A Review on Design of Hydraulic Braking System,Calculation and Design

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Abstract - The design of hydraulic braking system of automobile vehicle is the most important safety system

In high performance automobile system, the hydraulic pressure control problem of braking system. In hydraulic braking system pressurized fluid supplied by a pump which is driven by a motor. A hydraulic braking system is work on fluid mechanism such like ethyl glycol type fluid which is incompressible fluid. The main objective of braking system maintain reduction in

Speed of vehicle. The review paper presents the effective design hydraulic braking system and its calculations. It will help to avoid an incidental or an accidental.

Key Words: Hydraulic brake, braking torque, anti-braking system, hydraulic valve.

1. INTRODUCTION

A Hydraulic Braking system is an arrangement of braking mechanism which used a braking fluid such like ethylene glycol, to transmitted pressure through valve to braking mechanism. A Braking system is designed to slow and halt the motion of vehicle. A hydraulic braking system works on pascal's law which states that "a pressure exerted on piston produces an equal increase in pressure on another piston in the system". According to the law when pressure is applied to a fluid it transmitted equally in all direction so that uniform braking action applied on all four wheels. It converts the moment (Kinetic Energy) to friction energy interns heat energy which is dissipated to atmosphere.

There are various types of braking systems available such as Mechanical Disc Braking System and Hydraulic Disc System based on components involved. These brake enforcement systems convert kinetic energy into friction force at the friction surface.

A brake is a device used to generate friction which is an applied to moving member of machine, for stopping motion. For the execution of the braking operation, the brake pad absorbs the kinetic energy from the wheel.

The main objective of any braking system is to maintain reduction in speed of vehicle. Hence, we need to calculate the braking torque, stopping distance etc.

1.1. Design of Braking System Components-

Let's take a look at the different parts which make the hydraulic braking system. The braking system can be divided into the following parts:

Master Cylinder (Lever) –

The master cylinder is a heart of hydraulic braking system. It converts the force exerted on the pedal in hydraulic pressure to apply brakes. The pressure created displaces fluid through various brake lining to each of the wheels and apply brakes. Since the

fluid is incompressible it acts like a liquid linkage between master cylinder is piston and calliper and the wheel cylinder.

The master cylinder is a control device that converts force into hydraulic pressure. This device controls slave cylinders located at the other end of the hydraulic brake system.

Fig: master cylinder

Brake Lines -

Hydraulic brake lines (Hoses) play the important role in connecting the master cylinder and slave cylinder. Brake linings are consumable surface in brake system, such as drum brakes and disk brake used in transport vehicles.

Fig: brake lining

BRAKE FLUID-

Brake fluid is type of hydraulic fluid used in hydraulic brake and hydraulic clutch applications in automobile vehicle. It is used to transmitted force into pressure and to increase braking force. It works because liquid has incompressible.

Hydraulic braking system used two types of brake fluid such as DOT fluid or Mineral oil.

DOT brake fluid simply stands for **department of transport,** which sets safety regulation for the acceptable performance of different brake fluids. It is classified by its performance property mainly its boiling point.
The table below shows DOT brake fluid with its corresponding boiling temperature.

Mineral oil-based brake fluid is derived from crude

oil fractions. Furthermore, they are refined to a level at which they achieve adequate lubrication properties. they are **enhanced with a system of additives.** It's a premium quality anti – wear hydraulic fluids, utilizing a performance Proven additive system to provide maximum protection.

Wheel Cylinder-

wheel cylinder is a component in a drum brake system which is located in each wheel and is usually at the top above the shoes.
Wheel cylinders responsibility is to exert force on the shoes so they can contact the drum and stop the vehicle with friction.

Fig: wheel cylinder

Brake **pedal:**

Brake pedal is pivoted and connected from middle to the piston rod when the driver presses the oil inside the cylinder. It's made of mild steel and steels.

Fig: brake pedal

1.2 Working of Hydraulic Disc Braking System-

Hydraulic brake works on Pascal's law which states that "**pressure exerted in an enclosed system is same in all directions**". According to this law when operator pressed the brake pedal, this force is transmitted to piston in a master cylinder moves by compressing return spring.

This system is consisted of master cylinder, wheel cylinder, brake fluid, brake linkage, flexible hose, check valve and steel pipe etc.

The master cylinder is connected to all the four-wheel cylinders by tubing or piping. All cylinders and tubes are fitted with a fluid that acts as a link to transmit pedal force from the master cylinder to wheel cylinders. Brake Fluid The fluid-filled in the hydraulic brake system is known as brake fluid. It is a mixture of glycerine and alcohol or castor oil and some additives. The Master cylinder consists of a piston that is connected to peal through the connecting rod. The wheel cylinder consists of two pistons between which fluid is filled. Each wheel brake consists of a cylinder brake drum. This drum is mounted on the inner side of the wheel. The drum revolves with the wheel. Two brake shoes that are mounted inside the drum remain stationary. Heat and wear resistant brake linings are fitted on the surface of the brake shoes.

