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Design of ALB Tester for Heavy Vehicle Brake Systems

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Abstract

The brake system is used to keep the speed of the moving vehicle constant, slow down, stop it and fix it while parked. Heavy vehicles often have an air assisted hydraulic brake system. In our country, all parts used in the braking system of passenger and cargo vehicles traveling in road traffic should be produced in accordance with the "Type Approval Regulation (71/320/AT) [1] on the Braking Arrangements of Certain Motor Vehicle Classes and Trailers" and they should be used and their inspection tests should be carried out in legal periods by authorized inspection institutions. In the brake systems of heavy vehicles such as Trucks, Trailers, Trailers, Semi-Trailers, Buses, load adjusting valves called ALB are used, which increase or decrease the rear brake forces of the vehicle according to the load of the vehicle. ALB can be used mechanically or pneumatically in heavy vehicles. In this study, a test device was designed by using the microcontroller card, pressure sensor, LCD screen in order to make the test alone, without performing help, and to increase the reliability of the test, by the operator performing the pneumatic ALB test. As a result of the study, it is provided that the operator can perform the Pneumatic ALB test alone, increase reliability, and save time and labor.

Keywords: ALB Test, Load sensing valve, Air assisted hydraulic brake system

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1. Introduction

With the developing technology, besides comfort in vehicles; speed and also the load capacity in heavy and commercial vehicles is constantly increasing, which raises the need to develop effective, powerful braking systems. Vehicle brakes have a direct impact on road safety in order to control the speed of the vehicle in motion and to ensure an effective stopping [2].

One of the most important elements in terms of life and property safety in motor vehicles is the braking performance of the vehicle. The main factors affecting braking performance are vehicle weight, the structure of the braking system, braking effectiveness of the front-rear wheels, the design of the braking system, the condition of the brake hydraulic and mechanical parts, the environmental conditions that may affect the braking system, the condition of the tires, the load on the vehicle, road conditions, braking settings, the wheel - is the coefficient of friction and adhesion between the road [3]. However, there are still many problems in the vehicle stability and the braking performance [4]. Load sensing brake proportioning is a means of optimizing the ratio of front-to-rear wheel retarding forces for the full range of vehicle loadings and decelerations [5]. We can group brake systems used in vehicles under four headings, namely mechanical brakes, hydraulic brakes, pneumatic brakes and electric brakes [6]. Commercial vehicles such as trucks and buses are equipped with an air brake system that uses compressed air as the energy-transmitting medium.[7] Pneumatic brake systems are used in heavy vehicles due to insufficient power provided in the hydraulic brake system. Compressed air obtained from the compressor in the pneumatic brake system is sent to the wheel at the desired pressure according to the load and road condition of the vehicle. As there are a variety of uncertainty contained in dynamic systems [8], One of the systems that we control the air to be sent to the wheels is the Automatic

Loading of Brake Valve (ALB) system. The load-sensing valve system can improve braking performance and stability of vehicles[9].

All parts used in the brake system must be produced in accordance with the "Type Approval Regulation (71/320 / AT) on Braking Arrangements of Certain Motor Vehicle Classes and Trailers" and they should be used and their inspection tests should be carried out in legal periods by authorized inspection institutions [1]. Regarding the passenger and freight vehicles traveling in highways traffic in our country; In the 35th article of the Highway Traffic Law No. 2918 and the 35th article of the Highway Traffic Regulations, there is the provision “To make or have the vehicles inspected by registration, to inspect the inspection stations” [10]. With the publication of the regulation on opening and operating vehicle inspection stations, there are 210 stationary, 74 mobile, 5 motorcycle and 13 mobile tractor inspection stations operating under the control of the Ministry of Transport and Infrastructure as of 01-01-2005. These stations are inspected by vehicles in our country in legal periods in ISO 17020 standards. In the Official Gazette No. 26735 dated 19 December 2007, a list of the parts to be tested is published in the "Regulation on opening, operating and vehicle inspection of vehicle inspection stations". As a legal requirement, tests such as brake test, leak test, four-way control valve test, ALB test (Mechanical or Pneumatic), Yellow and Red coupling breakout tests, check valve test are carried out in periodic inspections of heavy vehicles with air braking system.

