Brake Drum Temperature Adjustment and The Brake Lining Gap's Impact On Motor Vehicle Brake Efficiency

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Abstract

Brakes are a key component in motor vehicle systems that play a vital part in decreasing the likelihood of accidents on the road. Improper component adjustment in the brake system, particularly with drum brakes, can cause the brakes to perform inefficiently. This research aimed to determine the effects of significant variations in drum brake and brake lining temperature on motorized vehicle braking efficiency. The brake lining gap size and the drum brake's temperature are controlled in this study's experimental setup. From these various modifications, the main braking efficiency was verified using a brake tester. The brake lining gap is 0.3 mm, 1 mm, and 1.7 mm. Meanwhile, the brake drums' temperatures have been adjusted to 30, 90, and 150 degrees Celsius. The results show that braking efficiency decreases with increasing brake lining gap. The effectiveness of the drum brake decreases as the temperature rises. Meanwhile, the fluctuating brake lining spacing and temperature also affect braking efficiency. The brakes' effectiveness decreases with increasing distance between the drum brake's lining and temperature.

Keywords: Adjustment, Brake lining gap, Brake efficiency, Drum brake, Temperature

Abstrak

Rem merupakan komponen utama dalam sistem kendaraan bermotor yang berperan penting dalam mengurangi kemungkinan terjadinya kecelakaan di jalan raya. Penyetelan komponen yang tidak tepat pada sistem rem, terutama pada rem tromol, dapat menyebabkan kinerja rem menjadi tidak efisien. Penelitian ini bertujuan untuk mengetahui pengaruh variasi besar celah kampas serta temperatur rem tromol terhadap efisiensi pengereman kendaraan bermotor. Ukuran celah kampas dan suhu rem tromol dalam penelitian ini dikontrol. Dari beberapa variasi tersebut, efisiensi pengereman utama diverifikasi dengan menggunakan brake tester. Celah kampas rem adalah 0.3 mm, 1 mm, dan 1.7 mm. Sementara suhu rem tromol telah diatur pada 30, 90, dan 150 derajat Celcius. Hasilnya menunjukkan bahwa efisiensi pengereman menurun seiring dengan bertambahnya celah kampas rem. Efisiensi rem tromol menurun seiring dengan meningkatnya suhu tromol. Sementara itu, fluktuasi besar celah dan suhu kampas rem juga mempengaruhi efisiensi pengereman. Efektivitas rem menurun seiring bertambahnya lebar celah kampas rem dan suhu tromol.

Kata kunci: *penyetelan, celah kampas rem, efisiensi rem, rem tromol, suhu*

1. Introduction

The increasing number of automobiles on the road has resulted in a major increase in traffic accidents worldwide. One of the most common causes of such accidents is braking failure. Some of these situations result in significant injury or death and can be avoided if the driver is given an early warning of brake failure. Wearing out of the liner and overheating of the Drum/Disc are two of the most common causes of brake failure [1].

Brakes are one of the components in automobiles that help to slow the car down when friction exists between the canvas and the drum [2]. If the braking system is not working properly, it might lead to danger and a significant risk of an accident [3]. Brake components that rub together must be composed of materials that are not easily worn, are heat-resistant, and do not deform easily at high temperatures [4]. With a vehicle's greater capacity to drive, the brake system's ability to reduce or stop speed must be greater and more reliable.

The driver must check that the braking system is working properly and efficiently. They absolutely want the braking process to appear as smooth and controlled as it did when the vehicle initially left the factory [2,4]. Routine maintenance by drivers is required to reduce the risk of accidents while driving. The KNKT / National Transportation Safety Committee (NTSC) on Route Traffic and Transportation Collision Investigation Report 2021 describes an accident on the Bawen-Semarang road in Central Java between a Trenton box truck and a dump truck. One of the results of the NTSC examination in that instance was that on the vehicle's 2nd (two) axis, on the left and right wheels. A 2.6 mm gap was discovered between the brake pad and the drum [5]. Because of the huge space between the brake lining and the drum, there may be little or no friction between the brake pad and the drum (brake force = 0). As a result, correct brake gap adjustment is required to avoid accidents, such as the one on the Bawen-Semarang route.

