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INFLUENCE OF THE FRONT AXLE BRAKE TYPE ON THE VEHICLE'S BRAKING PARAMETERS IN AN ABS EQUIPPED VEHICLE

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Abstract:- *Efficient heath removal from the friction surfaces of the brakes is one of the most important requirements necessary for a vehicle in order to achieve satisfactory braking performances. The above mentioned requirement led to the application of the vented disc brakes. The aim of this paper is to compare the braking parameters of the vehicles when solid disc brakes or vented disc brakes are mounted onto the front axel. For this purpose, the experimental research was conducted using an ABS equipped vehicle.*

Key words: *disc, vented disc, ABS*

INTRODUCTION

Friction brakes operate by converting the vehicle's kinetic and potential energy into thermal energy (heat). The rate of heat generation in a friction braking system is a function of the vehicles mass, velocity, and rate of deceleration. During braking, a large amount of heat can be created and has to be absorbed by brake components in a very short space of time. The absorbed heat must be effectively dissipated in order to achieve satisfactory performance of the braking system. If this heat is not dissipated effectively, the temperatures in the brake and surrounding components become too high, according to [9] high temperatures are responsible for most problems in vehicle braking systems.

Friction coefficient between the braking pads and the disc was calculated according to the results of the experimental research and is described by the expression [3,4,5] that shows the immense influence of the temperature:

$$\mu_p = 0.512\, pp^{-0.047} v^{0.012} \theta^{-0.046} \qquad (1)$$

where:

1. *pp* – pressure given in bars measured in the front braking ring/circle [bar]
2. v – speed of the vehicle [km/h]
3. θ - temperature [^{o}C].

The need for increased cooling of disc brakes led to the development of vented rotor discs, anyhow the advantages of vented discs over solid discs is the subject of some conjecture. The primary advantage of vented rotors is increased heat dissipation from internal pumping of air, however, under slow speeds the pumping action of the vanes is minimal and only becomes pronounced as the rotor speed increases [9]. At higher speeds the airflow flowing around the disc as a result of the forward movement of the vehicle, tends to prevent effective pumping of air through the vanes [9].

EXPERIMENTAL RESEARCH

In order to collect the data necessary for the comparison of the braking performances, the experimental research was conducted [1,6]. For the purpose of the experiment, the vehicle Zastava Florida 1.3 equipped with Bosch ABS 2X was used. The following measurements were taken: time measured from the beginning of the braking action, the speed of the vehicle, brake

pedal force, the pressure of the working fluid within the brake lines directed to the left front wheel, the pressure of the working fluid within the brake lines directed to the rear wheels in front of the braking corrector and finally, the angular speed of each wheel. For the purpose of illustration only in figure 1 is shown a vehicle on the runway with velocity sensor corevit L on vehicle's side panel.

Fig.1 Vehicle on the runway

The experiment was conducted on Ladjevci runway near the town of Kraljevo. The runway in question has the asphalt concrete surface that is characteristic for its good adhesion. For the purpose of compliance with the existing regulations, the breaking corrector was installed. Also during the tests the temperature of the brakes was taken into consideration. The measurements were taken for the vehicle fitted with either solid disc or vented disc brakes onto the front axle and in the following circumstances:

1. initial speed 80 km/h till halt for a vehicle carrying 2 passengers and 20 kg luggage
2. initial speed 80 km/h till halt for a vehicle carrying 5 passengers and 50 kg luggage
3. initial speed 140 km/h till halt for a vehicle carrying 2 passengers and 20 kg luggage
4. initial speed 140 km/h till halt for a vehicle carrying 5 passengers and 50 kg luggage.

Two drivers took part in the experiment and they were instructed to brake as if it had been panic braking. The fulfilment of their task was confirmed by consulting the paper [8] which thoroughly deal with the issue of panic braking as well as with the driver's reaction.

As the signal for the beginning of measuring, the signal emittted by the rear stop light switch mounted on the brake pedal was used. Thus the possibility of late reaction of the driver was excluded etc. This issue was thoroughly examined in previously published paper [8].

