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INFLUENCE OF SELECTED SERVICE OPERATIONS ON THE EFFECTIVENESS OF BRAKE SYSTEM OPERATION

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Abstract

This paper attempts to clarify what impact has selected technical maintenance tasks on the effectiveness of the braking system with special emphasis on the initial break-in period of associated components. Were conducted studies involving measurements of braking forces on a rolling station and road tests Renault Thalia of car braking during which was recorded deceleration, speed, temperature of brake discs and the force of the pressure on the brake pedal. Braking process on the rolling station was assessed with a braking efficiency ratio as a criterion. However, results collected during road tests allowed studying for more accurate of running-in process of car barking system elements. This was due to taking into account the total vehicle braking force compared with the force applied to the brake pedal. The study was performed for the discs and brake pads exhibiting a different degree of wear, with particular emphasis on the running-in elements occurring immediately after replacing brake pads. In this case, there is a noticeable loss of performance brake system, which persists after initial running in mating faces of the pad and the brake disc. This phenomenon is known from workshop car service practice, but there is a need for sensitization of staff at the Pre-reaching elements of the service operations, because operation of a vehicle with a temporarily reduced efficiency of the braking system on a public road has the potential to cause threats to the safety of road users.

Keywords: *transport, technical testing of vehicles, braking efficiency, brake disc, brake pad*

1. Introduction

Safe operation of the vehicle is connected with not only the road conditions but also the technical condition of the vehicle, which is determined by the correct operation of the various components constituting the vehicle. One of the basic components having a significant impact on the safety of road users is the braking system [1]. Repair technology and service braking systems are closely linked both to the procedures of the service of the vehicle make and manufacturers recommendations of individual elements included in the brake system. As you know, the basic elements of executive braking systems are friction pairs; block-brake disc and brake pad-brake drum. Very rarely, in some unusual vehicles were used or are used conveyor brakes. Limits of wear of elements mentioned above is determined by the respective limits dimensions, such as the minimum thickness of the friction material and brake shoe, the minimum thickness of the brake disc, and the maximum diameter of the brake drum. Service Practice shows that often the life of the brake disc than twice the time the normal operation of the brake pads. Accordingly, the brake pads often are mounted in brake systems with partially worn discs thickness of which referenced to a minimum thickness limit allows this operation. Should be noted however, that the parameters (roughness, profile) describing the surface of the partially consumed disc differ significantly from the surface of the new disc. The surface condition and even surface layer of the brake disc has a major influence on the strength of the friction between the brake pad and brake disc, which eventually translates into a braking rate of the braking system. The functioning of the associations of the friction pad-disc is inseparably connected with the process of reaching occurring in the form of increased especially in the initial phase of operation of these elements.

Manufacturers of brake pads are trying to determine the time of running-in the block with a disc until the proper braking parameters by providing an appropriate course expressed in kilometers. However, the running-in period is difficult to define by a course that does not include a variety of specific factors, among others such as weather conditions, variable mass of the vehicle, the frequency of operation of the brake system. From the point of view of road safety period of running in the pad and brake disc should be as short as possible, as quickly as possible to achieve the right inherent in the design parameters of the braking process. In addition to the above factors, operating a major impact on the speed of running-in described elements are conditions of the surface of the brake disc and the brake pad. Conducted observation allowed to state that despite the association of the friction: the new pad – the new disc even after driving 800 km, these elements did not cooperate the whole surface. Therefore, there is reason to fear that the combination of: a new block – partially consumed shield, will result in a significant prolongation of time of running in of these elements. This article is an attempt to take this research subject. Take the subject of research results directly from the observations of wear and tear pads and brake discs. Prolonged process of running in of the pad and brake discs also entails the risk of local overheating of the surface layer of the brake disc and changes in the material properties of friction lining [2, 5]. This is connected with a too small contact surface of the new block and a partially used disk. With an unchanged gross vehicle weight which applies the brakes with too small contact surface of the friction new pad - partly worn disc can cause local increase in pressure and thus considerable heat development which could lead to deformation of the brake disc and uncompleted its side beating, resulting vibrations on the brake pedal [3, 4].

