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A Review on Hydraulic Brakes

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Abstract: *Up-to-date automotive brake systems place strict conditions upon the performance, trust ability, and active safety. similar advanced systems asanti-lock retardation systems(ABS), the electronic stability programme system, and the anti-slip control system help a motorist in icing driving safety under numerous conditions. The influence of the boscage factors on active safety systems is substantially determined through the hysteresis circle range. Among other negative issues, this parameter limits the possible frequence of cyclic retardation during ABS operation. This paper presents an experimental analysis of the factors impacting the hysteresis pressure losses in a hydraulic boscage system. The factors under examinations are the boscage pedal stroke haste, the gaps between the boscage pads and the boscage slice, and the configuration of the boscage system. trials were carried out on the boscage test outfitat the automotive Engineering Department.*

Key Word: *Hydraulic Brake System, Braking System, Automotive EngineeringDepartment.*

I.INTRODUCTION

The main ideal of any retardation system is to attain a reduction in speed of a vehicle to grease speed control and project keeping in mind colorful constraints like cost, stopping distance, etc. Hence accurate computation of retarding force becomes a pivotal design concern. Like every design, retarding force computations also start with certain assumed parameters which are latterly corroborated or modified according to the results of these computations.

The stability of the static and dynamic characteristics of a boscage system depends in numerous ways on the frictional forces arising in a master cylinder, faucets, channels, and other boscage rudiments. The wear and tear, gaps, andbritches on the boscage bias are also caused by these inner frictional forces. Traditionally, the internal disunion is infrequently considered in boscage dynamics except for assessing the boscage necklace oscillations. still, the most critical outgrowth of the below influence is connected with a hysteresis miracle. The hysteresis takes place by changing the sign of the frictional forces at the boscage release mode and occurs because a pressing force on the disunion face of the boscage pad is still retained by the time of the boscage release.

The full power hydraulic boscage system has several advantages over traditional boscage actuation systems. These systems are able of supplying fluid to a range of veritably small and large volume service thickets with actuation that's faster than air/ hydraulic boscage systems. perpetration of full power hydraulic boscage system in out- road vehicles calls for good understanding of its dynamic characteristics. In this paper, we consider the problem of dynamic modeling of the boscage system and develop a dynamic model for a hydraulic boscage stopcock. First, the dynamic characteristics of full power hydraulic boscage system are anatomized theoretically. The goods of varying design parameters(boscage stopcock, accumulator and so on) and the different operating conditions are also anatomized. Second, we probe the dynamic characteristics of a full power hydraulic boscage system using a test bench, which is a haul boscage system specifically designed for one construction Machinery Company. Eventually, grounded on the experimental results, the fine models are amended and vindicated. The result shows that the model- calculated data agree well with tested data.

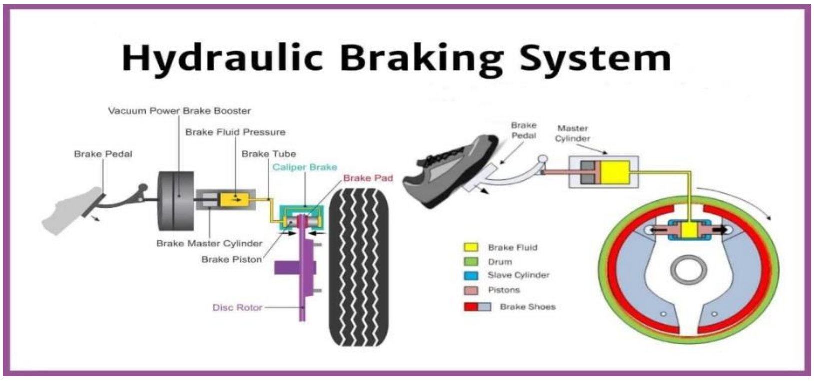


Fig. Hydraulic Brakes

1.1 Literature Review

In this paper of modeling analysis and optimization of master cylinder of hydraulic breaking system are performed and conclude that the polyimide is an indispensable material for aluminum which can be used in machine manufacturing. The weight of master cylinder made up of polyimide i.e.0.1 49 kg is lower than master cylinder made up of Aluminum i.e.0.282 kg. The stress convinced in aluminum master cylinder is further than the stress convinced in master cylindermade up of polyimide material as well as the convinced stress in polyimide material is veritably lower compared to ultimate strength of that material. The hunt for an machine to increase avail has started ahead numerous times. numerous machine manufacturing diligence are doing further exploration on how to increase avail of vehicle. In moment's machine competition every manufacturer is fastening on weight reduction of vehicle by considering this ideal, this paper focuses on furnishing indispensable material. The ideal of the present work is to optimize weight reduction to increase avail of vehicle. Saving grams at different corridor in a auto helps us in saving some kilograms at the end of the design. Also the main material like polyimide for machine element manufacturing can be the stylish volition result in all respect. The focus of this paper is on weight reduction of master cylinder. For modeling and analysis PRO-E and ANSYS is used. The results attained are comparatively better than being accoutrements and polyimide can be the indispensable result for automotive element. Braking system is a means of converting instigation into heat energy by creating disunion in the wheel thickets.