EXPERIMENTALLY MEASURED DATA

In order to get a general idea, only the partial results of the experimental research for four cases mentioned in item 2 are given. The vehicle has very good braking characteristics even without ABS and achieves deceleration in complience with the regulations of 5.8 m/s^2 and with the brake pedal force of 174 N continuosly, when the vehicle is ready for driving and with 1 driver i.e. total weight is 1020 kg. For the fuly loaded vehicle i.e. 1350 kg total weight, the brake pedal force should be 232 N [1]. In this paper experimental results are given for the same driver. However since the time till full halt in an ABS equipped vehicle depends on the initial reaction of the driver (more detailed information in [8]) and that during the experiment the magnitude of the initial speed was not strictly taken as the signal for the beginning of braking, thus for the sake of comparison of the vehicle's achieved speeds, the values shown in the diagrams are slightly smaller than the values of initial speeds.

This paper presents the cases that are considered critical during braking, and these are the cases when the fully loaded vehicle brakes at the preset initial speed.

In order to make an adequate comparison of the vehicle's braking parametars, the disc brakes characterized by the following features were used: the working cilindar diametar of the brake, outer brake disc diametar and active radius of the braking effect were identical. Identical braking pads were also applied. The clamp had to be additionaly modified when the vented disc was used (disc width 19 mm, the width of the paddle slot 6 mm) because of the difference in width between the vented and the solid disc brakes.

Experimentally measured data for driver M and initial speed 80 km/h till halt for a vehicle carrying 5 passengers and 50 kg luggage are shown on figures 2-5.

Experimentally measured data for driver Z and initial speed 140 km/h till halt for a vehicle carrying 2 passengers and 20 kg luggage are shown on figures 6-9.

Experimentally measured data for driver M and initial speed 140 km/h till halt for a vehicle carrying 5 passengers and 50 kg luggage are shown on figures 10-13.

Experimentally measured data for driver Z and initial speed 140 km/h till halt for a vehicle carrying 5 passengers and 50 kg luggage are shown on figures 13-16.

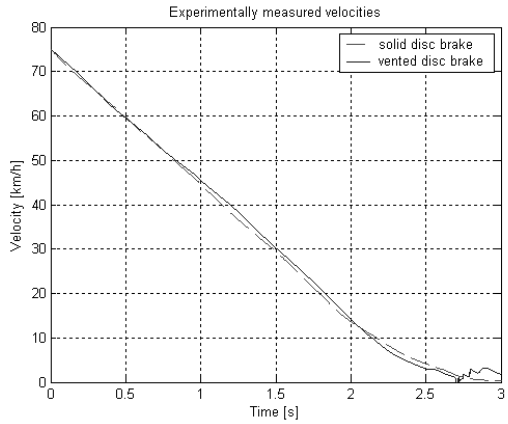

Fig.2 Measured speeds of the vehicle at the initial speed 80 km/h with 5 passengers and 50 kg luggage; driver M

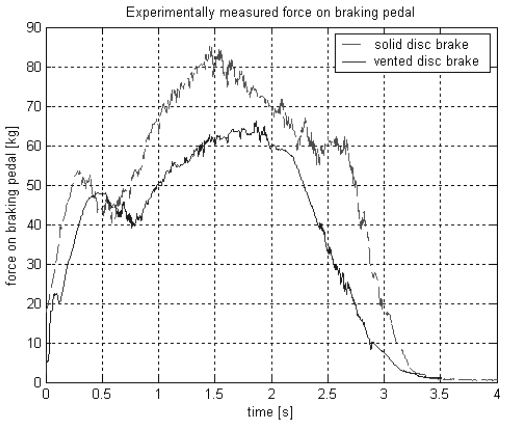

Fig.5 Measured forces on braking pedal at the initial speed 80 km/h with 5 passengers and 50 kg luggage; driver M

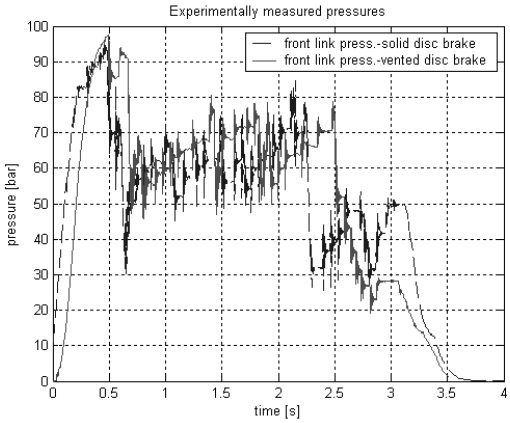

Fig.3 Front link pressures at the initial speed 80 km/h with 5 passengers and 50 kg luggage; driver M