Pneumatic ALB is shown in Figure 1. Vehicles with air suspension are equipped with Pneumatic ALB.

The air pressure in the pneumatic suspension bellows increases or decreases parallel to the weight of the vehicle. It enables the pneumatic ALB to detect whether the vehicle is loaded or unloaded, the vehicle's load status by the suspension bellows pressure from the suspension bellows. In other words, thanks to the suspension pressure it receives from the suspension bellows, pneumatic ALB detects the load condition of the vehicle and adjusts the brake pressure sent to the rear axles of the vehicle accordingly. When there is an error in the air suspension system, it takes the automatic semi-load position 11].

Fig. 1. Pneumatic ALB

In the vehicles they produce with ALB, the manufacturer companies stick the labels called ALB labels on the vehicle in order to perform ALB's working tests. An example of the ALB label can be seen in Figure 2. Authorized inspection institutions and private service organizations can determine whether ALB is working properly at factory values through these labels. The pressure values of the suspension bellows according to the rear axle weight, front axle brake pressure, rear axle brake pressure, rear axle load are on the label.

In Figure 1, there is a test control tip on the marked back of the ALB valve. The task of this control tip is to ensure that the suspension bellows pressure can be simulated for testing purposes. A hose connected to a compressed air source, for example the compressor line, with an adjustable manometer at the end, is connected to the ALB valve test lead, detecting the amount of pressure sent from the set manometer as the suspension bellows pressure of the ALB valve and delivering as much pressure as the manufacturer has determined.

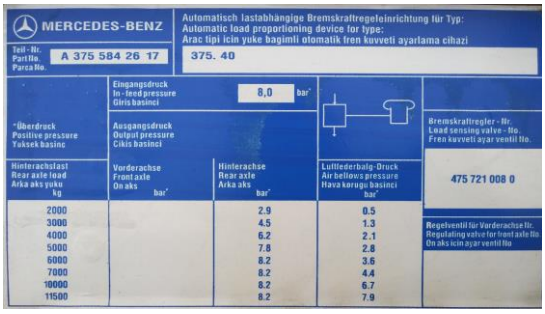

Fig. 2. Pneumatic ALB tag

For ALB test; One manometer connection is made to the front and rear axles of the vehicle.

A compressed air connection coming from the compressor line is connected to the ALB test control terminal and an adjustable pressure gauge is connected between them. Pressure is sent from the pressure gauge adjusted to the suspension bellows pressure on the ALB label to the ALB test tip. On the ALB label, force is applied to the brake pedal as much as the front axle pressure value. It is checked whether the value on the manometer connected to the rear axle is the same as the rear axle value on the label.

For example, for the 2 ton load in the label in Figure 2; Suspension bellows pressure 0.3 bar, front axle brake pressure (Pressure to be applied to brake pedal) 6 bar, the rear axle brake pressure is 1.5 bar.

According to the ALB label, to simulate a load of 2000 kg, a test pressure of 0.3 bar should be sent to the ALB test lead, and a pressure of 6 bar should be applied to the brake pedal (to be followed by the pressure gauge connected to the front axle) and a value of 1.5 bar should be taken from the rear axle. (To be followed from the manometer connected to the rear axle). In Table 1, while the simulation pressure is given

to the ALB test tip by an adjustable manometer, it is performed by an operator; By applying pressure to the brake pedal of the vehicle, the other operator must follow the front axle and rear axle pressure.

The fact that the technician performing the ALB test applies the simulation pressure with the help of another technician both reduces the reliability of the test and causes loss of labor due to the test being done with two people. With this study, it is aimed to perform the test with two people with a single technician and to earn from the workforce. And in order to increase the reliability of the test, it is aimed to develop a test device.

2. Method

2. 1. Design Of Pneumatic ALB Test Device

The study will be in the form of test device design. Digital pressure gauge, consisting of one pressure sensor, one microcontroller card and one LCD screen, is designed for the vehicle's front axle and rear axle connection. In order to send the desired pressure to the ALB test lead; Adjustable manometer is designed by using stepper motor, pressure sensor, button, gear mechanism, microcontroller card, pressure regulator and microcontroller card. In Figure 3, the compressed air coming from the compressor line is connected to the ALB test inlet from the pressure adjustment unit. With three pressure sensors on the pressure adjustment unit, ALB test pressure, front axle pressure value and arc axle pressure value can be determined and pressure values can be seen from three LCDs on the pressure control unit. ALB test pressure can also be adjusted according to the values specified on the ALB label by the manufacturer with the help of the buttons on the pressure control unit.

