

Impact of Adjusting Brake Lining Gap and Brake Drum Temperature on Brake Efficiency of Motor Vehicles

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Abstract

In motor vehicle systems, brakes are one of the important components that have a major role in reducing the risk of accidents on the highway. In the brake system, especially drum brakes, improper component adjustment can cause the brakes not to work optimally. This research was conducted to determine the impact of large variations in the brake lining gap and brake drum temperature on brake efficiency in motorized vehicles. This study uses an experimental method with variations in the adjustment of the size of the brake lining gap and the temperature of the drum brake. The main brake efficiency was tested using a brake tester from these several variations. The variations of the brake lining gap used are 0.3 mm, 1 mm, and 1.7 mm. Meanwhile, the brake drum temperature is set at 30, 90, and 150 degrees Celsius. The result of this research is that the wider the brake lining gap, the smaller the brake efficiency. The greater the temperature on the drum brake also affects the smaller the efficiency of the brake. Meanwhile, the variable brake lining gap and temperature simultaneously (together) affect the level of brake efficiency. The larger gap between the lining and the temperature of the drum brake, the lower the efficiency of the brake obtained.

Keywords: *Adjustment; Brake Efficiency; Brake Lining Gap; Temperature*



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INTRODUCTION

Brakes are one of the components in motor vehicles that function to reduce speed in the presence of friction between the canvas and the drum so that the vehicle slows down (Dzikrullah, Qomaruddin, and Khabib, 2017). If the brake system cannot function optimally, it will cause danger and a high risk of accidents (Lapisa *et al.*, 2022)

Brake components that rub against each other must be made of materials that are not easy to wear, are heat resistant, and are not easily deformed at high temperatures (Sukandi, Prayoga, and Rasyid, 2020). With the higher ability of a vehicle to drive, the brake system's ability must be higher and more reliable in reducing speed or stopping speed.

Vehicle owners are crucial in ensuring the braking system can function optimally and efficiently. To reduce the risk of accidents while driving, regular maintenance needs to be carried out by the driver (Antara, 2018). The KNKT / National Transportation Safety Committee (NTSC) on Road Traffic and Transportation Accident Investigation Report 2021 reports an accident that occurred between a Trenton box truck and a dump truck on the Bawen-Semarang road, Central Java. In that case, one of the findings of the NTSC investigation was that on the 2nd (two) axis of the vehicle on the left and right wheels. A gap between the brake pad and the drum was found of 2.6 mm (KNKT, 2021), where the standard from manufacture is 0.4-0.5 mm. The large gap between the

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brake lining and the drum can result in little or no friction between the brake pad and the drum (brake force = 0). Therefore, proper brake gap adjustment is needed to avoid accidents, such as in the case on the Bawen-Semarang road.

Braking performance is also influenced by several factors, including frictional surface factors and compressive forces. Braking power in the drum brake system depends on the heat that occurs in the brake lining. 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. (Wagino, Bahri Pratama and Fernandez, 2016).

LITERATURE REVIEW

Research conducted by (Sugiharjo and Wilarso, 2021) using the fishbone analysis method concluded that a lack of grip on the brakes and insufficient air pressure caused the failure of the braking process. One of the causes of high air consumption is the discovery of brake lining gaps outside the manufacturer's standards. It is due to the wear of the brake lining on the drum, so it needs greater pressure when braking, resulting in large air consumption.

Braking efficiency is influenced by the high and low axle load and drum temperature. From the results of brake efficiency obtained with variations in wheel axle load and drum temperature as well as the speed of increase in drum temperature, it can be concluded that the use of original brake pads is better than artificial ones (Wijayanta *et al.*, 2019)

Another experimental study used three kinds of grooves on the brake lining: inclined grooves, unidirectional grooves, and opposite grooves. The results of research on drum brake linings found that the brake linings of the opposite wheel rotation were better than the unidirectional grooves and inclined grooves because, in the opposite grooves, the braking distance was reduced. The temperature of the drum brakes was lower than the standard one (Wagino, Bahri Pratama and Fernandez, 2016).