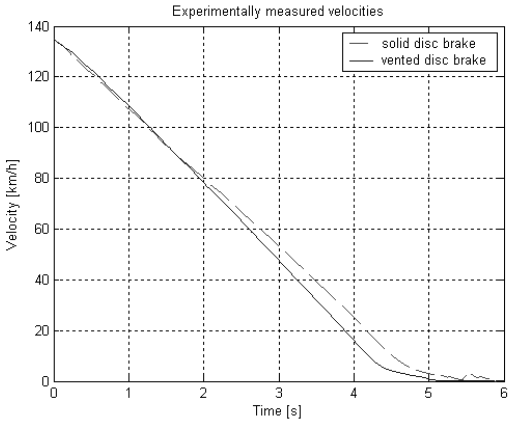

Fig.6 Measured velocities of the vehicle at the initial speed 140 km/h with 2 passengers and 20 kg luggage; driver Z

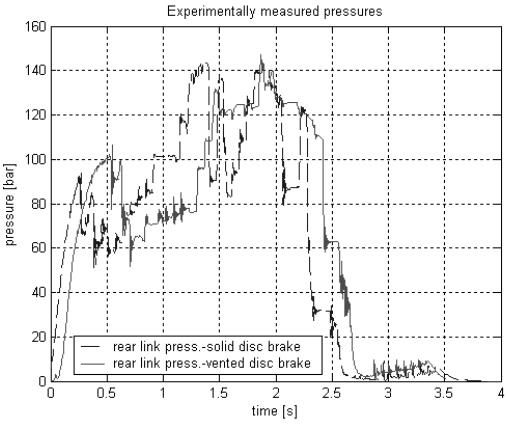

Fig.4 Rear link pressures at the initial speed 80 km/h with 5 passengers and 50 kg luggage; driver M

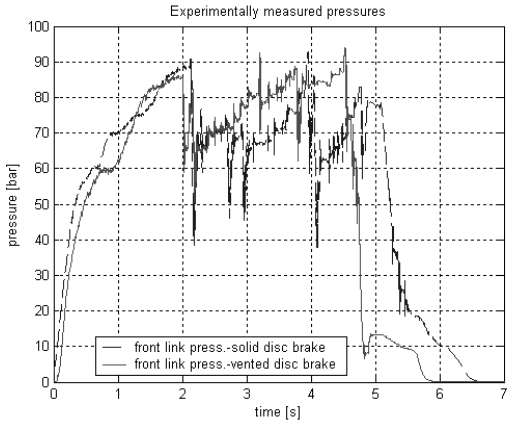

Fig.7 Front link pressures at the initial speed 140 km/h with 2 passengers and 20 kg luggage; driver Z

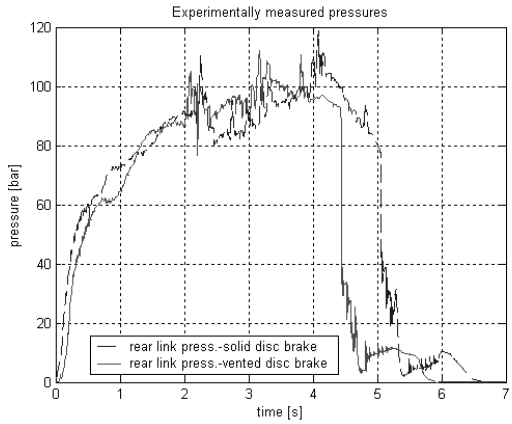

Fig.8 Rear link pressures at the initial speed 140 km/h with 2 passengers and 20 kg luggage; driver Z

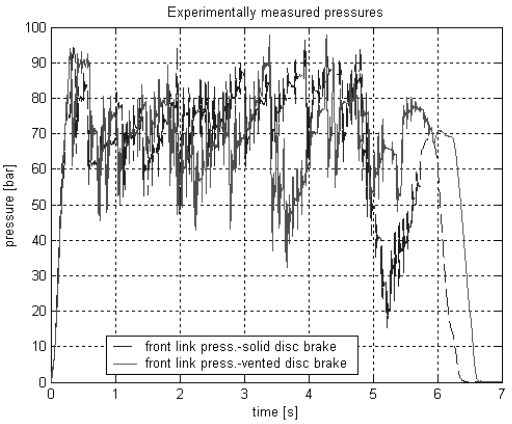

Fig.11 Front link pressures at the initial speed 140 km/h with 5 passengers and 50 kg luggage; driver M