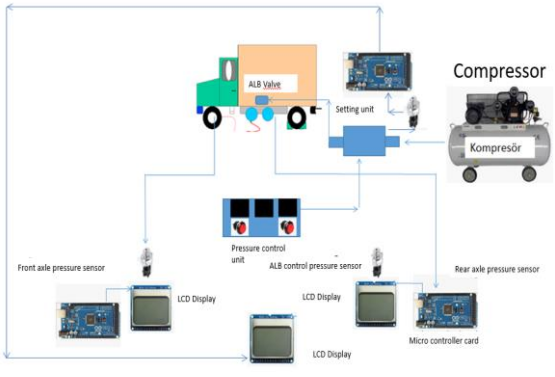

Fig. 3. Tester connection diagram

2.2 Design Of Tester

The test device consists of two parts, "Pressure adjustment unit" and "Pressure control unit".

The pressure adjustment unit is designed to simulate the ALB test pressure and to adjust the pressure from the compressor line to the desired value. As a central controller, we used an Arduino microcontroller that communicates with an Android application, our user interface [12].In order to adjust the high pressure (about 8 bar) coming from the compressor line according to the test pressure specified on the ALB label, a pressure regulator, consisting of a pressure regulator, a pressure sensor, a stepper motor, two helical gears, a micro controller card and controlled by two buttons, has been manufactured. The device prepared in Figure 4 is measured with the pressure of the pressure regulator controlled by the stepper motor and a pressure sensor, and this device is converted into digital data with the microcontroller card it is connected to and printed on the LCD screen in bars. Thus, how many bars test pressure is to be simulated, the step motor is controlled with the help of buttons, and the pressure regulator can be adjusted with the help of gears.

Fig. 4. Stepper motor pressure sensor connection for simulation pressure

There are also two pressure sensors on the pressure adjustment unit to detect the front and rear axle pressures of the test vehicle. The front and rear axle of the vehicle to be tested and the pressure adjustment unit are connected to each other with air hoses. Pressure sensors convert the sensed pressure into numerical data by means of microcontroller card and pressure sensors print in LCD screens to which they are connected.

There are 2 buttons for the operator to adjust the test simulation pressure on the pressure control unit and there are also 3 LCD screens in total so that it can see the simulated test pressure, the front axle pressure of the vehicle and the rear axle pressure of the vehicle. While the operator provides the pressure control he needs during the test with this unit, he can also monitor the front axle and rear axle pressure of the vehicle.

As shown in Figure 5, a digital gauge manometer design consisting of microcontroller card, pressure sensor, button and LCD screen was designed to connect the vehicle to the front axle and rear axle test leads and to observe the pressure

values there. This designed part will be used as a pressure control unit where front, rear and axle pressures can be viewed and controlled simultaneously. The implementation of the system has been done using an Arduino microcontroller.[13].

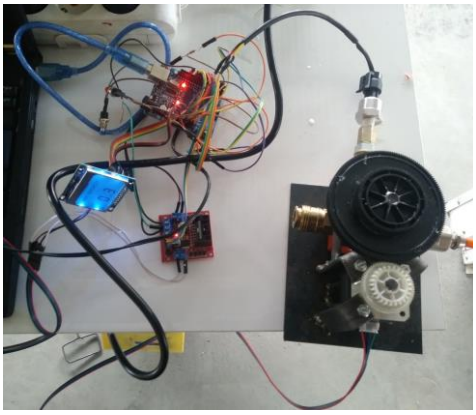

Fig. 5. Sensor LCD and Microcontroller Card Connection

2.3 Using the Tester

The compressor inlet, front axle air inlet and rear axle air inlet jacks are located on the pressure adjustment unit. Pressure adjustment unit and pressure control unit are followed by using multiple cables and front axle, rear axle and adjusted pressure gauge pressure values are monitored on LCD screens on the control unit. Again, the set pressure gauge value is controlled by two buttons on the control unit. The compressed air coming from the compressor line is connected to the pressure adjustment unit inlet.