This research aims to determine the effect of adjusting the brake lining gap and the temperature variation of the brake drum temperature on the efficiency of the main brake on the 2nd axis of the vehicle by using a brake tester. In braking, use a pedal force so that the pedal gets the same force. The object of the research is to use a Mitsubishi L300 pickup.

Drum brakes on motorized vehicles consist of several components (Komarudin, Prasetya and Suryaman, 2021), including:

1. Backplate
This plate serves as a frame while protecting other drum brake components. This component is usually made of thin metal that is directly behind the drum brake system.
2. Wheel cylinder
This component serves to convert fluid pressure into mechanical motion. The piston pushed by hydraulic pressure will push the brake shoes out.
3. Brake shoes and lining
The brake shoe is a place to place the brake pads on the vehicle's drum brake system. The brake shoes are in the form of two semi-circles which, when combined, will form a circle
4. Return spring
Serves to restore the position of the brake shoes after the braking process takes place
5. Brake shoe adjuster
Its function is to adjust the distance between the drum brake lining and the surface of the drum when the brake pedal is not pressed.
6. Drum brakes
The brake drum is a component made of cast steel that is shaped like a drum or tube. This component is useful as a friction medium with the brake pads so that the wheels can stop spinning.

7. Parking brake lever

The parking brake lever is used for braking a motor vehicle when the vehicle is parked or stopped

8. Parking brake cable

This component connects the movement of the parking brake lever with the parking brake lever, whose position is located on the drum brake system.

In the normal braking process, contact with the leading shoe pressure is greater than with the trailing shoe. Contact pressure at both ends of both shoes is higher than the middle area. The friction plate contact pressure is greater on the side near the brake drum flange than on the side at the edge of the brake drum (Shahid *et al.*, 2018).

Adjusting the brake shoe gap too large will result in a force braking that occurs and will experience delays when the driver steps on the brake pedal. It is because the driver has to step on the brake pedal deeper. It will cause an increase in free play (free distance brake pedal). Meanwhile, if the adjustment of the brake shoe gap is too small, it will happen to brake on the wheels even though the driver has not stepped on the brake pedal (KNKT, 2021). So that the brake pads will become hot because they continue to touch with the brake drum so that heat arises, making the brake pads stick with the drum. When the temperature rises, it will result in a reduction in braking performance on the vehicle (Sugözü and Sugözü, 2021). Braking is a form of change in kinetic energy into heat energy reflected in an increase in temperature, both on the brake pads and the drum (Wagino, Bahri Pratama and Fernandez, 2016).

The drum brake system's braking power depends on the brake lining's heat. Braking quality will worsen (not gripping) if the brake pads receive excessive heat. When the brakes are used too often, if the pad material is not suitable for high temperatures, the coefficient of friction (braking force) will decrease (Wagino, Bahri Pratama and Fernandez, 2016). The friction coefficient on the brake will also increase along with the increase in the applied braking force (Ghazaly and Makrahy, 2014)

RESEARCH METHOD

This research was conducted using experimental research methods. The experiment intends to determine the independent variable's effect on the dependent variable. The independent variables are the brake lining gap and brake drum temperature. At the same time, the dependent variable is brake efficiency. This experimental research aims to analyze the impact of adjusting the brake lining gap and brake drum temperature on vehicle brake efficiency test results. The vehicle used in this study is a Mitsubishi L300 pickup, a freight car included in the mandatory test motor vehicle.

To measure the efficiency of the main brake, a brake tester is used in the UPUBKB of Denpasar Bali. The brake tester used is the Muller BEM brand, Bilanmatic 10000 type. An Autostop brand pedal force tool is used to get the same braking force, which has an accuracy rate of 0.5%. Meanwhile, an Infrared Thermal Gun is used to measure the temperature of the brake drum.