2. CALCULATIONS -

We consider,

1. Rotor diameter = 120mm
2. Brake pad diameter = 15mm
3. Brake line (cable) diameter = 1.2mm
4. Total weight of bicycle with cyclist = 180 kg
5. Bicycle wheel diameter = 24 inch = 0.6096 m
6. Speed of bicycle = 80kmph

· Weight on single wheel = 180/2
= 90 kg
= 90 × 9.81
= 882.9N

· Speed (v) = 80 kmph
= 80 × 5/18 **= 22.2m**

We know that,

· Kinetic Energy = 1/2 ×mv^2
= 1/2 × 180 × 22.2^2
= 3996 J…… (For two wheels)

· Angular velocity (ω) = velocity/radius of wheel
= 22.22/0.3048
= 72.178rad/sec

Consider the driver can apply the force on brake of 65N

Pressure in brake cable,

P_{cable} = (Applied force)/ (area of wire)
= 65/ π/4 × (1.6)^2
= 32.32N/mm^2

Force generated by calliper piston, $C_{alliper}$ = (Pcable) × (area of brake pad)
= 32.32 × (π/4 × (12)^2)
= 3656.25N

Caliper clamp load,

Fclamp = (Fcaliper) × 2
= 3656.25 × 2
= 7312.5N

Force on disc by brake pad (friction force),
$F_{friction}$ = Fclamp × μ ..... (Where μ is coefficient of friction)
= 7312.5 × 0.3
= 2193.75N

Toque on rotor (braking torque), τR = Ffriction × Refficient = 2193.75 × 0.09
= 197.43Nm
∴ Braking torque is equal to 197.43Nm

- Angle through which disc rotated during brake period(θ),

Braking torque (τ_R) = (K.E.)/θ 197.43 = 1851.48/θ θ = 1851.48/197.43 **θ = 9.37**
θ = ω/2 × t t = (θ × 2)/ω
t = (9.37 ×2)/36.45 **t = 0.51 sec**
Now,

- Stopping distance (s) = 1/2 × 22.22 × 0.51

= 5.6661m

∴ stopping distance of bicycle running at a speed of 80 kmph is 5.6661m.

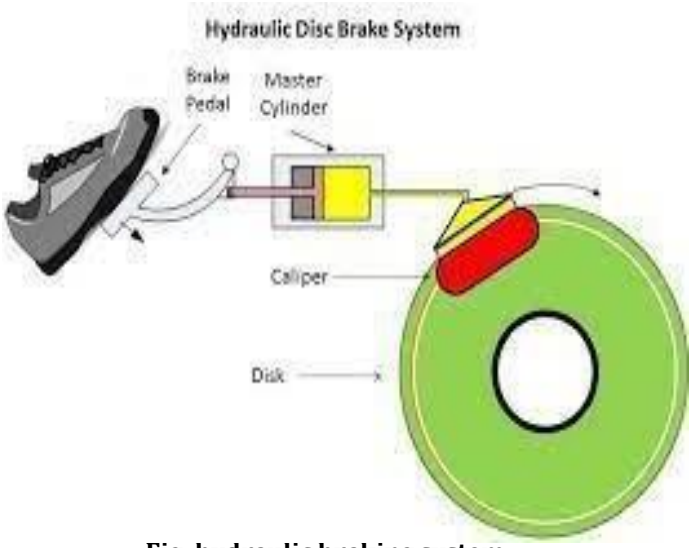

Fig: hydraulic braking system

4. WHY BRAKES FAIL?

Hydraulic brakes can fail or stop working for temporary time because of some reasons such as fluid leak or due to air bubble. Hydraulics depends on pressure within the system and brakes depends on friction. Absence of any of this results in failure of the system. A loss of brake fluid will decrease the pressure and a loss of friction will occurs due to the lubricating nature of brake fluid.

5. RESULT-

From above design and calculations of hydraulic disc braking system, the system will be able to slow and stop the bicycle
from 80kmph to 0kmph within the stopping distance of 5.6661m and braking time of 0.5 seconds.

6. CONCLUSION-

As discussed in above design and calculations, we conclude that the braking force acting on bicycle and stopping distance of bicycle are depends upon the speed of bicycle, size of rotor, brake cable (hose) diameter, slave cylinder and coefficient of friction.
in this paper different hydraulic brake system for automobile vehicle was analysed. liquids are used in hydraulic system because liquid

incompressible. Hydraulic hybrid technology has the advantage of high-power density and the ability to accept the high rates/high frequencies of charging and discharging.

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