The pressure adjustment unit is also connected to the ALB control port at the outlet end. The pressure adjustment unit is accessed with air hoses from the front axle and rear axle test leads. The operator detects the vehicle's ALB label and notes the pressure values that it will simulate on that label, notes the pressure it will apply to the front axle of the vehicle and notes the pressure values that must be taken from the rear axle.

In Figure 6, the compressed air coming from the compressor line, the front axle of the vehicle and the rear axle of the vehicle are connected to the pressure adjustment unit. The technician gets into the vehicle with the control unit and stops the vehicle after it has completely filled the vehicle's air tanks by starting the vehicle.

The control unit applies the simulation pressure on the label to the vehicle's ALB control tip using the buttons on it and monitors the pressure it applies on the LCD screen on the control unit. It applies force to the brake pedal as much as the front axle pressure stated on the label and monitors the pressure it applies on the LCD screen on the control unit.

When the simulation pressure applies the front axle pressure values, it shows the rear axle pressure on the control unit. It is checked whether the pressure value indicated on the label and the required pressure value is obtained from the LCD screen. The test is completed by performing these operations in three steps as empty, semi-loaded and fully loaded positions on the label.

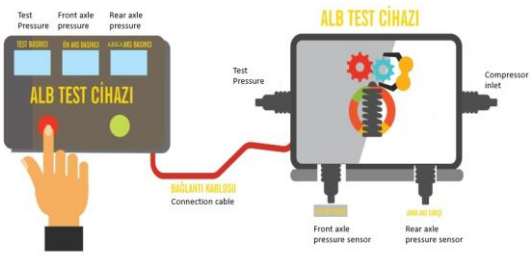

Fig. 6. Tester view

3. Discussion

ALB testing is possible when one operator puts pressure on the ALB test inlet end with an adjustable manometer and another operator controls the front and rear pressure values by applying force to the brake pedal.

As a result of this study, a test device was developed for Pneumatic ALB test. The test device consists of two parts. The first part is the unit where the simulation pressure to be applied to the ALB test lead can be controlled. The second part is the unit consisting of LCD screens where the front axle, rear axle and ALB simulation pressure of the test vehicle can be seen at the same time and two buttons where the ALB simulation pressure can be adjusted. The test results with the device are shown in Table 1. The operator has adjusted the test pressure he wants to apply with the help of the buttons on the hand unit to 0.7 bar. By applying the brake of the vehicle, he applied 6 Bar pressure from the front axle pressure indicator (LCD screen) on the hand unit. He observed the pressure of the rear axle (from the LCD screen) and found that the rear axle pressure was 1.8 Bar. He compared the values he obtained with the vehicle manufacturer's ALB label and concluded that the test was successful. The results were completed by doing these operations for 1.2 bar and 5.1 bar.

With the developed device, the operator made the test operation alone, without any help. The operator can perform these operations without ever leaving the vehicle, thus eliminating non-ergonomic movements in terms of employee health. The operator's ability to adjust the test pressure on his own increased the reliability of the test.

The test was carried out on the vehicle belonging to the Alb label, which is given in Figure 2, with the developed device and the data in Table 1 were obtained.

Table 1. Designed tester according to the following ALB label

Front axle pressure	Rear axle pressure	Test Pressure
6,0	1,8	0,7
6,0	2,2	1,2
6,0	5,3	5,1

4. Conclusions

In this study, a test device was developed for the test of Pneumatic ALB (Load sensing valve) valve used in air braking systems of heavy vehicles.

As a result of the work done, after the necessary connections of the vehicle tested by the operator were made, the operator allowed the vehicle to perform the test on its own without ever leaving the driver's place. The time spent by the two operators during the test has been halved by the fact that the test can be done with one person, and time and workforce have been gained. Due to its sensitivity to external factors such as falling, crashing etc., measurement errors that may occur in analog manometers are minimized by the use of pressure sensors and more reliable results are obtained.

In our country, the periodic inspection of thousands of vehicles are carried out continuously. The repairing and checking process of the defected ALB valves detected at the process of inspection can be performed at both by private and authorized services. It is considered that the use of an ALB test equipment in the inspection companies, and in the private and authorized services could make the significant contributions to the economy of our country.

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Nomenclature

ALB : Load sensing valve [14]

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