2. Research

For the study was selected Renault Thalia passenger car, which was produced in 2003. It is equipped with a hydraulic brake with vacuum assistance without the ABS system. The brakes on the front axle are disc brakes, while the rear axle of the vehicle has drum brakes with mechanical equalizer of braking forces, which distributes brake fluid so that the more weighted front axle is responsible mainly for the effectiveness of the braking process. This vehicle has been operated on the factory discs whose technical condition is shown in Fig. 1. The discs on the course of more than 105000 km already showed noticeable mechanical wear and tear, so that the protruding edge formed at the outer edge (Fig. 1b). However, even though it has not yet reached the lower border dimension of discs thickness, which would decide on the need to replace them. One of the mating surfaces due to uneven wear was characterized by the nature of barbs (Fig. 1c), the remaining was characterized by smaller bumps, but they could be observed at a number of corrosion pitting (Fig. 1d). On surfaces that do not cooperate with the brake pads occurred thick deposits of corrosion products crumble in the form of flakes of layers (Fig. 1e-f). For the study was also purchased a new set of brake discs made by TRW DF1013. Their appearance is shown in Fig. 2. Brand new surface was free from any traces of corrosion and at closer examination showed a gentle, regular channels resulting from machining (Fig. 2b), which could not be seen after a course of about 1000 km. Instead, the surface was uniformly worn without signs of overheating or corrosion.

During the technical inspection of vehicles on a rolling station is assessed the braking rate. It is expressed as a percentage ratio of the sum of the braking forces to the vehicle's weight. For the passenger cars, it cannot be less than 50%. The work was evaluated on a rolling station braking performance of the front axle of the vehicle equipped with disc brakes.

It was first examined the vehicle equipped with brakes on partially used discs and pads. This was followed by replacing only the new brake pads. Immediately after this exchange entered the vehicle to the position of the roller station and investigated the braking performance. Was then carried out a controlled process running in by some brakings from a speed of approx. 70 km/h to a complete stop of the vehicle. During these brakings with Decelerometer MAHA VZM300 were recorded values obtained of delays and the strength of the pressure on the brake pedal. In addition,