The data collection process carried out in this study using the experimental method was carried out by braking on the Brake tester with variations in brake lining gap adjustment and temperature on the drum brake that had been determined.

Data collection techniques carried out:

1. Prepare according to the research plan, and prepare the tools and materials used in the research.
2. Ensure that all tools and materials used in the study can function normally.
3. Adjust the drum brake lining gap according to the variations used in the research experiment, namely 0.3 mm, 1 mm, and 1.7 mm. Adjustment of the brake lining gap is made by removing the drum.

4. After the drum is released, measure the drum's inner diameter and the outer diameter of the brake lining to get the desired gap.
5. Subtract the drum's inside diameter from the outside diameter of the brake lining. It is to find the difference or gap between the lining and the drum.
6. On the left rear wheel, adjustments can be made by turning the gear up to increase the gap and down to reduce the gap. For the rear right, the opposite applies.
7. After adjusting the drum brake lining gap, the next step is to determine the temperature on the drum according to the predetermined variation.
8. Enter the 2nd axle of the vehicle on the roller speedometer tester, then run the vehicle at a speed of 20-40 Km/hour, simultaneously stepping on the brake pedal slowly until it reaches the temperature according to the specified variation, namely at temperatures of 30°C, 90°C, and 150°C.
9. After the variation has been determined, insert the 2nd axis of the vehicle into the roller brake tester. Then, test the efficiency of the main brake of the 2nd axis of the vehicle with the same pedal force of 200 N in each experiment using the pedal force tool when testing the brake tester and record the results of the brake efficiency test.
10. Experiment on each variation 4 (four) times to get accurate results and input the test results of the data collection table.

To obtain the data, this research uses direct observation and documentation on the dependent variable, namely braking efficiency, which is influenced by the independent variable, namely the variation of the brake lining gap adjustment and the predetermined brake drum temperature. Measurements were carried out four times to obtain data variations with the experimental research subject formula using the Federer formula (Putri Andini Rahmah, Bahar and Harjono, 2017)

$$\begin{aligned} (t-1)(n-1) &> 15 \\ (9-1)(n-1) &> 15 \\ 8n-8 &> 15 \\ 8n &> 23 \\ n &> 3 \dots\dots\dots(1) \end{aligned}$$

Note:

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

So, sampling is 4 times. Based on the research data above, several tests can be carried out, namely:

1. The t-test was conducted to determine whether a partial impact was obtained from the independent variables (X1, X2) individually on the dependent variable (Y).
If the significance value is < 0.05 or the t arithmetic > t table, then there is an effect of variable X on variable Y. If the significance value > 0.05 or t arithmetic < t table, then there is no effect of variable X on variable Y.
2. The F-test was conducted to determine the simultaneous impact given by the independent variables (X1 and X2) on the dependent variable (Y). If the significance value is < 0.05 or F arithmetic > F table, then there is a simultaneous effect of variable X on variable Y. If the significance value is > 0.05 or F count < F table then there is no simultaneous effect of variable X on variable Y.

FINDINGS AND DISCUSSION

This research was conducted directly, namely testing using a Brake Tester on a Mitsubishi L300 vehicle with variations in the adjustment of the brake lining gap and the temperature on the drum brakes. Using the pedal force ensures that all the forces used are the same, 200 Newtons.

