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Research Article

Construction Effectiveness of Vehicle Drum Brakes

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Abstract

The safety factor for the driver is very important, where braking for the vehicle is one part of the vehicle that affects safety. Although braking is controlled by the driver, the braking system will also affect and help the driver to reduce the risk of an accident because the brake system is not functioning properly. The purpose of this study was to evaluate the construction of drum brakes on car bicycles, which are used on both rear wheels. The brake construction that will be evaluated is the construction of the drum brakes on xxx vehicles. Furthermore, calculations and drawings of disc brake designs are carried out. The evaluation results obtained the Brake Effectiveness Factor (FER) of 0.76 N and the results of the braking force with a disc of 299.5 N, using a drum (Tromol) with a diameter of 240 mm. It is felt that it is sufficient to provide stability and safety for the driver and passenger of the vehicle.

Keywords

Brake, Drum, FER

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Introduction

An automobile engine consists of many components that can reach more than a hundred component parts. All work together to support each other which is very integrated, so that it can produce a movement. Many things must be considered and considered by a designer in designing a component of a machine or machine component, including adjusting a component to its actual function. Factors of safety, efficiency and cost factors must be taken into account by a designer (Taylor, 1998). The safety factor for the driver is very important, where braking for the vehicle is one part of the vehicle that affects safety. Although braking is controlled by the driver, the braking system will also affect and help the driver to reduce the risk of an accident because the brake system is not functioning properly. In general, the braking system on the car itself there are two types that are commonly used, namely drum brakes and disc brakes. Both types of brakes certainly have the same function and purpose, and also have their own advantages and disadvantages.

Drum brakes (tromol) are braking systems on vehicles, which use the friction method between the canvas and a bowl-shaped component. Drum brakes have the characteristics of a protected brake layer, can produce a large brake force for a small brake size, and the brake lining life is quite long. The brake force depends on the position of the brake shoe hinges and hydraulic cylinders and the direction of rotation of the wheels. The advantages of drum brakes are more durable because they have wide brake pads, wide brake lining surfaces make the braking force strong and soft, making them suitable for use on large cars and also cleaner (safe from outside dirt) because this brake system is closed (Day, 1988).

When the brake lever is pulled or the brake pedal is stepped on, there will be movement of the components of the drum brake (tromole), namely friction between the drum and the brake pad. The piston will press on the brake pad and cause a strong friction force so that it can stop the rotation or movement of the drum. The problems formulated in the evaluation of this construction are how the effectiveness of the brakes and the magnitude of the braking force using drum brakes on xxx vehicles can ensure stability and safety for the driver. Meanwhile, the scope of this construction evaluation includes the construction of disc brakes on xxx vehicles. The purpose of this study was to evaluate the construction of the drum brake on a car, which is used on both rear wheels. The brake construction that will be evaluated is the drum brake construction, then calculations and brake design drawings are carried out.

Literature Study

The brake is a supporting component in a motor vehicle that functions to dissipate the energy of the vehicle's motion so that the vehicle experiences a deceleration. The working principle of this brake is the friction between the disc and the brake lining when the two brake components are in contact. With the friction, the kinetic energy of the vehicle is converted into heat and sound when the brakes operate.

Drum brakes are brakes that work on the basis of friction between the brake shoes and the drum that rotates with the rotation of the vehicle's wheels. In order for friction to slow down the vehicle properly, brake shoes are made of materials that have a high coefficient of friction. Drum brakes work on the principle of friction, this friction will convert the motion energy of the drum brakes into heat energy so that the rotation of the wheels stops and the temperature around the brakes increases. Drum brake construction has two brake linings located on the inside. Then on the outside of the brake lining there is a bowl-shaped component that we know as the brake drum. The direction of movement of the drum brakes is away from each other, meaning that when the brakes are pressed, the two brake pads will move outward (away from each other). This movement will make the brake lining press against the inner surface of the brake drum. So there is friction that will stop the rotation of the drum and wheels (Lee, 2000).

Components of drum brakes:

1. Back plate

This backing plate functions as a frame as well as protecting other drum brake components. The backing plate is usually made of thin metal which is right behind the drum brake system.

2. Wheel cylinder

Wheel cylinder serves to convert fluid pressure into mechanical motion. The pistons are pushed by hydraulic pressure will protrude and push the brake shoes outwards.

3. Brake shoes and lining

Brake shoes are a place to put the brake pads on the drum brake system. In disc brakes, this is called a brake pad. Brake shoes are in the form of two half circles which when combined will form a circle

4. Return spring (upper spring and lower spring)

The main function of the return spring is to return the position of the brake shoes after the braking process takes place
There are usually two springs in one drum brake, namely:

- Upper spring, this spring is at the top, just below the wheel cylinder. The main function of this spring is to return the position of the brake shoe to close.
- Lower spring, while the second spring located near the adjuster functions to keep the two brake shoes from pressing the adjuster.Brake shoe holder

The brake shoe holder consists of a pin that has a lock, a spring and a pressure plate. These three parts when paired will keep the brake shoes attached to the backing plate but can still be moved left and right.