Several elements influence braking performance, including frictional surface characteristics and compressive stresses. The heat generated in the brake lining determines braking power in the drum brake system. Materials such as brake linings have a specific heat which can determine how high a temperature they can accept when braking [6]. Braking quality will worsen (not gripping) if the brake pads receive excessive heat. If the brakes are used too often, the friction that occurs between the brake pads and the drum causes the temperature to rise and heat so that the coefficient of friction (braking force) between the brake pads and the drum decreases [7].

The purpose of this study is to use a brake tester to determine the effect of altering the brake lining gap and the temperature variation of the brake drum temperature on the efficiency of the main brake on the vehicle's 2nd axis. When braking, apply a pedal force so that the pedal receives the same force. The study's goal is to employ a Mitsubishi L300 pickup.

A drum brake is a type of brake in which brake shoes with lining (friction material) attached are forced by hydraulic pistons on the inner surface of a drum that rotates with the axle. This causes friction, which turns kinetic energy into heat and slows or stops the drum and the associated wheel [8].

The backplate, wheel cylinder, brake shoes and lining, brake shoe adjuster, return spring, drum brake, parking brake cable, and parking brake lever are all components of a drum brake on a motorized vehicle [9]. The backplate protects other drum brake components by acting as a frame. This part is typically composed of thin metal and is located right beneath the drum braking system. The function of a wheel cylinder is to transform fluid pressure into mechanical motion. The brake shoes will be pushed out by a piston pushed by hydraulic pressure [10]. Figure 1 is a picture of the vehicle’s drum brake.

Figure 1. Vehicle’s drum brake

Previous research by Sugiharjo and Wilarso [11] used the fishbone analysis approach to conclude that a loss of grip on the brakes and insufficient air pressure caused the failure braking process. The detection of gaps in the brake lining that exceed the manufacturer's limits is one of the causes of high air consumption. The brake pads on the drum have worn out, requiring more pressure when braking, resulting in high air consumption.

Drum temperature and axle load, both high and low, affect braking efficiency. It may be inferred from the braking efficiency results achieved with changes in wheel axle load, drum temperature, and the rate at which the drum temperature increases that using original brake pads is preferable to using fake ones [12].

Another experimental investigation on brake linings included three types of grooves: inclined grooves, unidirectional grooves, and opposing grooves. According to the findings of a study on drum brake linings, the brake linings of the opposing wheel rotation were superior to those of the unidirectional and inclined grooves because the braking distance was lowered in the opposite grooves. Drum brake temperatures were lower than normal [7].

On a vehicle's drum brake system, the brake shoe is where the brake pads are installed. The brake shoes are two semicircles joined together to make a circle. After braking, the return spring restores the position of the brake shoes. When the brake pedal is not engaged, the brake shoe adjuster adjusts the distance between the drum brake pads and the brake surface drum.

The drum brake is a cast steel component fashioned like a drum or tube. This component serves as a friction medium between the brake pads, allowing the wheels to stop rotating. When a vehicle is parked or stopped, the parking brake lever is used to brake it. The parking brake cable links the movement of the parking brake lever to the position of the parking brake lever on the drum brake system [9].

Drum brakes have the following advantages:

a. This brake is protected against any dirt that could stick from the outside since the system is closed. You won't have to overdo it and it will seem cleaner if you use these brakes.
b. The large canvas surface makes sure that the holding power is enough and the procedure is gentle.
c. Powerful brakes that enable it to stop large automobiles or commercial vehicles.

Weakness:

a. In contrast to disc brakes, drum brakes need a specific stopping distance from the vehicle before they engage.
b. The drum brakes are less responsive.

