tr = Fr * Rr

= 280.65Nm

Where,

Ff - Frictional force on front and rear

Rf – Front rolling radius

Rr – Rear Rolling radius

For effective radius,

$Fc = Tb/\mu*n*Re$

Where,

Fc = Clamping Force

Tb = Brake Torque

μ = coefficient of friction of brake pads

n = no. of frictional faces

Re = effective radius

Front effective radius = 70mm

Rear effective radius = 85mm

Front brake disc = 170mm

Rear brake disc = 190mm

Pedal design:-

Pedal ratio = 6:1

Pressure from master cylinder = 6.20 N/mm^2

Clamping force = 4375.45N

V. MATERIAL

Material is selected by considering the machinability, weight, cost, and availability. We have selected Stainless Steel 420 for our brake disc and EN8 for brake pedal. SS420 has less coefficient of thermal expansion and also is resistant from corrosion. Carbon ceramics, Grey cast iron, Titanium alloys, Aluminium matrix composite are some materials used for brake rotor. Stainless steel was selected on the basis of cost, machinability, availability and properties mention in the table below.

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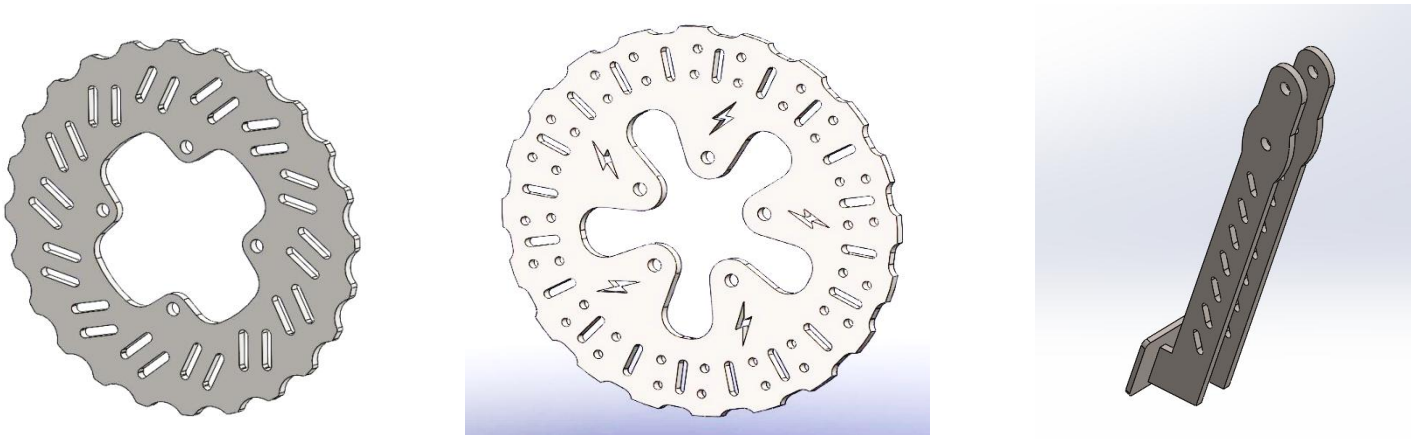

FIGURE: CADMODEL OF BRAKE DISC AND BRAKE PEDAL

TABLE 2
PROPERTIES OF MATERIAL USED

Sr. No	Properties	Data
01.	Yield strength	345 MPa
02.	Brinell hardness	241 HB
03.	Mean coefficient of Thermal Expansion	10.3 µm/m.K (at 0-100°C) and 10.8µm/m.k(at 0-315°C)
04.	Thermal conductivity	24.9 W/m. K
05.	Melting range	1495°C
06.	Magnetic Permeability	High
07.	Corrosion resistance	High

VI. COMPONENTS USED

TABLE 3
COMPONENTS

Sr. No	OEM	Specification
01.	Master Cylinder	Bosch tandem master cylinder
02.	Brake Caliper	KBX single piston fixed
03.	Fluid Lines	Steel Braided flexible and rigid lines
04.	Brake Oil	MOTUL DOT 4

CONCLUSION

With concern of efficient braking capability and increased driver and passenger safety, the braking system designed is such that it satisfies all the parameters of safety and ensures effective locking of all four wheels without skidding within shortest distance covered.

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