

Smart Braking System

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Abstract— Now a days, using two wheelers which is having ABS system is indispensable need. In India riders of two wheelers are the most vulnerable users. In 2014, 32,524 lives were lost involving these vehicles and over 1.27 lac persons were left injured. In majority of these accidents the number of vehicles which is not having braking safety measures are very large. If the electronic ABS system is provided with vehicle then it increases its cost by 35-40 thousand. In countries like India, majority of the two wheelers are sold by consideration of cost factor rather than safety factor by the customers. So including the electronic ABS to the vehicle will not be an easy decision for company. Considering this reality there should be a strong need of safe braking system having low cost value. In our project we have designed and manufactured a mechanically operated ABS system which is having cost value of Rs.1500-2000. The smart braking system having such a low cost value will be affordable to customers also.

Keywords— Mechanically operated ABS System

I. INTRODUCTION

Concept of SMART BRAKING is specially designed for Two-wheeler vehicles, in which both front and rear brakes are controlled by single lever. The pedal force is distributed in 40:60 ratio to uniformly control both the brakes which results in skid-free operation of vehicle. Skidding results when friction in brakes become more than the friction between tyre and road surface. That means that the wheel gets locked and start skidding on the road surface. Less force leads to poor braking and more force leads to skidding. So to avoid the skidding of vehicle, the braking force should remain in limit.

BRAKE FAILURE INDICATOR- In this case sensors are fitted in the brake shoes at certain distance from shoe surface, when shoe get wear out sensor detect it and gives signal to operator.

II. OVERVIEW OF SMART BRAKING SYSTEM

As shown in fig. 1, smart braking system consists of cylinder piston arrangement connected to the rear brake pedal. when we press the pedal for braking, rear brake as well as front brake get operated by this arrangement. We are connecting a fluid line to this cylinder piston arrangement which is used to operate front brake. As we press the pedal the movement causes displacement of piston. The cylinder piston arrangement is double acting, as piston gets displaced the brake fluid in the cylinder is compressed. This pressurised fluid passes through the fluid line to the front brakes. We chose the cylinder as per our requirement of having 40 percent of total braking force to the front brake and 60 percent to the rear brake.

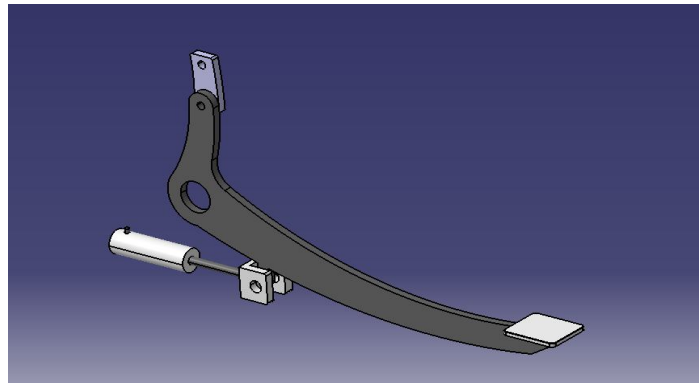


Fig no. 1- Assembly of smart braking system.

A. Cylinder Piston Arrangement

In our system we are going to apply 40 percent of total braking force to the front brakes. Firstly by calculation we found the total required force to be applied on front brakes to avoid skidding. After that by trial and error method we gone through various cylinders in actual braking. From that we got nearly perfect cylinder as per our force requirement. To get the perfect force on front brakes we decide a accurate position for a link connecting to the piston.