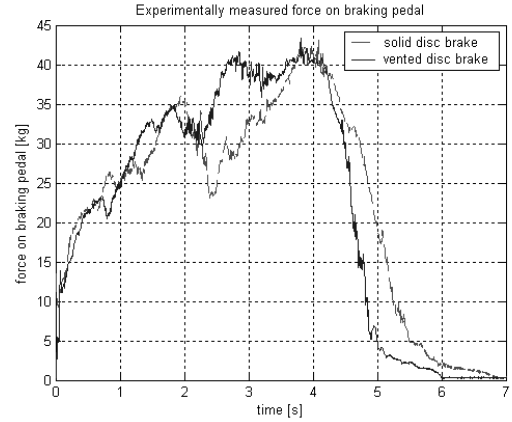

Fig.9 Measured forces on braking pedal at the initial speed 140 km/h with 2 passengers and 20 kg luggage; driver Z

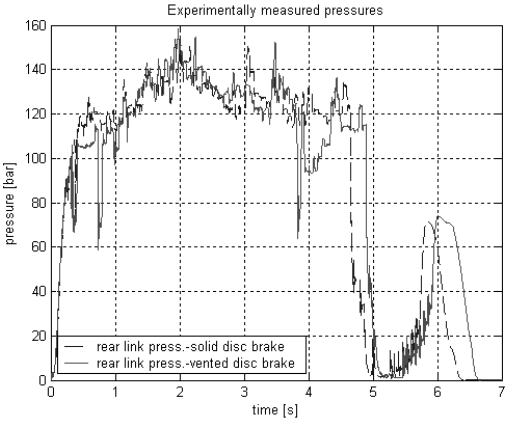

Fig.12 Rear link pressures at the initial speed 140 km/h with 5 passengers and 50 kg luggage; driver M

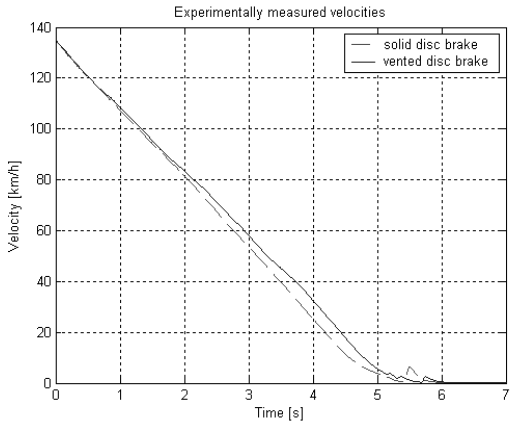

Fig.10 Measured velocities of the vehicle at the initial speed 140 km/h with 5 passengers and 50 kg prtljaga vozac M

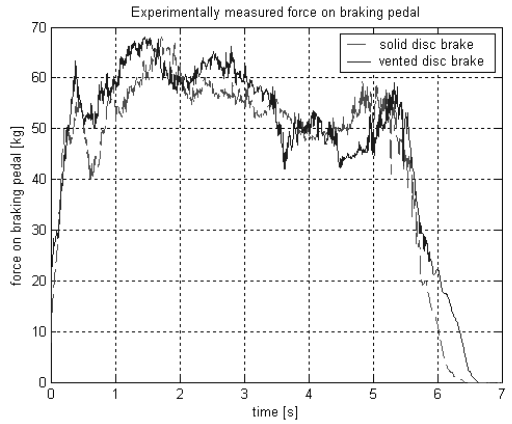

Fig.13 Measured forces on braking pedal at the initial speed 140 km/h with 5 passengers and 50 kg luggage; driver M