During the usual braking process, contact with the leading shoe is greater than contact with the trailing shoe. Contact pressure is greater at both ends of both shoes than in the centre. The friction plate contact pressure is greater on the side towards the brake drum flange than on the side at the brake drum's edge [13].

Adjusting the brake shoe gap too widely will result in force braking and delays when the driver steps on the brake pedal. It's because the driver has to press harder on the brake pedal. It will result in more free play (free distance brake pedal).

Meanwhile, if the adjustment of the brake shoe gap is too tiny, the wheels will brake even if the driver has not stepped on the brake pedal [5]. As a result of the brake pads continuing to make contact with the braking drum, heat is generated, causing the brake pads to adhere to the drum. When the temperature rises, the vehicle's braking performance suffers [14]. Braking is a type of conversion of kinetic energy into heat energy, which increases the temperature of both the brake pads and the drum [7].

The braking power of a drum brake system is determined by the heat of the brake lining. If the brake pads become too hot, the braking quality will deteriorate (no grip). When the brakes are used too frequently, the coefficient of friction (braking force) decreases if the pad material is not appropriate for high temperatures [7]. The friction coefficient of the brake will likewise rise as the applied braking force increases [8]

2. Materials and Methods

This study used experimental research methodologies. The experiment is designed to determine the influence of the independent variable on the dependent variable. The brake lining gap and brake drum temperature are the independent variables. The dependent variable is brake efficiency at the same time. The purpose of this experimental study is to examine the effect of altering the brake lining gap and brake drum temperature on the outcomes of vehicle brake efficiency tests. The vehicle employed in this investigation is a Mitsubishi L300 pickup, which is a freight car and mandatory test vehicle.

A brake tester is used at the UPUBKB/ Vehicle Periodical Inspection Testing Unit of Denpasar Bali to evaluate the efficiency of the service brake. To get the same braking power, a pedal force tool with a 0.5% accuracy rate is used.

Meanwhile, the temperature of the brake drum is measured using an infrared thermal gun. The experimental method was used in this study to collect data by braking on the brake tester with determined variations in brake lining gap adjustment and temperature on the drum brake.

Techniques used to collect data:

a. Prepare the instruments and materials to be used in the research by the research strategy.
b. Check that all tools and materials utilized in the study are in good working order.
c. Adjust the drum brake lining gap based on the study experiment fluctuations of 0.3 mm, 1 mm, and 1.7 mm. By removing the drum, the brake lining gap can be adjusted.
d. After releasing the drum, measure the inner diameter of the drum and the outside diameter of the brake lining to obtain the appropriate gap.
e. Deduct the interior diameter of the drum from the outside diameter of the brake lining. Its purpose is to determine the distance or difference between the lining and the drum.
f. Adjustments can be made to the left rear wheel by turning the gear up to increase the gap and down to decrease the gap. The reverse is true for the back right.
g. After adjusting the drum brake lining gap, the temperature on the drum is determined based on the predefined variation that reaches the temperature according to the specified variation, namely at temperatures of 30ºC, 90ºC, and 150ºC.
h. Place the vehicle's second axle on the roller speedometer tester, then drive at a speed of 20-40 km/h while slowly stepping on the brake pedal until the temperature exceeds the specified fluctuation, namely 30°C, 90°C, and 150°C.
i. After determining the variation, insert the vehicle's second axis into the roller brake tester. Then, using the pedal force tool while testing the brake tester, test the efficiency of the vehicle's service brake on the second axis with the same pedal force of 200 Newton in each experiment, and record the results of the brake efficiency test.

j. Experiment with each variation four times to acquire reliable findings, and then enter the data collecting table's test results.

