Journal of Information Engineering and Applications
ISSN 2224-5782 (print) ISSN 2225-0506 (online)
Vol.13, No.1, 2023

Compressor Air Pressure and Brake Shield Distance to Braking Speed in Antilock Braking System Brakes

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Abstract
The development of automotive technology to date is very fast. In the city, it is almost rare to find conventional cars. Most are already using modern technology. The hallmark of modern cars is that they are not fully mechanical. Already combined with several electric and pneumatic tools. Until now the development in the field of chassis is endless. Its initial development began with the discovery of ABS (Anti Lock Brake System) brakes. Basically, ABS is followed by supporting components such as EBD, ESP, and so on.All of this is actually inseparable from the main function of braking. Namely so that the car can run well / smoothly, deceleration and stop as desired appropriately. The parts of the brakes that are most influential are the brake shoes and discs and the compressed air from the brakes. Also the most influential accuracy is the distance of the brake shroud. Therefore, in this study the aims of 1. To find the effect of pressure and brake shroud distance. 2. What is the minimum air pressure and brake shroud for the brakes to work properly (grip). This research uses experimental design method. The data is processed with the Minitab program. Data processing shows that: 1. The braking speed is influenced by the amount of compressed air pressure. Partially the distance of the brake shroud does not affect the braking speed. But the interaction of pressure and shroud distance has an effect on braking speed. 2. Air pressure that can be used as a fast ABS braking process is 3.75 – 4.25 (bar) with a shroud distance of 5 (mm)
Keywords: Car Brake, Antilock Brake System, Brake Air Pressure, Brake shroud.
DOI: 10.7176/JIEA/13-1-04
Publication date: February 28th 2023

1. Introduction

Technological advances in the automotive sector to date are very fast. As if the innovation and renewal will not stop. Both in the engine, chassis and body and power transfer. Especially in the accessories section. Apart from being a human need in the transportation sector, automotive is also a commodity in the automotive industry. Not only producing conventional vehicles but there are modern and even super sophisticated vehicles. The proof is that there are vehicles that were programmed before being used according to human will. When it stops, it stops by itself. When you have to walk, it will run by itself. In addition to being able to walk and stop by itself, the vehicle/car can also choose a flat/good and safe road. Withstand when the road is slippery and even watery.

Therefore, a vehicle like this does not only develop the engine but also the chassis and body. In the field of chassis and body things that play an important role in this case are the brake system and steering system. Brakes can work well, definitely supported by the components and setting the right and careful tools. The brakes developed so far are based on ABS (Anti Break System). These brakes can be programmed from scratch so that the user is left to operate. This is the modern class. While the super-sophisticated before the operation we program first and will run by itself. One of the important brake components in this case is the brake lining, disc, brake shroud, as well as braking power. For that we will conduct research on ABS (pneumatic) brakes on the car. That is the distance between the brake shroud and the brake power (compressor). What is the distance of the casing that can operate properly and grip. As well as providing air power with minimal pressure. As well as research conducted by: Deajeng Prameswari, and Yohanes, in 2019, and published in the ITS Engineering journal stating that the performance analysis is carried out by calculating the minimum braking distance and comparing it with roadworthy standards, and calculating the proportion of braking force (Kbf and Kbr) to determine the stability of the vehicle direction (understeer, oversteer). Braking performance was analyzed with variations in speed (20, 40 and 80 km/hour) and loads (600, 800, and 1000 kg). From the results of the study, it is known that the distribution of braking according to the ability of the system is Kbf = 0.82 and Kbr = 0.18. . The value of the front brake force is 5. 181.34 N while the rear brake force is 1. 100.58 N. In an empty vehicle with the value of the braking force generated by the system, the vehicle tends to be understeer. However, with the addition of load, the tendency of the vehicle to turn into understeer. For the braking system on this rural car from a speed of 20 km / h to 40 km / h the braking distance is increased by 300 percent.