1.2Early History:

During 1904, Frederick George Heath (Heath Hydraulic Brake Co., Ltd.), Red ditch, England devised and fitted a hydraulic (water/glycerine) brake system to a cycle using a handlebar lever and piston. He obtained patent GB190403651A for "Improvements in hydraulic actuated brakes for cycles and motors", as well as subsequently for improved flexible rubber hydraulic pipes.

In 1908, Ernest Walter Weight of Bristol, England devised and fitted a four-wheel hydraulic (oil) braking system to a motor car. He patented it in Great Britain (GB190800241A) in December 1908, later in Europe and the USA and then exhibited it at the 1909 London Motor Show. His brother, William Herbert Weight improved the patent (GB190921122A) and both were assigned to the Weight Patent Automobile Brake Ltd. of 23 Bridge Street, Bristol when it was established in 1909/10.

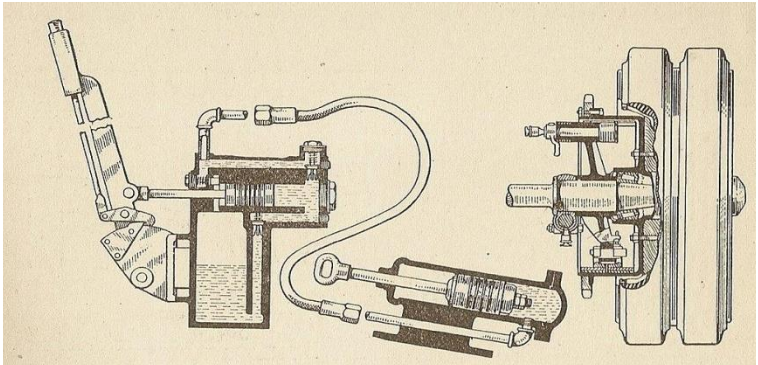


Fig. 479. Layout of Hydraulic Brakes Used on Knox Tractor
Courtesy of Knox Motors Company, Springfield, Massachusetts

Knox Motors Co. used hydraulic brakes in 1915, in a Tractor unit. Malcolm Loughead (who later changed the spelling of his name to Lockheed) invented hydraulic brakes, which he patented in 1917. "Lockheed" is a common term for brake fluid in France. Fred Duesenberg used Lockheed Corporation hydraulic brakes on his 1914 racing cars and his car company, Duesenberg, was the first to use the technology on the Duesenberg Model A in 1921. Knox Motors Company of Springfield, MA was equipping its tractors with hydraulic brakes, beginning in 1915. The technology was carried forward in automotive use and eventually led to the introduction of the self-energizing hydraulic drum brake system (Edward Bishop Boughton, London England, June 28, 1927) which is still in use today.

II. TEST PROCEDURE

The experimental investigations of hydraulic brake components were performed on the special test bench configuration with a 'brake robot', allowing the dynamic and precise reconstruction of the brake pedal action. Table 1 shows the maindata of the test stand.

The following brake system components and equipment were used for experiments:

Brake robot actuator, brake master cylinder, vacuum booster, wheel brake, signal converter, real-time computer, laptop with controlling software, force and pressure sensors, hydraulic and vacuum pump, hydraulic and vacuum tank, charging unit, storage batteries, overflow tank, and hydraulic and air pipes.

The research work consists of several stages :

1. The influence of the brake pedal stroke velocity on hysteresis value is estimated; next the operating modes were chosen:

(a) steady state braking;

(b) service braking;

(c) Emergency braking.

None of these braking modes has exact limits on the brake pedal stroke velocity. From statistical and practical data, the following intervals of brake pedal stroke velocity were taken: steady state braking, 5–15 mm/s; service braking, 50–200 mm/s; emergency braking, 1000–1300 mm/s .

