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Influence of tire inflation pressure on the results of diagnosing brakes and suspension

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Abstract

Diagnosis, as a noninvasive method of checking the status of a technical system, involves the use of the so-called „diagnosis parameters", which can be relatively easily measured, without dismantling the respective system. One disadvantage of diagnosis is the influence of some parasite factors that can affect the accuracy of the test results. The paper aims to highlight the extent to which the tire pressure influences the results of diagnosing the braking system and suspension of a passenger car. The study concerns the testing on specialized benches used in automobile diagnosis during which the values of the diagnosis parameters for the braking system (effectiveness, relative imbalance, ovality, rolling resistance) and the suspension (EUSAMA coefficient) are measured. Tests are conducted for several values of tire inflation pressure in order to estimate the influence of this parameter on the accuracy of diagnosis. The experimental results emphasized that the tire pressure has an important influence on the suspension diagnose, it can emphasize faults affecting the rolling resistance, but has no much influence on the maximum braking force, at least at low speed – as in the case of testing the braking system on a roller bench (method commonly used in Periodic Technical Inspections) when the simulated speed is usually 5 – 7 km/h. However, tire inflation pressure has a major influence on the dynamic behavior of the car, it contributes to the passengers' comfort and has an important role in defining tires reliability.

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1. Introduction

More and more severe standards concerning the vehicles active safety imposed, during the last decades, spectacular evolutions in engineering of braking and suspension systems. Obtaining shorter braking distances, no matter the state of the running surface, as well as the control of the vehicle trajectory when braking during cornering, leaded to the appearance and development of the Antilock Braking Systems (ABS) that avoid the wheels locking during severe braking.

The improvement of the vehicle traction performances on different and low grip between the two wheels of the same drive axle and the rolling surface made necessary the cooperation of the propulsion and braking systems. To avoid the slip of the driving wheels or the vehicle side skidding, the traction control systems (known as TCS – Traction Control System, ESP – Electronic Stability Program, ASR – Anti Slip Regulator, etc.) reduce the engine load, but also activate the braking mechanism only on one wheel, so that the desired trajectory of the vehicle can be maintained.

Therefore, the braking system become a very complex device, including several sub-systems of different types: hydro- or pneumo-mechanical, electronic, several types of sensors and transducers, actuators, wiring, connectors, a computer and a CAN – bus.

A detailed diagnosis of a system of such complexity will imply a large number of tests, some of which being of large amplitude. This will lead to a low productivity of the diagnosis activity and to a long period of immobilization of the vehicle which will affect also the productivity off the transport activity.

However, above all, it is important to retain that the braking system is one of the most important systems of the vehicle in defining the level of the active safety. Consequently, current regulations stipulate its inspection every 6 to 24 months, depending on the vehicle type and its domain of utilization [1].

Considering all the above-mentioned aspects, a global diagnosis, capable to correctly estimate the technical condition of the braking system, is recommended. It should ensure a rapid and as simple as possible test of which result should depend on the technical status of all the system components. The parameters that meet all these requirements are the braking forces developed at each of the vehicle wheels. Based on the values of these forces, measured on a rolling braking stand, several diagnosis parameters can be calculated [1]: effectiveness of the braking system, relative imbalance between the braking forces on the same axle, the difference between the minimum and maximum brake force, measured on the same wheel. If one or several of these parameters does not correspond to the acceptable limits, a more detailed diagnosis should be performed.

To calculate some of these parameters, the load on each wheel must be measured. For this purpose, a supplementary device is used; this one is also dedicated to induce an oscillation of which analyze allows the diagnose of the suspension of the respective wheel. This diagnose consists in evaluating the "road grip" coefficient, defined by the European Shock Absorber Manufactures Association (EUSAMA) as the minimum percentage of the remnant vertical tire contact force between the tire and the vibrating platform of the testing bench during the vertical oscillation of the wheel [2]:

$$RG = DFmin/SF \cdot 100[\%] \quad (1)$$

where: *DF min* is the minimum dynamic force registered during the test; *SF* is the static force.

Fig. 1 presents a typical example of a damped oscillation when testing a car suspension and emphasizes the values of *DF min* and *SF*.

It is also useful to determine the difference between the values of road grip measured at the two wheels of the same axle:

$$RGD = \left|RG_{left} - RG_{right}\right|/Max(RG_{left},\ RG_{right}) \cdot 100[\%] \quad (2)$$

According to [2], the minimum value of EUSAMA road grip coefficient is 20% per wheel; a maximum difference between the left and right wheels of each axle is 50%.

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