The research conducted by Rohmad Setiyono with the title Analysis of Braking Forces on Mini Truck National Cars, in 2015, resulted in the conclusion that the Mini Truck National Car is a vehicle with a speed of 80km/hour with a braking distance of 5 meters, the time required is 0.45 seconds, giving the vehicle deceleration is 49,284 m/s. And produce the brake lever force from the left brake cylinder is 2378.35 N. and the brake lever force from the right brake cylinder is 1818.74 N. Here also calculate the pedal force against the oil pressure when the brake pedal is loaded with 5kgf then the oil pressure is 14.93 kg/cm2.

Several methods have been used to reduce discomfort in driving a vehicle. Both in a state of deceleration or stopping the vehicle speed. It is mostly from this braking process that accidents occur. For this reason, this time the author takes the title of the study: Analysis of the effect of compressor air pressure and the distance of the brake lining on the braking speed of the vehicle.

2. Literature Review

The brakes are designed to reduce speed [slow down] and stop the vehicle or allow parking on an incline. This equipment is very important in vehicles and serves as a safety device and ensures safe driving.

Today, according to automotive experts, brakes are a very important requirement for vehicle safety and can also stop at any place, and in various conditions can function properly and safely.

2.1 Work mechanism

master cylinder

The master cylinder converts the motion of the brakes into hydraulic pressure. The master cylinder consists of a link reservoir, which contains brake fluid, as well as a piston, and a cylinder, which generates hydraulic pressure. There are two types of cylinders: single type and double type [bunch] master cylinder double type (bunch type master cylinder) is more widely used than single type [single type].

In the cluster master cylinder, the hydraulic system is separated into two, one each for the front and rear wheels. Thus, if one system does not work, the other system will function properly so that braking can still take place.

Brake Boster (bralew Broster)

The holding force on the brake pedal from a driver is not strong enough to stop the vehicle immediately. The [Brake Booster] booster doubles the braking force of the brake pedal, so that greater braking power can be obtained. The brake booster can be installed together with the master cylinder (integrated type) or it can be installed separately from the master cylinder itself. The integral type is widely used in passenger vehicles and small trucks.

The brake booster has a diaphragm that operates by the difference in pressure between atmospheric pressure and the vacuum generated from the engine intake manifold. The master cylinder is connected to the brake pedal and diaphragm to obtain high braking power from minimum pedal stroke.

If the brake booster does not work for one reason or another, the booster is designed in such a way that only the booster power is lost. By itself the brakes will require a greater pedal force, but the vehicle can brake normally without the help of a booster. For vehicles driven by diesel engines, the brake booster is replaced with a vacuum pump because the vacuum that occurs in the manifold on the diesel engine is not strong enough. The brake booster is mainly composed of the booster housing, piston, diaphragm, reaction mechanism and control valve mechanism. Boster body is divided into front and rear and each space is limited by a membrane and piston booster.

The control valve mechanism regulates the pressure in the variation pressure chamber. Including air valves, vacuum valves, control valves and so on which are connected to the brake pedal via the valve actuator stem.

2.2 Brake Chamber

The brake chamber converts the compressed air back into the mechanical force needed to stop the vehicle. A simple service brake chamber consists of a two-part housing in which the diaphragm, pushrod and retraction springs. The two parts of the sleeve are clamped together so that the diaphragm forms an airtight seal. The push rod is connected to the foundation brake using a slack adjuster.

When compressed air acts on a flexible rubber diaphragm, a force is applied to the push rod plate. The amount of linear force is proportional to the amount of air set by the operator using the service brake application valve. Figure 1-25 shows the principle behind actuation of the foundation brake by a single chamber actuator. The springs in this assembly are relatively light and serve only to restore (retract) the pressure plate after brake application.

The amount of linear force exerted by the brake chamber can be calculated by knowing the cross-sectional area of the diaphragm and the amount of air pressure applied to it . The common size of the diaphragm is 30 square inches. If a 100-psi service application is applied to a 30 square inch brake chamber, the developed linear force can be calculated as follows:

1) Spring Brake Operation

All spring brakes have a way of being a mechanical cage. Locking the spring brake compresses the main spring. Spring brakes must be mechanically locked before being removed or replaced. Most spring brakes are sold with cage bolt assemblies. Caging of a spring brake consists of inserting a cage bolt into a slot in the internal cage plate, turning the bolt, and then compressing the spring using a cage nut and a washer. Locked spring brakes are to be considered armed and dangerous.