5. Brake shoe adjuster

At the bottom of the car's drum brakes, we will find the screw adjuster mechanism. Its function is to adjust the gap between the drum brake lining and the drum surface when the brake pedal is not pressed.

6. Drum/tromol brake

The brake drum is a component made of cast steel that is shaped like a drum or tube. The function of this drum is as a friction medium with the brake lining so that the wheel rotation can stop.

7. Parking brake lever

Parking brake lever works to brake the vehicle when the vehicle is stopped or parked.

8. Parking brake cable

Parking brake cable serves to connect the movement of the parking brake lever with the parking brake lever on the brake.

Methodology

The steps taken in this effectiveness evaluation are as follows :

1. Identify the problem.
2. Conduct a literature study.
3. Perform data collection.
4. Create a flowchart for data processing and calculation of the effectiveness of disc brakes.
5. Making detailed drawings.
6. Make a conclusion.

Specification data on drum brakes as follows:

1. Vehicle length (p) : 4200 mm
2. Vehicle width (l) : 1660 mm
3. Vehicle height (t) : 1695 mm
4. Vehicle load (w) : 1085 kg
5. Vehicle rear load (W_B) : 400 kg
6. Brake drum inner diameter : 240 mm
7. Diameter of brake lining : 182 mm

a Drum radius : 140 mm
b Lining thickness : 80 mm
e dimensi : 151 mm

8. Coefficient of friction (μ) : 0,38
9. Wheelbase : 2655 mm
10. Maximum Power : 96,5/6000 HP/rpm
11. Maximum Torque : 12,3/4200 kg.m/rpm
12. Effective tire diameter : 562 mm
13. Vehicle speed : 60 km/h
14. Braking distance : 20 m

Figure1. Drum brake

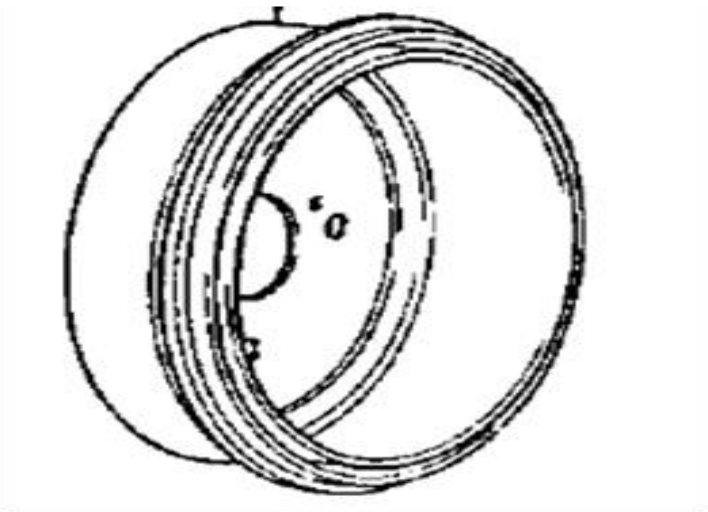
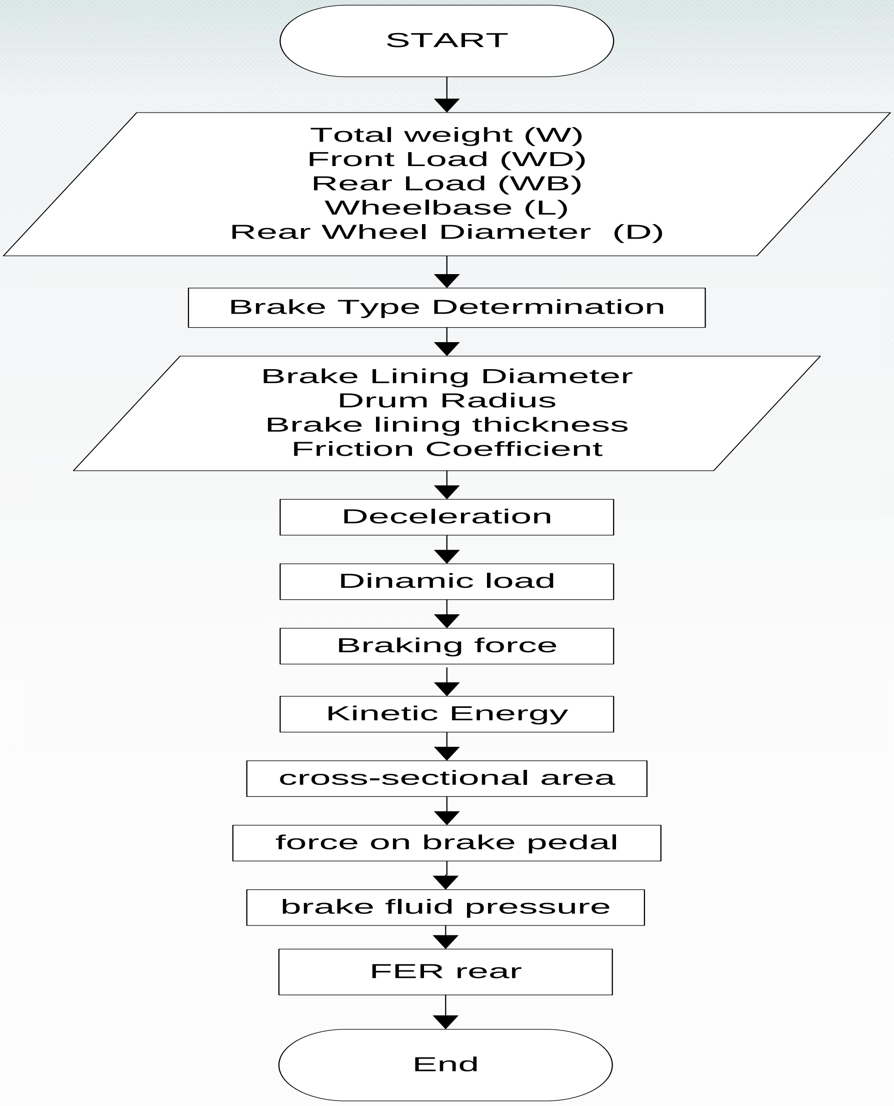