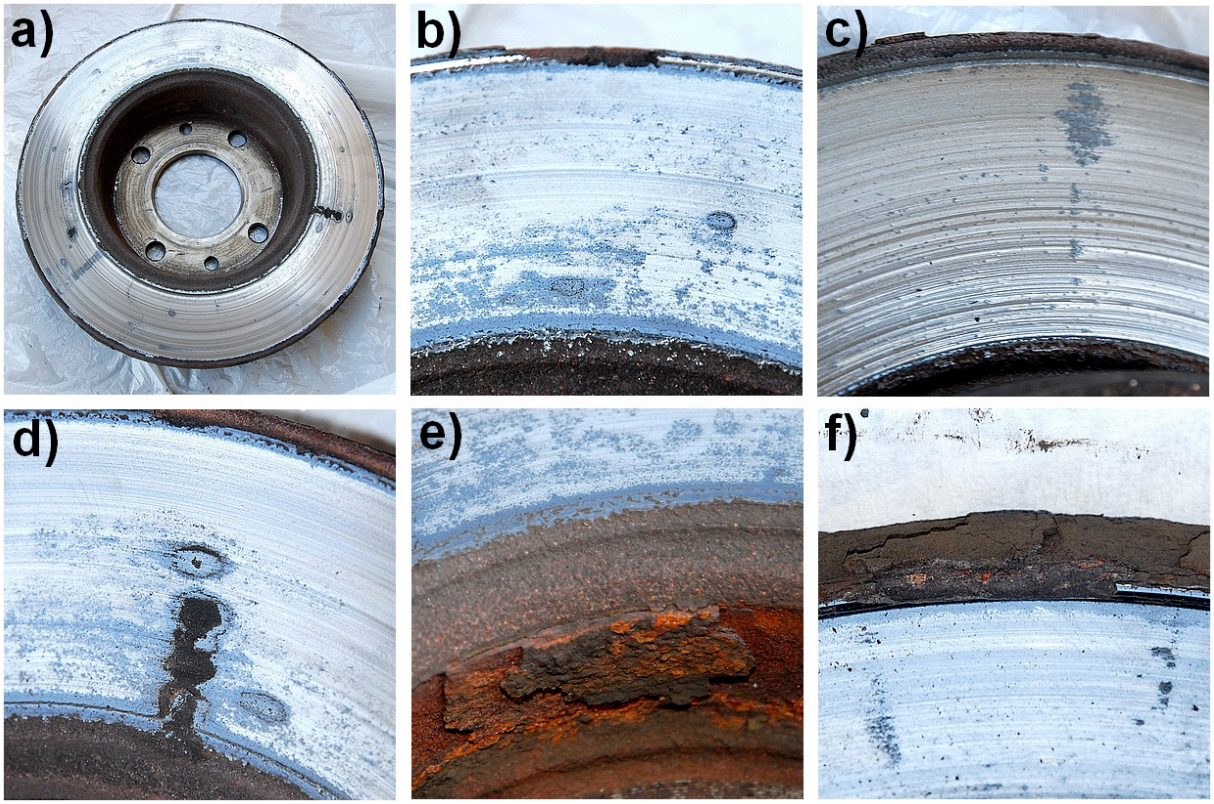

Fig. 1. Used brake disc: a) general view, b) chipping of the shore, c) surface roughness, d) corrosion pitting, e) deposition of corrosion products from the hub side, f) corrosion edge of the disc

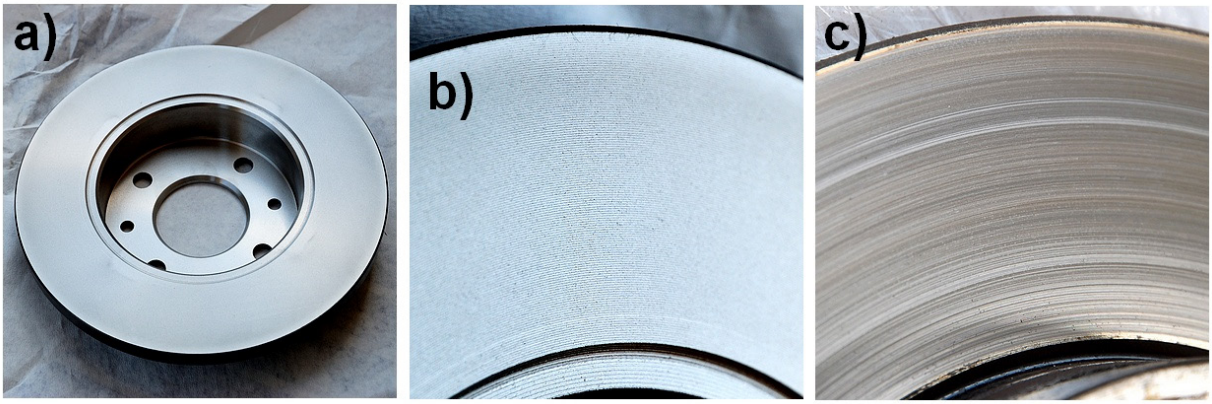

Fig. 2. New brake disc: a) general view, b) the surface in the factory state, c) the surface of the course of 1000 km

after each braking were measured by the pyrometer the temperature of brake discs. The process of preliminary running-in discs and pads was completed when it was possible to achieve locking the wheels of the vehicle during braking. The study was conducted on a road with a dry, asphalted road in sunny and warm weather. After completion of the initial running in of the brakes re-examined its performance on a rolling station. Analogously were tested vehicle after replacing brake pads and discs to the new.