Each of the velocity intervals was divided into several parts during experiments to obtain hysteresis characteristics for all subintervals. The simulation of the brake pedal action in the considered brake system configurations was realized using a special actuator allowing control of the rod velocity and displacement. The actuator rod is directly connected to the rod of the brake master cylinder or booster rod. Taking into consideration the pedal ratio Uped, calculated on the basis of geometric parameters , the values of the rod velocities for brake pedal stroke velocity during the emergency, service, and steady state braking were obtained.

2.To estimate the influence of different brake system components (vacuum booster, disc brake, brake master cylinder, and pipelines) on the value of the hysteresis losses, the sequential exclusion of these components from the hydraulic system configuration with one disc brake was carried out with subsequent repetition of all experiments.

III.PROBLEM STATEMENT

As the most critical application of braking is during sudden stopping of a vehicle, the condition of decelerating from a reference speed to zero speed is used to calculate braking force. Consider a vehicle moving at an initial speed of u m/s and time in which the vehicle should be stopped is t seconds. Let the braking acceleration or deceleration is a_b m/s^2 and mass of the vehicle is m kg. For calculating a_b, kinematic equations are used

From the first kinematic equation,

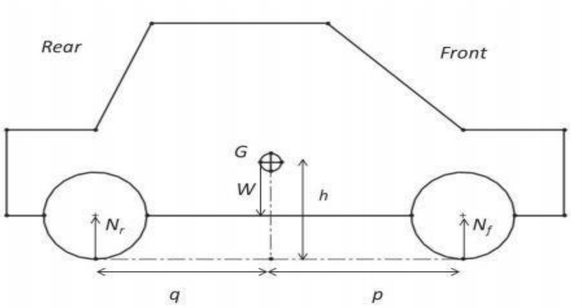
$0 = u - a_b \times t$ (1)

$\therefore a_b = u/t$ (2)

In equation (2), the time t is exclusive of driver's reaction time as well as system response time[1]. Also, from these calculations and second kinematic equation we can find out the stopping distance s m

$u^2 = 2.a_b.s$ (3)

$\therefore s = u^2/2.a_b$ (4)



Force Body Diagram (FBD) of a vehicle in static condition

The force body diagram of a stationary vehicle is shown. The normal reactions by the ground on the vehicle atthe tires at the front and rear are Nf and Nr respectively. The position of center of gravity is at a height of h denoted by G. Also, p and q denote the horizontal distance of G from the front and rear tire contact points respectively. The weight of the car is WN.

From the Newton's third law of motion,

$N_f = W.q / p+q$ (5)

$N_r = W.o /p+q$ (6)

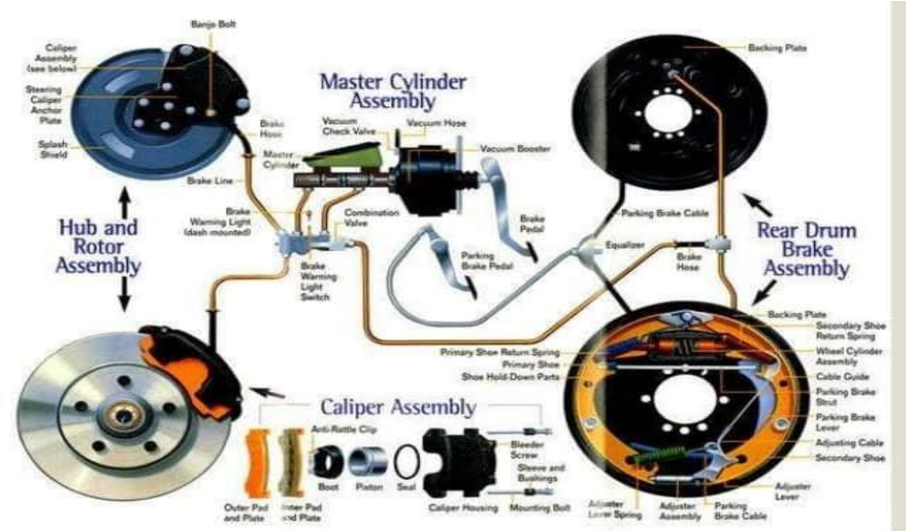
$X_1 =(N_f / N_f+ N_r) \times 100$ (7)

The static normal reaction distribution on the car on front two wheels with respect to rear two wheels is x1, is expressed as a percentage in equation (7). Now, consider that the vehicle is decelerating by abm/s2. In this case the car is acted uponby frictional force. The force body diagram is shown .

The normal reactions at the tires are different from the initial static condition. The normal reactions in this case are Nf' and Nr' calculating using equations (8) and (9). The frictional forces at the front and rear tires are Bf and Br respectively. These values are given by equations.