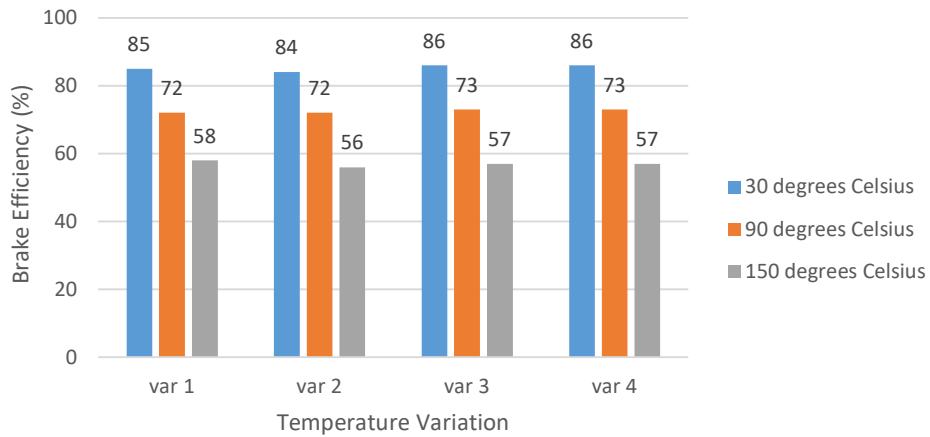


Figure 1. Experimental Results on Brake Lining Gap 0.3 mm

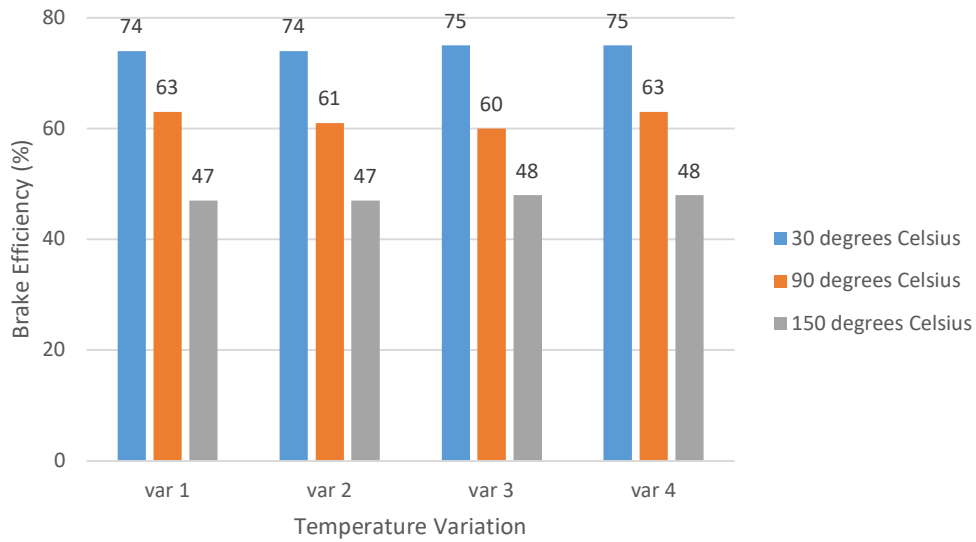


Figure 2. Experimental Results on Brake Lining Gap 1 mm

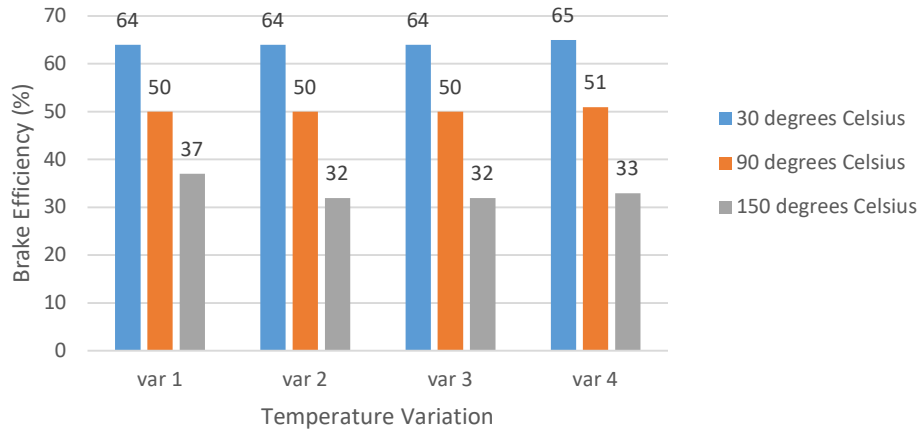


Figure 3. Experimental Results on Brake Lining Gap 1.7 mm

Figure 1 above illustrates the brake efficiency test at 0.3 mm brake lining gap, where in four data collection times with temperature variations of 30^o C, 90^o C, and 150^o C, the average brake efficiency results were 85.25%, 72.5%, and 57%. Meanwhile, based on Figure 2, the results of the brake efficiency test on the brake lining gap of 1 mm, wherein four data collection times with temperature variations of 30^o C, 90^o C, and 150^o C, the average brake efficiency was 74.5%, 61.75%, and 47.5%. The average result of brake efficiency is shown to be decreasing in Figure 3. When the brake drum temperature rises from 30^o C, 90^o C, and 150^o C, the brake efficiency decreases by 64.25%, 50.25%, and 33.5%.

The t-test between X1 (brake lining gap) and Y (Brake efficiency) shows the t arithmetic is -39.081, while the t-table value is 2.035. Because the t arithmetic is greater than the t table, it can be concluded that X1 (brake lining gap) hurts the brake efficiency level. It means that the larger the independent variable (brake lining gap), the smaller the dependent variable (brake efficiency). The large gap between the brake lining and the drum causes little or no friction between the pads and the drum (KNKT, 2021). The t-test between X2 (Temperature) and Y (Brake Efficiency) shows the t-count is -50.351, while the t-table value is 2.035. Because t arithmetic is greater than the t table, it can be concluded that X1 (temperature) harms the level of brake efficiency. It can be interpreted that the higher the temperature, the smaller the brake efficiency results. The higher temperature during braking will affect the friction between the pads and the drum, making the brake less efficient in its use (Wagino, Bahri Pratama and Fernandez, 2016).