3. Research results

The results of measurements of brake performance (WSH), of the front axle of the vehicle tested are shown in Fig. 3. Although already described shortcomings of the old brake disc and a noticeable brake pad wear, Renault Thalia in the initial state was characterized by a satisfactory

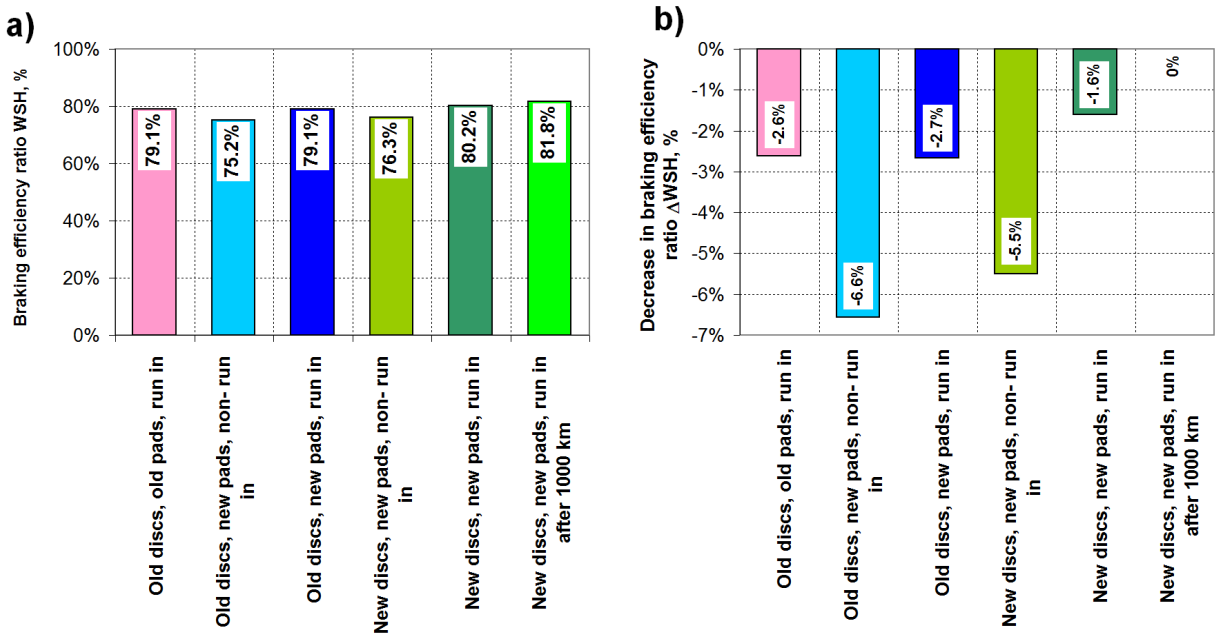

Fig. 3. Results of research of the braking system on a rolling station: a) the braking rate, b) changes in braking rate

value of braking rates of 79.1%. However, according to forecasts brake pad replacement resulted in the decrease brake performance by about 5%. Preliminary running in of pads for used discs consisting of six times inhibition from a speed of 70 km/h to a complete stop of the vehicle led to the recovery of the effectiveness of the brake system. Replacing the discs and brake pads with new ones initially also causes a similar decrease in the braking efficiency. It is associated with a small contact surface parts is not lapped each other while working. However, after the preliminary running-in stage of the observed increase in brake performance baseline of less than 1.5% – of the value of 79.1% to 80.2%.

