Ensuring reliability of the brake drive of cars in operation

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Abstract. The article deals with ensuring reliability of the brake drive of cars in operation. Attention is given to the dynamic brake force controller which is installed in the diagonal brake drive in the braking mechanism of rear wheels. On the basis of the hypotheses made concerning the limiting quantities of operational kilometers of the brake force controller and its drive, bench and road tests of cars were carried out. Results of experimental tests confirmed theoretical hypotheses.

1. Introduction

Modern vehicles of category M1 of home manufacture and assembly, such as LADA Kalina, LADA Priora, LADA Granta, LADA 4x4, LADA Largus, Renault Logan, Chevrolet Niva, etc. in bog-standard manufacture are completed with brake force controllers (BFC) in the drive to rear braking mechanisms. When carrying out the statistical analysis it was established that the share of vehicles of category M1 with brake drive BFC makes 37 % (15.54 million) of the park of cars in the country [8]. It means that in the next decades there will be vehicles (V) with brake systems fitted with BFC. Statistics of the AvtoVAZ enterprise should also be taken into account. In 2017 311,588 thousand cars were produced and 24 thousand of this number were exported. Russian LADA cars are officially imported in 24 countries [9]: Azerbaijan, Armenia, Republic of Belarus, Bolivia, Bulgaria, Chile, Egypt, Georgia, Germany, Hungary, Kazakhstan, Kyrgyzstan, Latvia, Lebanon, Republic of Moldova, Slovakia, Tajikistan, Turkmenistan, Ukraine, Uzbekistan, South Ossetia, Serbia, Syria and Peru.

The hypotheses concerning the BFC service life limit and its mechanical drive corresponding to 44,600 ± 2,230 thousand km and 51,120 ± 3,578 thousand km received by calculation are described in the articles [1]–[3].

The hypotheses consist in that the BFC in question stops to perform its functions after running 45,0 thousand km. To check these hypotheses bench and road tests were carried out. Vehicles of category M1 were tested. Technical characteristics of the tested cars are given in Table 1.
Table 1. Technical characteristics of the cars tested

| №  | brand, model of the car | Kilometerage (milage) (thousands) | Parameters | brand, model of tires | BFC information |
|----|------------------------|----------------------------------|------------|----------------------|-----------------|
|    |                        |                                  | front axle | rear axle            |                 |
| 1  | VAZ-2190 «Granta»      | 3                                |            | KAMA-217             | didn’t change   |
|    |                        |                                  |            | 175/65 R14           |                 |
| 2  | VAZ-2192 «Kalina»      | 42                               |            | Cordiant Comfort     | didn’t change   |
|    |                        |                                  |            | 185/60 R14           |                 |
| 3  | VAZ-2192 «Kalina»      | 48                               |            | Ovation W586         | didn’t change   |
|    |                        |                                  |            | 185/60 R14           |                 |
| 4  | VAZ-2172 «Priora»      | 54                               |            | Tunga Nordway        | didn’t change   |
|    |                        |                                  |            | 185/65 R14           |                 |
| 5  | VAZ-2113 «Samara»      | 87                               |            | Rosava WQ-102 175/70 R13 | didn’t change |
|    |                        |                                  |            | Medved 175/70 R13    |                 |
| 6  | Chevrolet «Niva»       | 140                              |            | KAMA-frame 205/70 R16 | was replaced with new one before tests |
| 7  | IZh-2126 «Ode»         | 226                              |            | KAMA-205 175/70 R13  | was replaced with new one 200 thousand km of operation |
| 8  | VAZ-21093 «Satellite»  | 234                              |            | Dunlop SP winter ICE01 175/70 R13 | didn’t change |

According to the bench tests results (the tests are described in [5]) and requirements imposed by specification documents [6, 7] to the brake system implementable grip of wheels was calculated. On this basis point-to-point curves of implementable grip for each wheel of the cars in question (Figure 1) were constructed.

\[ Y_1 = \frac{R_{x1}}{R_{z1}} = \frac{R_{x1}}{P_{i+z} + \frac{h_c}{L} M_a g} \]  \hspace{1cm} (1)

where \( \gamma_i \) – the realized grip of \( i \) axis; \( R_{x1} \) – force transferred by brakes to an axis \( i \) under usual conditions of braking on the road; \( R_{z1} \) – normal reaction of a road surface on axis \( i \) while braking; \( P_{i+z} \) – normal reaction of a road surface on axis \( i \) under static conditions; \( z \) – the index of an axis (\( i = 1 - \) a forward axis, \( i = 2 - \) the second axis, etc.); \( z \) – vehicle’s braking coefficient; \( g \) – acceleration due to gravity; \( h_c \) – the height of the center of gravity specified by the manufacturer and accepted by technical services which carry out test for official approval; \( L \) – wheel base; \( M_a \) – mass of the vehicle.

2. Results and Discussion

Experimental investigations carried out to determine technical condition of BFC of random cars showed that the life service of the BFC in question is up to 45.0 thousand km.

Road tests results have confirmed those of the bench tests.
Figure 1. Curves of an implementable grip for the car wheels at the equipped weighting state: a) – VAZ-2190 «Granta»; b) – VAZ-2192 «Kalina»; c) – VAZ-2192 «Kalina»; d) – VAZ-2172 «Priora»; implementable grip: 1 – front left wheel; 2 – front right wheel; 3 – rear left wheel; 4 – rear right wheel; 5 – $\gamma = z$.

3. Conclusion

The results obtained correlate with frequency of servicing of the LADA cars. Organizational and technical activities can be recommended to include BFC and its drive in the vehicle maintenance schedule:

1) when carrying out each maintenance it is necessary to remove impurities (dirt, ice, slime, etc.) from the casing of the BFC and its drive. Then remove a protective cover of BFC, remove the old lubricant and put under the cover new lubricant in amounts of 5 – 7 gr, for example, of DT-1, then reinstall the protective cover;

2) when carrying out scheduled maintenance after running 30.0 ± 0.5 thousand km, check the position change of the drive fastening, correct its position by measuring of the $\Delta$ gap between the lower part of the lever 4 (Figure 2) of the regulator drive and a spring in the 7th lever. Gap size $\Delta$ has to be in the limits of 2.0 $\pm$ 2.1 mm;

3) when carrying out scheduled maintenance after running 45.0 ± 0.5 thousand km before changing the brake fluid replace the BFC and the drive fastening elements: bolt M8×50 of drive fastening III (Figure 2), bracket 2 fastening of the regulator fastening to the car body. Make a necessary gap $\Delta$ between the heel of the lever 4 (Figure 2) of an adjuster actuator and a spring of the 7th lever;

4) at each subsequent scheduled maintenance after running 15.0 ± 0.5 thousand km it is necessary to carry out maintenance of the BFC mechanical drive described in points 1 and 2, and 4 after running 5.0 ± 0.5 thousand km – the works described in point 3.
Figure 2. BFC of VAZ-2108-351205211 with the drive: 1 – brake force controller; 2 – a bracket of fastening of the controller to a car body; 3 – controller elastic drive arm; 4 – controller drive arm; 5 – controller drive arm bracket; 6 – pin; 7 – lever spring; I, II, III, IV – interfaces of elements of the drive design where deviations from the mutually joint members can result in the malfunctioning of the controller; ∆ – an adjusting gap

These recommendations come to an agreement with Technical Maintenance frequency VAZ cars according to the service manual; they were implemented into technology process of scheduled maintenance on adjustment and repair of the BFC.

References

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