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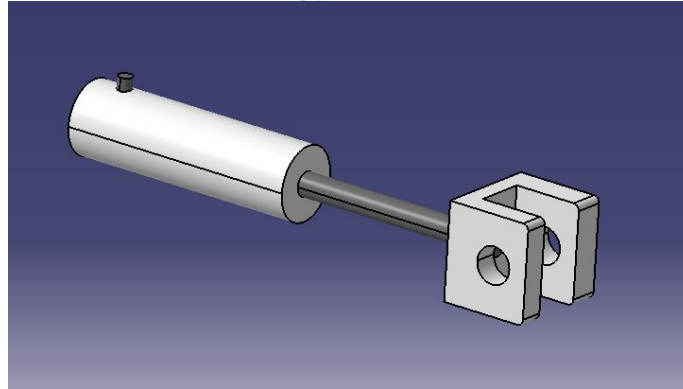


Fig. 2. Cylinder Piston

B. Foot Pedal

Foot pedal is used for the operating both brakes. Brake lever is made up of stainless steel. It is used to operate both brake at the same time by pressing, it operates by a solid link as well as it incorporates displacement of piston into cylinder to pressurize brake oil, by which front brake is operated.

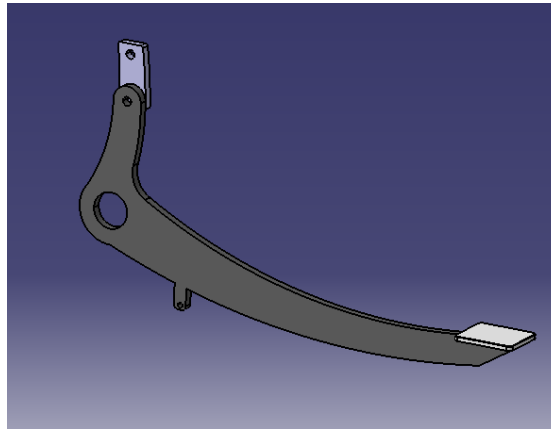


Fig. 3. Foot Pedal

C. Brake Failure Indicator

Due to continuous use the brake pads get wear out after some time. Brake failure indicator is used to warn the driver when the vehicle brake pads crosses the safe limit of wearing out. When the pads wear out beyond safe limit marked on brake pad, sensor senses it and completes the circuit. After completion of the circuit the indicator fixed near speedometer shows signal to the driver. The prior detection of brake failure avoids accidents.

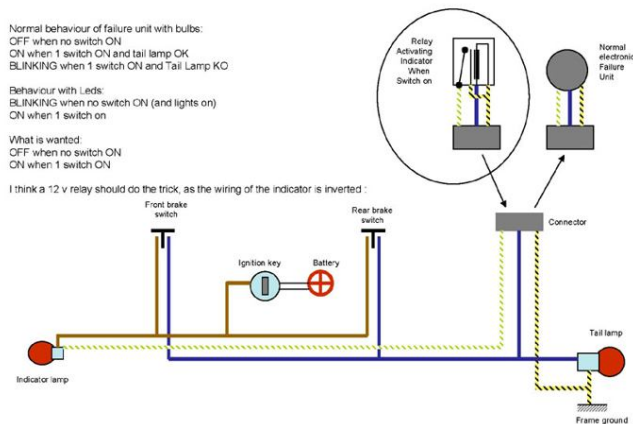


Fig. 4. Brake failure indicator.

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D. Design Calculations

where

F_r	= Rear axle Braking force, N
μ	= Coefficient of friction between tire and road surface
F_{ZRdyn}	= Rear axle dynamic load
P_1	= Hydraulic brake line pressure, N/m ²
P_0	= Push out pressure, required to bring brake pads in contact with disc in N/m ²
A_{wc}	= Caliper cylinder area in m ²
η_c	= Wheel cylinder efficiency
BF	= Brake factor
R	= Effective radius of disc in m
R	= Effective rolling radius of tire in m

Table 1. Notations for brake design

Weight of bike with rider = 125+ 75 = 200kg
On front wheel = 29% weight of total = 58 kg
On rear wheel = 71% weight of total = 142kg

Assume condition

Velocity of bike 80 kmph
Time of braking 5 seconds

Let's calculate acceleration

$$A = \frac{V_2 - V_1}{(T_2 - T_1)}$$

V_1 = initial velocity = 80 kmph

V_2 = final velocity = 0 kmph

T_1 = initial time = 0 sec

T_2 = final time = 5 sec

$$A = \frac{(0 - 80)}{(5 - 0)}$$

Acceleration = -4.44m/s²

Here negative sign indicates deceleration

Braking force at rear wheel = F_r

$$F_r = ma$$

$$F_r = 142 \times 4.44$$

$$F_r = 630.48 \text{ N}$$

Braking force at front wheel = F_f

$$F_f = m \times a$$

$$F_f = 58 \times 4.44$$

$$F_f = 257.52 \text{ N}$$

These force should apply on rear & front wheel at 80Kmph, and 5 sec to stop bike.