Further running in of pads and discs during normal operation of the vehicle over a distance of 1000 km made it possible to achieve a braking rate of the front axle of approaching the 82%. The results of tests on a rolling station appear to show a small but noticeable impact on service operations on the braking performance. However, even during this study has been noted that to obtain a sufficient braking force is necessary a very strong impact on the brake pedal. Therefore, it was decided to investigate in detail the process of running-in the braking system with Decelerometer VZM300 equipped with a strain gauge force transducer. This transmitter expanded measurement capability of device, and allowed registration of pressure on the brake pedal. Obtained during the research, the deceleration values of the vehicle and the impact of the driver on brake pedal is graphically shown in Fig. 4.

The results of these research show that under road conditions influence of running-in pads and discs on the braking system operation is significant and noticeable. With each subsequent braking, increases the obtained braking deceleration and simultaneously vehicle driver can use smaller and smaller compressive forces on the brake pedal. In addition, it should be noted that the run-in process for the new disc is much shorter, because are sufficient only four instead of six brakings, yet higher values vehicle obtained by delays on road. As a result, matching mating surfaces of frictional pairs, satisfactory results can be obtained at smaller and smaller values of the brake pedal. However, in the case of establishment of new blocks to the old disc, the driver must act on the brake with a force close to 50 daN and the car still does not brake too well.

To ensure more accurate analyse this phenomenon on the basis of the braking deceleration of the vehicle mass was calculated the total braking force of the vehicle and compared with the force applied to the brake pedal. The ratio of forces F_H/F_P was calculated from the formula by the pattern 1.

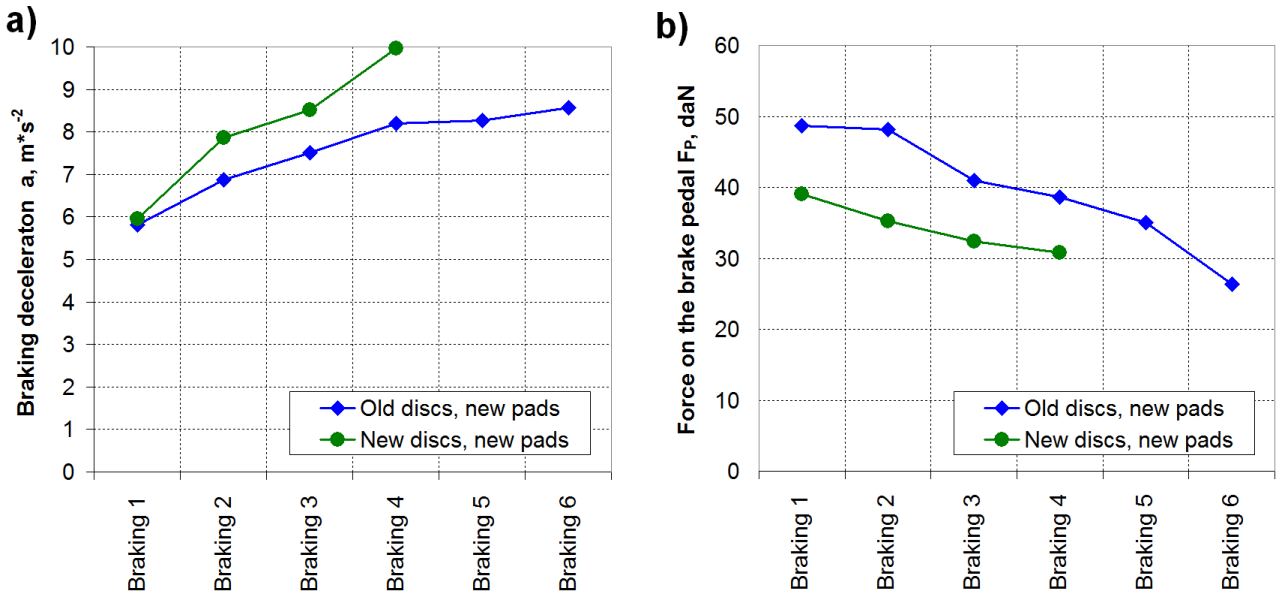

Fig. 4. The results of road tests: a) the braking deceleration, b) force on the brake pedal

$$\frac{F_H}{F_P} = \frac{m \cdot a}{F_P}, \tag{1}$$

where:
F_H – vehicle braking force,
F_P – pressure on the brake pedal,
m – vehicle mass,
a – braking deceleration.