Spring brake operation summary follows:

There is no air pressure in the hold or service circuit: the brakes are applied mechanically by the full force of the main spring in the spring brake assembly. This condition is used to "park" the brake mechanically or to apply emergency braking in the event of a total air loss.

Air pressure in hold circuit, not in service room: parking brake is released and vehicle is capable of being moved. In order to release the parking brake and move the vehicle, air pressure greater than 60 psi must be in the spring brake retaining chamber.

Air pressure in hold circuit, service application pressure in service room: service brake is applied to the value of service brake application pressure. This condition exists whenever the vehicle is moving and the service brake is applied.

No air in hold circuit, service application pressure in service room: braking is compounded by springs and air pressure is applied to the foundation brake assembly simultaneously. Brake application pressure compound can damage foundation brake components. Most systems have an anti-compounding valve to prevent this condition.

Spring brakes are mechanically locked with cage bolts, nuts, and washer assemblies, often bolted to the sides of the spring brake assemblies.

3. Research Methodes

This study aims to obtain the minimum air pressure on the ABS brakes and the distance of the ABS brake lining on the braking speed of the vehicle. The brakes used in this study were disc brakes and were pressurized. Factors other than the above were conditioned the same for each sample. The sample/specimen in this study used a tank filled with compressed air and a disc brake with a slightly spaced installation.

The test is carried out by providing a load on the simulator construction. Data were recorded and collected on data sheets prepared with three factors.

This research was conducted at the Mechanical Engineering Workshop of the State Polytechnic of Malang specializing in automotive. The research time is 60 (days) starting. The sample that we used was 40 (forty) pieces which were well selected. The selected variable is

1. The independent variable is that there are two factors: the distance of the brake lining and the brake air pressure.
2.Level factor distance of the lining of the brake lining 4 mm, 5 mm and 6 mm.
3. Brake air pressure factor level 3 bar, 4 bar and 5 bar.
4. The dependent variable is the stopping accuracy.

3.1 Research Result Data

Table 4.1 Braking time (seconds)

Braking air pressure (bar)	Padding cover distance (mm)		
	4	5	6
3	1,60 2,45 1,64	1,56 1,60 1,62	2,35 1,90 1,65
4	1,70 1,60 1,45	1,88 1,75 1,70	2,00 2,75 1,66
5	1,90 1,85 1,70	1,95 1,95 1,85	2,45 2,50 2,00

4. Reaults and Discussion

Analysis using minitab software used is analysis of variance (ANOVA). This analysis is to check whether there is an effect between variables. From the minitab output, the anova table is generated as follows:

Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Model	8	1,6355	0,20443	2,70	0,038
Linear	4	1,0354	0,25886	3,42	0,030
Air Pressure	2	0,6022	0,30108	3,98	0,037
Sheath distance	2	0,4333	0,21663	2,86	0,083
2-Way Interactions	4	0,6000	0,15001	1,98	0,140
Air Pressure*Dist	4	0,6000	0,15001	1,98	0,140
Error	18	1,3613	0,07563		
Total	26	2,9968			

From the table results show that the F value of Air Pressure to Braking Time is 3.98

Meanwhile, from table F with degrees of freedom 2 of 3.37. So it can be said that the null hypothesis (Ho) is rejected. While Hypothesis a (Ha) is accepted. Consequently, there is an influence between air pressure on braking time. Similarly, a review of the distance between the covers from the table shows that the distance between the lining of the lining and the braking time has a small effect, and it can also be seen from the ANOVA table above that the P value of 0.089 means that it has an effect on the error value of 10%.

Compressed air is the main factor a pneumatic brake can operate properly or fail. When the air pressure is high, the brakes work quickly, the braking speed is determined by the air pressure in the compressor tube. It turned out that the distance of the lining of the lining did not significantly affect the brake performance. The distance that can be adjusted is the maximum distance of the carry cylinder or rotochamber. This is shown by the table of model summary results as follows.