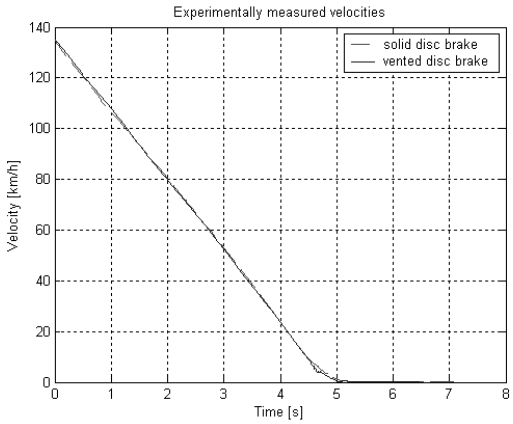

Fig. 14 Measured velocities of the vehicle at the initial speed 140 km/h with 5 passengers and 50 kg luggage; driver Z

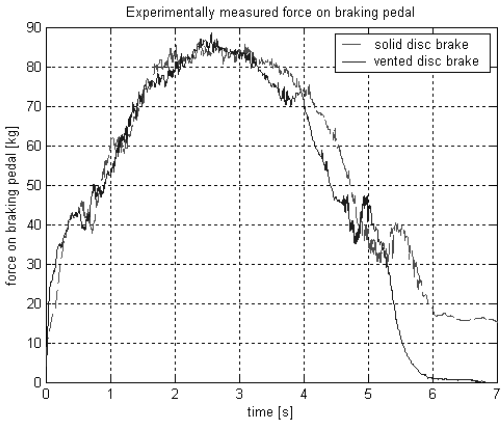

Fig. 17 Measured forces on braking pedal at the initial speed 140 km/h with 5 passengers and 50 kg luggage; driver Z

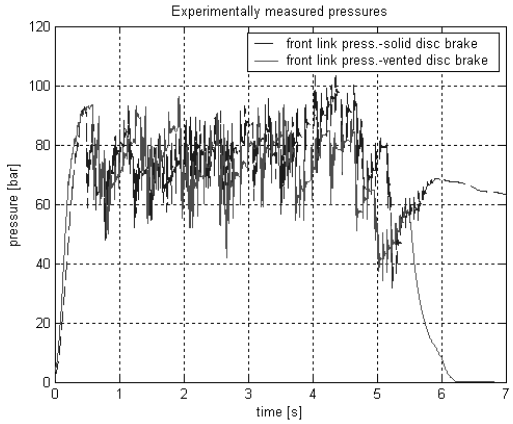

Fig. 15 Front link pressures at the initial speed 140 km/h with 5 passengers and 50 kg luggage; driver Z

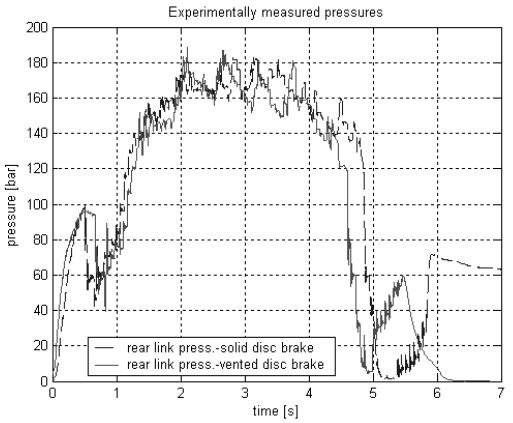

Fig. 16 Rear link pressures at the initial speed 140 km/h with 5 passengers and 50 kg luggage; driver Z

ANALYSES OF THE EXPERIMENTALLY MEASURED DATA

Based on the figures 2,6,10 i 14 it can be concluded that the application of the vented disc brakes mounted onto the front axle resulted in more satisfactory braking parameters of the vehicle. The time needed for the full halt of the vehicle is slightly shorter. During the conduction of the experiment, one panic braking was performed under conditions previously described in this paper. Brake pads characterized with very satisfactory heat resistance features were used and they were in compliance with Zastava Vehicles technical documentation [10]. Under the above mentioned conditions, the difference between the times necessary for the full halt of the vehicle are not great, because the difference in vehicle's breaking performances depends on the change of the adhesion coefficient which in turn depends upon the temperature.

As far as the change of the pressure in the line/link that leads to the front wheels is concerned, by applying vented brakes we achieved lower average values for the pressure at the initial speed of 140 km/h. The mean pressure values in the front installation were calculated by using Matlab mean function computer program in the following cases – for the first 3 seconds of braking at the initial speed of 80 km/h as well as for the first 5 seconds of braking at the initial speed of 140 km/h.