IV.CONSTRUCTION

When the brake pedal is pressed, the force is transmitted to the brake shoes through a liquid (link). The pedal force is multiplied and transmitted to all brake shoes by a force transmission system. The figure shows the system of a hydraulic brake of a four-wheeled automobile. It consists of a master cylinder, four-wheel cylinders, and pipes carrying a brake fluid from the master cylinder to a wheel cylinder.



The most common arrangement of hydraulic brakes for passenger vehicles, motorcycles, scooters, and mopeds, consists of the following:

a. Brake pedal or lever
b. A push rod (also called an actuating rod)
c. A master cylinder assembly containing a piston assembly (made up of either one or two pistons, a return spring, a series of gaskets/ O-rings and a fluid reservoir)
d. Reinforced hydraulic lines
e. Brake caliper assembly usually consisting of one or two hollow aluminum or chrome-plated steel pistons (called caliper pistons), a set of thermally conductive brake pads, and a rotor (also called a brake disc) or drum attached to an axle.

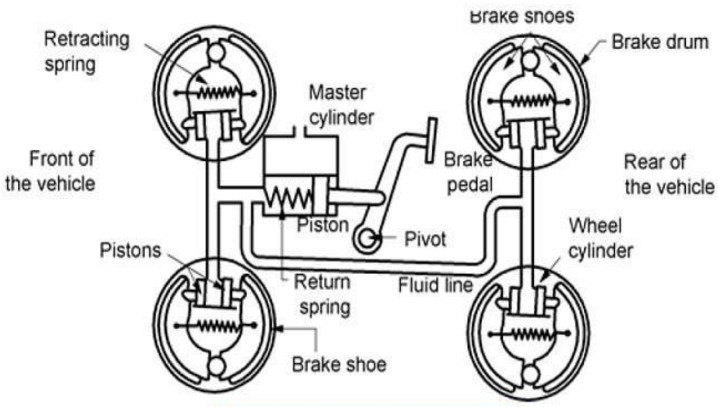


Fig : hydraulic brake system

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.

V.WORKING OF HYDRAULIC BRAKES

When the brake pedal is pressed to apply the brakes, the piston in the master cylinder forces the brake fluid. This increases the pressure of the fluid. This pressure is transmitted in all the pipes and up to all-wheel cylinders according to Pascal's law. This increased pressure forces out the two pistons in the wheel cylinders. These pistons are connected to brake shoes. So, the brake shoes expand out against brake drums. Due to friction between brake linings and drums, wheels slow down and brakes are applied.

Working of master cylinder of Hydraulic brake:

1) Brakes applied:

When the brake pedal is operated, the pushrod moves the piston against the action of the spring force. When sufficient pressure is built up, the rubber cap of fluid check valve deflects and the high-pressure fluid enters the wheel cylinder through fluid lines and operates the brake shoe against the revolving drum.

2) Brakes released:

When the pedal is released, the piston return towards its initial position due to the spring force and closes the fluid checkvalve for a short time to avoid entry of any air. The fluid from the lines also comes back in the compression chamber by lifting the check valve off its seat.

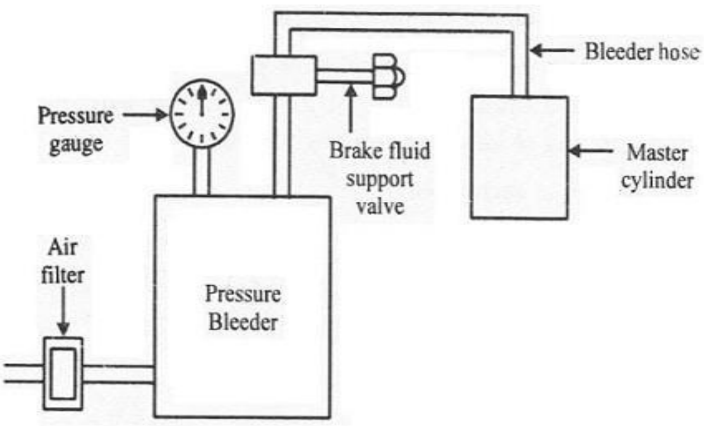
Method of Bleeding of hydraulic brakes:

1) Pressure Bleeding
a) Using air b) By forcing brake fluid
2) Manual Bleeding
3) Gravity bleeding

1. Pressure bleeding:

Pressure bleeder is a device used for bleeding procedure that is attached to the master cylinder. The pressure bleeder supplies pressurized brake fluid to the master cylinder.