Figure 2. Tromol



Discussion Result

1) Deceleration, a

$Vt^2 = V0^2 + 2\ a\ s$

$0^2 = (16{,}7\ m/s)^2 + (2 \times a \times 20\ m)$

$0 = 278{,}89\ m/s + 40\ a$

$40a = -278{,}89$

$a = -6{,}9\ m/s^2$

2) Rear Dynamic Load, W_{dB}

$W_{dB} = W - W_B \times e \times (h/L)$

$W_{dB} = 1085 - 400 \times 0{,}38 \times (1400/2655)$

$W_{dB} = 1085 - 400 \times 0{,}38 \times 0{,}52$

$W_{dB} = 1085 - 70{,}04$

$W_{dB} = 1014{,}96\ kg$

3) Braking Force, B_{IB}

$B_{IB} = e\ (W_B - w \times e \times \frac{h}{L})$

$B_{IB} = 0{,}38\ (400 - 1085 \times 0{,}38 \times 1200/2655)$

$B_{IB} = 0{,}38\ (400 - 1085 \times 0{,}38 \times 0{,}45)$

$B_{IB} = 0{,}38\ (400 - 185{,}5)$

$B_{IB} = 0{,}38 \times 214{,}5$

$B_{IB} = 81{,}5\ N$

4) Kinetic Energy, Ek

Ek = (w/2g) v^2
Ek = (1085 / 2×9,8) 60^2
Ek = 55,35 × 3600
Ek = 199260 J

5) Force on brake pedal, Fp
Fp = m × g
Fp = 25 kg × 9,8 m/s^2
Fp = 245 N

6) Upper Brake Master Press Force, Fa
Fa = Fp × a × sin a
Fa = 245 N × 60 mm × sin 60^o
Fa = 48,96 N

7) Lower Brake Master Press Force, Fb
Fb $= \frac{Fa \times (D2)2}{(D1)2}$
Fb $= \frac{48{,}96 \times (35)2}{(50)2}$
Fb = 23,9 N

8) Cross section area, A_{Wb}
$A_{Wb} = \frac{\left(\frac{\pi}{4}\right)(dwb)2}{100}$
$A_{Wb} = \frac{\left(\frac{\pi}{4}\right)(50)2}{100}$
$A_{Wb} = \frac{\left(\frac{\pi}{4}\right)2500}{100}$
A_{Wb} =19,63 cm^2

9) Drum Brake Effectiveness Factor, FER_B
FER_B = 2 × $\boldsymbol{\mu}$
FER_B = 2 × 0,38
FER_B = 0,76

10) Brake Effectiveness procentage, FER
FER = 0,4 × u^2/S
FER = 0,4 × 60^2 / 20
FER = 72 %

11) Drum Braking Force, B_{Db}
B_{Db} = 2 $(FER)_B$ × Fb × Awb × $\frac{rb}{R}$
B_{Db} = 2 × 0,76 × 23,9 × 19,63 × $\frac{120}{281}$
B_{Db} = 2 × 0,76 × 23,9 × 19,63 × 0,42
B_{Db} = 299,5 N

Table 1
The calculation results

Parameter	Hasil
Deceleration, a	-6,9 m/s^2
Rear Dynamic Load, W_{dB}	1014,96 kg
Braking Force, B_{IB}	81,5 N
Kinetic Energy, Ek	199260 J
Force on brake pedal, Fp	245 N
Upper Brake Master Press Force, Fa	48,96 N
Lower Brake Master Press Force, Fa	23,9 N
Cross section area, A_{Wb}	19,63 cm^2
Drum Brake Effectiveness Factor, FERB	0,76
Procentage Efektivitas Rem Drum, FER	72%
Drum Braking Force, B_{Db}	299,5 N

Conclusion

The results obtained by breaking the drum brake with a drum size of 240 mm is 299.5 N and uses an effectiveness factor of 72%. There is a factor in the use of an anti-lock braking system (ABS) in the car so that it helps when braking so that the brakes can be maximized.

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