When the initial speed was 80 km/h, the mean values of pressures in the front installation were slightly grater in the vehicle that had vented disc brakes installed. The mean pressure value shown in the figure 3 for the solid disc is msd=57.8407 bars while the mean pressure value for the vented disc brakes is msvd=59.5951 bars.

However, this ratio changes when the initial braking speed is increased. Namely, in the cases when the initial speed is 140 km/h, the mean pressure value is greater in the vehicles that use solid disc brakes. Thus the mean pressure value in the case shown in figure 11 for the solid disc brakes is msd=73.4033 bars, and for the vented disc brakes it is msd=67.8508 bars.

The mean pressure values in the line/link that leads to the rear wheels have similar values.

From the figures 5,9,13 i 17 one can conclude that the drivers fulfilled the recommendation to break as if it were panic breaking.

CONCLUSION:

The application of vented discs mounted on the front axle improved vehicle's braking parameters.

According to the assumption expressed at the beginning of this paper, the advantages of ventilated discs brakes were clearly distinguished when the initial speeds at the beginning of braking were greater.

Braking pads that were applied in this experiment had very satisfactory features in terms of small change of the friction coefficient for the temperature increase. The data related to the fact that at higher initial speeds, the smaller pressure was measured in the lines leading to the front wheels when the vented discs brakes were installed, speaks for itself and supports the claim that braking performances were definitely improved.

REFERENCES:

[1] Technical documentation of ZA a.d., Research and Development Center 2007.

[2] Demić M.,Raičević M.: Modelling of suspension system behaviour for a vehicle equipped with ABS during the straight line braking, International congress motor vehicles and motors, paper MVM20060050, Kragujevac, Serbia, October 4th-6th, 2006.

[3] Todorović J.,Duboka Č.,Arsenić Ž.: Modelling of non-asbestos disc brakes friction, journal MVM br.81/82, The Mechanical Faculty of Kragujevac 1988.

[4] Todorović J.,Duboka Č., Arsenić Ž.,Mandić D. : Laboratory tests of pads FIAZ 2102/07 for front disc brake of YUGO Florida A103.00 according to ZCZ TU7. H2000, Report No. 09-1145/97, The Mechanical Faculty of Belgrade, 1997.

[5] Technical documentation of Zastava cars a.d. regarding the disc brake research with materials N890, textar T46866, Galfer 3000 GG, Kragujevac, Serbia, 1991.

[6] Raicevic M.: ABS algorithm influence on vehicle's braking parameters, master of science thesis, Mechanical Faculty, Kragujevac 23.01.2007.

[7] Demić M.,Diligenski Dj,Raičević M.:Simulation model of a vehicle fitted with ABS during the straight line braking, MVT 2006., Timisoara, Romania, November 2006.

[8] Demić M., Raičević M., Neagu E.: Comparison of braking parameters and drivers' reactions in case of vehicles with and without ABS, Scientific bulletin N°16, Automotive series XII pages 50-59, University of Pitesti, Faculty of mechanics and technology, 2006. Pitesti, Romania

[9] Stephens A.,: Aerodynamic Cooling of Automotive Disc Brakes, thesis submitted for the degree of Master of Engineering, School of Aerospace, Mechanical & Manufacturing Engineering RMIT University, march 2006.

[10] Zastava automobili technical protocol 9.02122, 9.02122/64 supplement 25/64 and 26/64, Zastava cars a.d. Research and Development Centre, May 1989.

ВЛИЯНИЕ НА СПИРАЧКАТА НА ПРЕДНАТА ОС ВЪРХУ ПАРАМЕТРИТЕ НА СПИРАНЕ ПРИ МПС, ОБОРУДВАНО С ABS

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Сърбия

Резюме: *Ефективното отстраняване на триещите се повърхности на спирачките е едно от най-важните изисквания, необходими за моторното превозно средство, за да бъде постигнато удовлетворяващо спиране.Това изискване води до прилагането на пневматични спирачки. Целта на доклада е да сравни параметрите на МПС, когато на предната ос са монтирани спирачки с твърд диск или пневматични спирачки. За тази цел са проведени експериментални изследвания чрез използване на МПС, оборудвани с ABS.*

Ключови думи: *диск, пневматичен диск, ABS.*