The result of the F-test calculation based on the significance value is 0.000. It means that the significance value is less than 0.05, so it can be concluded that the independent variables, namely gap and temperature, simultaneously (together) affect the dependent variable, namely the level of brake efficiency. Simultaneous test decision-making (F test) is based on calculated F values and the F table. The calculated F value is 2031.257, while the F table is 3.32. After knowing the calculated F value is greater than the table F value, it can be concluded that the independent variables, namely gap and temperature, simultaneously (together) affect the dependent variable, namely brake efficiency.

The results of this study indicate that it is not only the temperature of the drum that causes the brake efficiency to decrease, but it turns out that the adjustment of the brake lining gap also has a major effect on braking. It is an essential new thing and needs to be known by drivers and vehicle

technicians so that they are not careless in adjusting the brake lining gap. When adjustment is made, it must follow the standards recommended by the manufacturer.

CONCLUSION

From the series of experiments that have been carried out, the results can be concluded as follows

1. The larger the brake lining gap (independent variable), the smaller the brake efficiency (dependent variable) obtained. It is seen in the experiment with a gap of 1.7 mm, the brake efficiency obtained is the smallest compared to the experiment with a gap width of 0.3 mm and 1 mm.
2. The higher the temperature, the lower the brake efficiency. At the highest temperature of 150 degrees Celsius with various variations of the gap, it can be seen that the efficiency is the smallest compared to temperatures of 30 and 90 degrees Celsius.
3. Temperature and gap variables simultaneously (together) affect the brake efficiency level. The higher the temperature and the wider the brake lining gap, the lower the braking efficiency obtained.
4. Changing the factory default brake pad gap setting is very dangerous for the safety of the vehicle and the driver. It also has a high risk of accidents on the highway.

LIMITATION & FURTHER RESEARCH

Further research needs to be done using other methods, including the road test method. It is recommended to carry out the adjustment at an authorized workshop. It is to maintain compliance with the standards recommended by the manufacturer.

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