With successive brake applications its value (Fig. 5a) is growing many times, what most clearly shows the important role of running-in parts of the brake system. Monitoring the temperature of the brake discs (Fig. 5b) did not show the risk of overheating during the proposed running-in cycle in attempts to road, although in the case of new discs should be more careful.

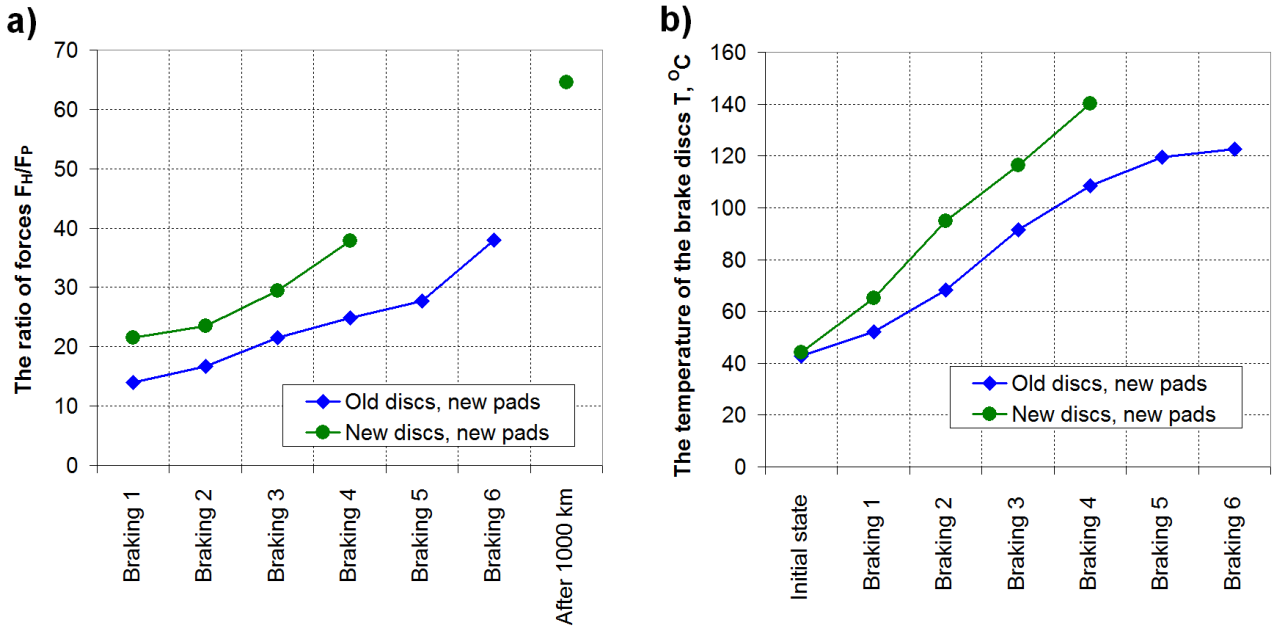

Fig. 5. The results of road tests: a) the ratio of braking force to the force on the brake pedal; b) the temperature of the brake discs

4. Conclusions

Giving the driver to operate the vehicle immediately after replacing the brake pads can be associated with an increased risk of occurrence of a vehicle crash when the driver driving a car will not have the full awareness that it is necessary to brake to exert pressure on the brake pedal several times even stronger pressure. In emergency braking situations and the often observed on our roads practice of keeping a small distance from the vehicle in the operation of such a vehicle carries a very serious risk of collision. At the same time, road tests have shown that the study on a rolling station may be insufficient for fully assess the effectiveness of the brake system of motor vehicles. Further studies are required about the impact of maintenance activities on the effectiveness of the braking process.

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