When the bleeder screw is opened, the pressure force air and brake fluid out of the bleeder screw. With a pressure bleeder,you can bleed the hydraulic system without any helper. The pressure used in pressure is usually 104 to 138 KPa.



2. Manual bleeding of Hydraulic brakes:

Two service technicians are needed for the manual bleeding. One technician opens a bleeder and the other technician depresses the pedal, to force out air and brake fluid from the bleeder screw. To bleed the system following procedure is adopted.

a. Attach a bleeder hose to bleeder screw at the wheel cylinder and insert the other end of the hose into the clean plastic container which is partially filled with clean brake fluid.
b. Loosen the bleeder screw at least one full turn.
c. Have an assistant to depress and hold the brake pedal and then tighten the bleeder screw.
d. Have your assistant to release the brake pedal.
e. Repeat steps b,c & d until the fluid flow in the container is free of air bubbles. Periodically check the brake fluid level in the master cylinder and brake fluid of correct grading to keep the reservoir filled.
f. Repeat this procedure at each wheel.

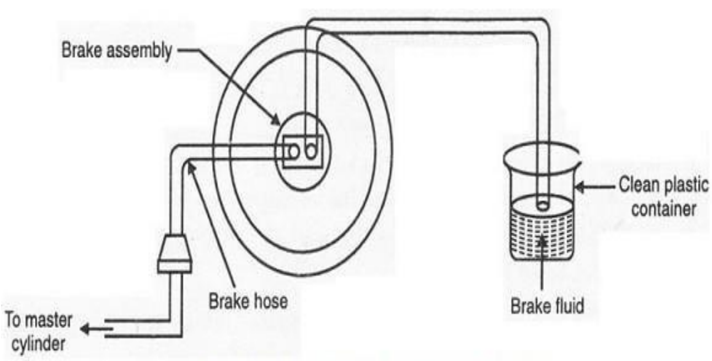


Fig. Manual bleeding of hydraulic brakes

3.Gravity bleeding:

Gravity bleeding is the method of bleeding that uses the earth's gravity to bleed air from the hydraulic system. No external force is applied to brake fluid. To bleed the system following procedure is adopted.

a. At the wheel, the cylinder loose the bleeder screw at least one full turn.
b. Remove the cover from the master cylinder reservoir. The level of brake fluid to flow from the bleeder screw.
c. Watch the bleeder hose when brake fluid flows from opening and tightening the screw.
d. Repeat this procedure at each wheel in sequence and it should be changed.

VI.DIFFERENCE BETWEEN MECHANICAL BRAKING SYSTEM AND HYDRAULIC BRAKING SYSTEM

Sr. no.	Mechanical Braking System	Hydraulic Braking System
1.	Less Braking efficiency.	More Braking Efficiency.
2.	Poor Anti fade characteristics	Better Anti-fade characteristics
3.	Complicated due to more parts.	Simple in construction
4.	It do no self compensate	Self-compensating system
5.	Construction is less flexible	Construction is more flexible
6.	Low mechanical advantage	High mechanical advantage
7.	External Lubrication is required	System is self-lubricating
8.	No leakage problem	Leakage may take place
9.	No hydraulic oil use	Hydraulic oil is used
10.	More effort required for braking operation	Less effort required for braking operation
11.	Cheaper	Expensive
12.	Ex: Motor Cycles	Ex: Cars and Jeeps.

VII.ADVANTAGES AND DISADVANTAGE OF HYDRAULIC BRAKING SYSTEM

Hydraulic Braking System has some advantages and limitations over other Braking System i.e. Mechanical, Pneumaticbraking System;

Advantages of Hydraulic Braking System:

The advantages of the hydraulic braking system are as follows,
(a) Equal braking action on all wheels.
(b) Increased braking force.
(c) Simple in construction.
(d) The low wear rate of brake linings.
(e) The flexibility of brake linings.
(f) Increased mechanical advantage.

Disadvantages of Hydraulic Braking System:
Disadvantages of the hydraulic braking system are as follows,
(a) The whole braking system fails due to leakage of fluid from brake linings.
(b) The presence of air inside the tubings ruins the whole system
(c) Maintenance is more than other braking systems.
(d) Construction is complex.

VIII.CONCLUSION

Hydraulic hybrid technology has the advantage of high power density and the ability to accept the high rates/ high frequencies of charging and discharging, therefore it is well suited for off-road vehicles and heavy duty trucks.

For the brakes to work effectively, the applied braking force should be more than required braking force. There are various methods to achieve this, each having distinct advantages.

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