This study collects data through direct observation and documentation of the dependent variable, braking efficiency, which is influenced by the independent variable, variation in brake lining gap adjustment and specified brake drum temperature. The Federer formula was used to produce data changes with the experimental research subject formula four times [15].

$$(t-1)(n-1) > 15 \quad (1)$$

$(9-1)(n-1) > 15$
$8n-8 > 15$
$8n > 23$
$n > 3$

Note:
n = number of subjects per group
t = number of groups

As a result, the sampling is four times. Several tests can be performed using the research data presented above, namely:

a. The t-test was used to see if the independent factors (X1, X2) had any effect on the dependent variable (Y). There is an effect of variable X on variable Y if the significance value is < 0.05 or the t arithmetic > t table. If the significance value is more than 0.05 or t arithmetic < t table, variable X does not affect variable Y.
b. The F-test was used to examine the concurrent effect of the independent variables (X1 and X2) on the dependent variable (Y). If the significance value is < 0.05 or F arithmetic > F table, then variable X has a simultaneous influence on variable Y. There is no simultaneous influence of variable X on variable Y if the significance value is greater than 0.05 or F count < F table.

3. Result and Discussion

This study was carried out directly, with a Brake Tester being used on a Mitsubishi L300 vehicle and varying the adjustment of the brake lining gap and the temperature of the drum brakes. Using the pedal force ensures that all forces are equal, 200 Newtons. The experiment results can be seen in the figures below.