Now we are going to calculate actually how much force is applied to both brakes.

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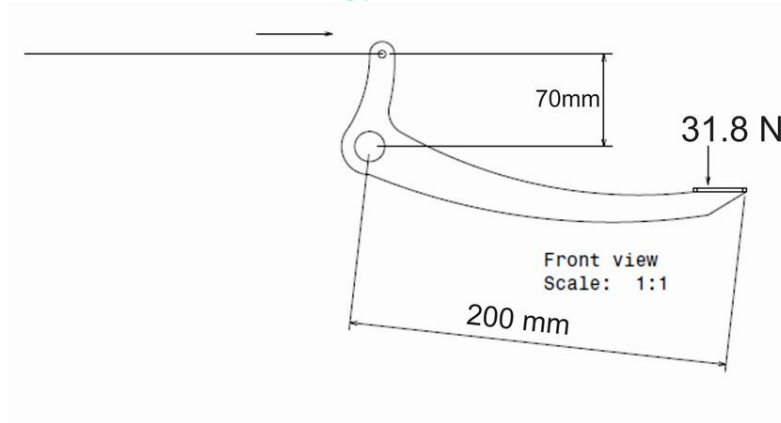


Fig. Brake paddle

Here we apply 31.8 N on brake pedal, and distance of brake pedal is 200mm
 So moment generated at pivot is,

$$M = 200 \times 31.8$$

$$M = 6360 \text{ N-mm}$$

This moment transmitted to other side of fulcrum and force where magnified.

$$6360 = 70 \times F$$

$$F = 90.85 \text{ N}$$

Force applied to front brake (disc)

Force applied at lever 12N

Area of master cylinder = 50.26 mm²

Pressure in fluid pipe line

$$P = F/A$$

$$P = 12/50.26$$

$$P = 0.238 \text{ N/mm}^2$$

Further this pressure amplify in caliper

Area of piston = $3.14/4 \times 25^2$

Area of piston in caliper = 490.87 mm²

Force applied by piston

$$P = F/A$$

$$0.238 = F/490.87$$

$$F = 0.238 \times 490.87$$

$$F = 116.82 \text{ N}$$

This force approximately half of required force to stop front wheel

Hence it stops front wheel more quickly than rear wheel.

E. Actual Design of Cylinder

Hydraulic cylinder 16*150(1.15 Mpa)

Applied force on brake pedal=32N

Area of cylinder=201.06 mm²(Cal- $3.14/4 \times d^2$ where d= 16 mm)

Pressure in fluid line=F/A

$$=32/201.06$$

$$=0.16 \text{ N/mm}^2$$

This pressure is less than that of which we calculate first in original fluid line pressure was 0.238 N/mm²