Model Summary

S	R-sq	R-sq(adj)	R-sq(pred)
0,275008	54,57%	34,38%	0,00%

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S	R-sq	R-sq(adj)	R-sq(pred)
0,275008	54,57%	34,38%	0,00%

From the model above, it can be said that the support between the variable air pressure and the distance of the shroud to the braking speed is 54.57%. the remaining 100% of 45.43% is for the support of other variables on the braking speed of the Anti Lock Breaking System. Another influential factor is the material of the brake lining or discbreak or the cross-sectional area of the rotochamber. It could also be the stiffness of the spring in the rotochamber.

To show the accuracy of the influential value, it can be done by checking with a graph plot for braking speed.

Check with Plot chart. Produced as in the following image:

To check each factor.

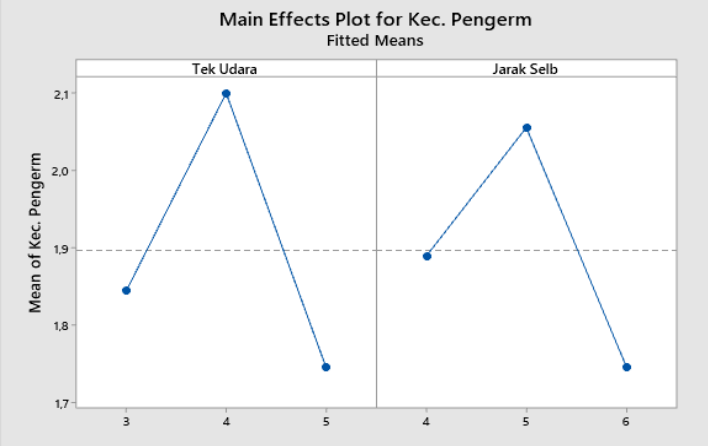

Figure 4.1 Plot Graph

From the figure shows that the distance of the 5 mm lining is the same as if the air pressure is 3.75 (bar) or 4.25 (bar). So it can be said that the maximum adjustment distance of 5 mm is the same as air pressure between 3.75 - 4.25 (bar) which results in fast braking time. Shows that air pressure is maintained at a pressure between 3.5 - 4.5 (bar) is good. Do not let the air pressure is brought or above that pressure.

Tentative conclusions.

That with a significance value of 0.5% indicates that the air pressure in the primary brake tube has a significant effect on the braking speed of the Anti Lock Breaking System. But for the shroud distance, the effect is not so significant as seen from the significance value which is still above 0.5% but below 10%. After looking at the interaction, it turns out that the effect is still small. This shroud distance can also be caused by the two surfaces of the braking device material which have a small coefficient of friction so that fast braking does not occur spontaneously. In this case it can be said as follows:

1. There is a significant effect between the amount of air pressure and braking time on ABS brakes.
2. The minimum air pressure for fast braking is 3.75 – 4.25 (bar).
3. Distance of the brake lining to prevent slipping is 5 (mm)

6. Conclusion

From the results of data collection and data analysis with the help of minitab software, the following conclusions are obtained:

1. Compressed air pressure in the pneumatic braking system greatly affects the speed of braking / stopping the vehicle on the Anti-Lock Braking System brakes. This brake system is different from conventional brakes. Because the system does not work gripping throughout the process. So a little bit of air intake can occur braking. What needs to be considered is the availability of sufficient pressure. Because this brake is assisted by the chamber. The function of the chamber itself is to change the pressure into a straight motion. In which there is a spring.
2. To provide the minimum air pressure for braking to occur is 3.75 (bar). This pressure is also not necessarily a pressure value that can bend braking quickly. Because in this research, the minimum pressure value for braking speed is 3.75 to 4.25 (bar).
3. Partially for the distance of the brake shroud does not affect the braking speed. But simultaneously/interaction with air pressure has an effect, although not too significant. That is equal to 54.57% only.

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