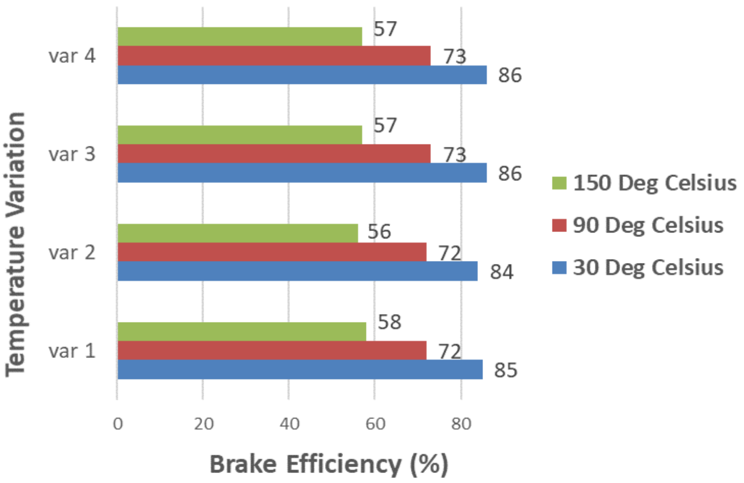

Figure 2. Brake lining gap of 0.3 mm experiment results

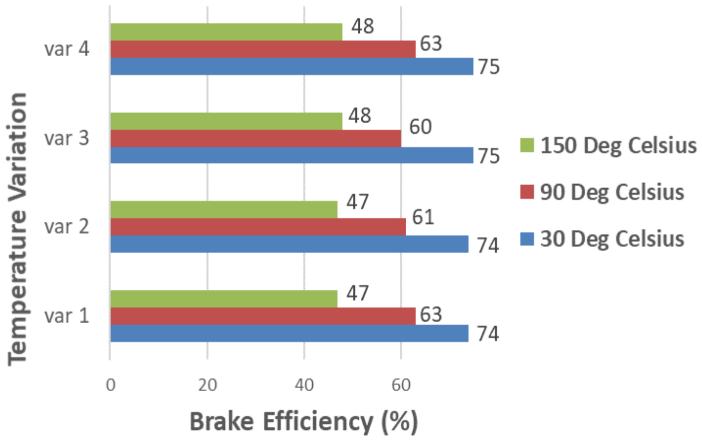

Figure 3. Brake lining gap of 1 mm experiment results

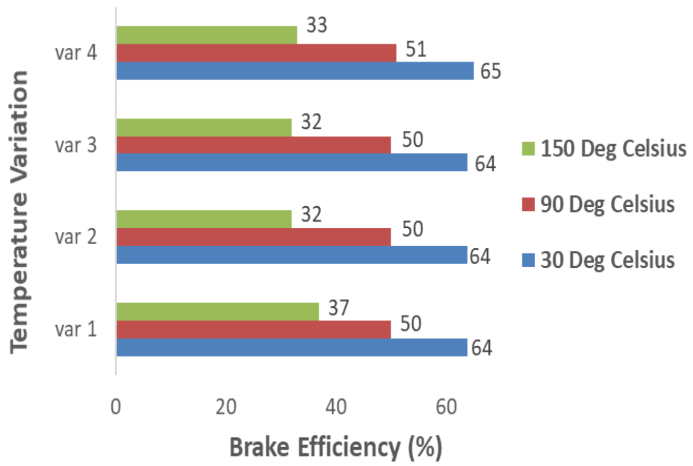

Figure 4. Brake Lining Gap of 1.7 mm experiment results

Figure 2 depicts the brake efficiency test at 0.3 mm brake lining gap, where the average brake efficiency results were 85.25%, 72.5%, and 57% in four data collection times with temperature differences of 30° C, 90° C, and 150° C. Meanwhile, according to Figure 3, the average braking efficiency was 74.5%, 61.75%, and 47.5% based on four data collecting times with temperature differences of 30° C, 90° C, and 150° C. Figure 4 depicts the average outcome of braking efficiency decreasing. When the temperature of the brake drum climbs above 30° C, 90° C, and 150° C, the brake efficiency falls by 64.25%, 50.25%, and 33.5%, respectively.

The t arithmetic for the t-test between X1 (brake lining gap) and Y (brake efficiency) is -39.081, while the t-table value is 2.035. Because the t arithmetic is bigger than the t table, it is possible to conclude that X1 (brake lining gap) reduces brake efficiency. It means that the larger the independent variable (the space between the brake linings), the smaller the dependent variable (brake efficiency). Because of the huge gap between the brake lining and the drum, there is little or no friction between the pads and the drum [5].

The t-count for the t-test between X2 (Temperature) and Y (Brake Efficiency) is -50.351, while the t-table value is 2.035. Because t arithmetic exceeds the t table, we can conclude that X1 (temperature) reduces brake efficiency. It is possible to deduce that the higher the temperature, the lower the braking efficiency. The friction between the pads and the drum will be reduced when the temperature rises while braking, making the brake less efficient [7].

Based on the significance value, the F-test computation yields 0.000. It signifies that the significance value is less than 0.05, implying that the independent factors, namely gap and temperature, simultaneously (together) affect the dependent variable, namely the level of braking efficiency. Simultaneous test decision-making (F test) is based on determined F values and the F table. The F table has a value of 3.32, while the computed F value is 2031.257. Because the computed F value is bigger than the table F value, it may be assumed that the independent factors, namely gap and temperature, simultaneously (together) affect the dependent variable, namely brake efficiency.

According to the findings of this study, it is not only the temperature of the drum that reduces brake efficiency, but it also turns out that the adjustment of the brake lining gap has a significant impact on braking. It is a relatively new phenomenon that drivers and vehicle technicians should be aware of to avoid being reckless when changing the brake lining gap. When making adjustments, the manufacturer's standards must be followed.

4. Conclusions

A series of experiments have shown that the wider the brake pad gap (independent variable), the lower the brake efficiency (dependent variable). This can be demonstrated in trials with a 1.7 mm brake gap, where the efficiency attained is the lowest compared to experiments with a slit width of 0.3 mm and 1mm.

The lower the braking efficiency, the higher the temperature. The effectiveness is lowest at the highest temperature of 150 degrees Celsius with varied variations of the gap compared to temperatures of 30 and 90 degrees Celsius.

Variable temperature and gap both affect braking efficiency. The greater the temperature and the greater the brake pad separation, Changing the factory default brake pad gap setting is extremely harmful to the safety of the vehicle and the driver. It also has a high rate of highway accidents.

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