So now pressure applied to disc caliper is

Force applied by piston

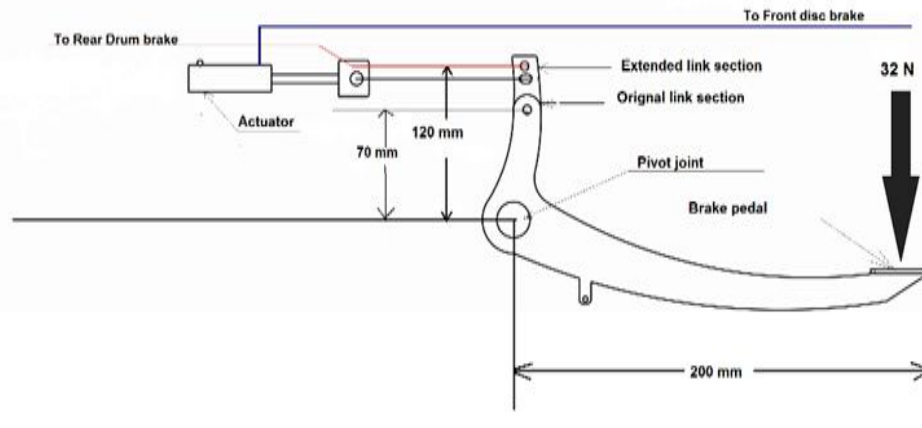
$$P=F/A$$

$$0.16=F/490.87$$

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$$F=0.16 \times 490.87$$

$$F=78.53$$



And then increased length of link from 70 to 120mm hence

Force transmitting also increased

So momentum generated at pivot is,

$$M=200 \times 31.18$$

$$M=6360 \text{ N-mm}$$

This momentum transmitted to other side of fulcrum and force where magnified

$$\text{Torque} = 120 \times 32$$

$$\text{Torque} = 3840 \text{ N-mm}$$

Now distance of cam in drum brake to its pivot 12.5 mm

$$\text{Force} = \text{Torque} / \text{Distance}$$

$$\text{Force} = 3840 / 12.5$$

$$\text{Force} = 304.6 \text{ N}$$

Rear brake force 304.6 N

III. MATERIAL SELECTION FOR SMART BRAKING SYSTEM

The material used for cylinder piston arrangement is stainless steel. Steel is the material having high strength as well as high weldability. The link joining the rear brake pedal and piston rod is also made up of stainless steel. The fluid line passing through the cylinder to the front brake is made up of thermoplastic. The fluid line material does not affect on the properties of brake fluid. Sensor used is made up of aluminum.

IV. MACHINING PROCESS FOR SMART BRAKING SYSTEM

Smart braking system consists of cylinder piston arrangement stainless steel material. This arrangement is connected to rear brake pedal by means of fixed link. The link has two ends one is joined to the pedal screw and nut arrangement for which the hole is drilled on pedal. Another end is attached to the piston by oxy-acetylene welding. Another part of our smart braking system is brake failure indicator. In brake failure indicator we are fixing a non-contact type sensor. For fixing the sensor the brake pad is drilled with a drill bit of size equal to size of sensor. For fixing indicator near speedometer we used screws. Screws are fixed in the drilled holes.

V. WORKING AND DATA ANALYSIS

Here we have developed a new arrangement of both brakes, new piston and cylinder attached to brake paddle near to pivot joint. When we press foot paddle it also presses the piston which further activates caliper piston and applied disc brake. Same time it applies rear brake with greater braking force. In smart braking arrangement master cylinder is fitted above the foot lever in such a way that when we push the lever by foot at the same time the piston in master cylinder also starts moving in cylinder where braking fluid is filled. Due to piston movement the brake fluid get pressured and this pressured fluid flows towards front brake caliper through brake lines. At front caliper the pressurized fluid pushes caliper piston into the caliper cylinder which

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incorporates movement of one of brake pad towards disc. The motion of vehicle is controlled by converting the speed of vehicle into the heat energy generated by friction. On the other hand, when we push the foot lever the mechanical linkage connected to it get linear motion which causes movement of cam placed in rear drum brakes. When cam starts moving its shape causes movement of trailing and leading shoes which rubs against rotor and causes controlling of vehicle speed.

Our mechanically operated anti-lock braking system is based on the principle of force distribution. For that purpose we are extending foot lever vertically which gets angular displacement directly proportional to the foot lever movement. By the extension of lever we can vary the braking force provided to rear drum brake and by controlling the motion of piston of master cylinder placed below the foot lever.

VI. CONCLUSION

Mechanically operated anti-lock braking system simplifies the braking system as well as avoids skidding of vehicle while driving. By consideration of cost factor and its effectiveness it is a affordable and safe replacement for the traditional braking system. Brake failure indicator effectively alerts driver when there are the chances of wear out of brake pads beyond safe limit.

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