METHODS OF ASSESSING THE TECHNICAL CONDITION OF AUTOMOTIVE SHOCK ABSORBERS IN THE ROAD VEHICLES OPERATION

Ing. Šarkan B. PhD.[1], Ing. Vrábel J. PhD., Ing. Skrúcaný T., Ševčík M.
The Faculty of Operation and Economics of Transport and Communications– University of Zilina, the Slovac Republic [1]
sarkan@fpedas.uniza.sk

Abstract: *Automobile shock absorbers are an important part of the vehicle suspension, which directly affect the driving comfort and maneuverability. Therefore, they direct impact on the safety of their operations. Wrong technical condition of the car shock absorbers can cause extension of braking distance by up to 20%. In actual service station practice, the automotive shock absorbers are diagnosed by several methods. This article presents the results of measurements of automotive shock absorbers on various diagnostic devices. During testing, on the vehicle there were replaced shock absorbers and they were compared with the results of the technical condition before and after the exchange.*

Keywords: SHOCK ABSORBERS,

1. Introduction

In this time is in automobile industry given the increasing emphasis on the safety of vehicles, so passive (a stronger constructions, more durable materials, different crumpling zones), as well as active (different systems and sensors actively involving to the driving the vehicle, for example: ABS, ESP, BAS etc.). Among the basic elements of security is necessary to ensure permanent contact wheels of the vehicle on the roadway. This is in charge of overall construction of the chassis vehicle within the frame of fulfill the role the suspension damping — automobile shock absorber. Their task is to muffle the oscillating movement of the suspension of car and keep wheel in constant contact with the roadway.

It is important to check the aspect of the shock absorbers, because even these components will gradually wear out and reduces their ability to dampen the suspension. In the large wearing the damping's lose effect and already in the larger health the wheel loses contact with the roadway. It is undesirable in terms of security.

There are two options to verify the status of automobile shock absorber. It is a test of the damper in the disassembled and undisassembled condition. In the testing disassembled damper is measure character alone damper, what is however more time consuming. In the testing undisassembled damper is not measure alone damper but road grip – adhesion all axles of the vehicle. It is only an approximate state of shock absorber. We can say, that the testing undisassembled damper verification the overall condition of the axle.

In this report we are going to continue to deal only with the method of diagnosis of the shock absorbers mounted on the vehicle.

2. Methods of diagnostic of automobile shock absorbers

In normal car service practice we meet with the following methods of diagnosis of automobile shock absorbers, which were also used in practical measurements.

1 *Principle EUSAMA*

Resonance method composed on the principle EUSAMA (EUropean Shock Absorber Manufactures Association) is resonance adhesion method, where is measured the static strength of the wheel to the bearing surface. Its advantage is, that the result is a percentage, which indicates the status of the shock absorber, as well as the overall suspension and there is no need to compare it with the values from the manufacturer. Disadvantage is the inaccurate measurement of lighter vehicles that is due to the fact, the engine with an eccentric transfer the oscillating movement directly on the plate, on which the vehicle rests.

The measurement shall be carried out on both sides of the axle at the same time. First measure the vertical force applied to each side of the axle – the overall axle weight. Then using the electric motors start vibrating platforms for prescribed amplitude with a frequency 25 Hz. After reaching the maximum frequency, the electric motor is turned off and the platform vibrates to complete stop. Measured instant contact force on the platform. The percentage will then be evaluated the smallest force of thrust to force in stationary. [19]

Table 1: *The percentage evaluation according of the principle EUSAMA*

Condition of damper	Value of weight in %
excellent	61% and more
good	41% - 60%
fair	21% - 40%
bad	20% and less

2 *Principle THETA*

Resonance method based on the principle of THETA is the youngest method, launched in 2009. When measuring the unsprung mass holding in oscillating movement constantly and the computer controls the frequency of oscillation by measuring procedure. The result is a dimensionless number THETA, which are determined by the overall condition of the suspension and shock absorbers. The advantage is a measure even lighter vehicles, because oscillation is not transmitted directly, but through a special spring, that is transmitted oscillation to the platform, on which the vehicle rests. The frequency of oscillation is managed by the computer, and as with the principle of EUSAMA the resulting value is nothing compared.

The measurement shall be carried out on both sides of the axle at the same time. With using the electric motors will start vibrating platforms into forced oscillation with frequency 10 Hz. Gradually decreases to almost frequency 0 Hz. Frequency in doing so, passes through a zone resonant frequency of the unsprung masses. The maximum amplitude of the frequency is measured and compared with the time course absorption oscillation.

Table 2: *Evaluation by dimensionless number THETA*

Condition of damper	Value of THETA
bad	0,00 - 0,09
on the border of life	0,10 - 0,13
good	0,14 - 0,30

3. Practical measurement for the diagnosis of automobile shock absorbers

This chapter is dedicated to undisassembled testing of shock absorber on several devices using a variety of methods. It will be used for the measurement of personal vehicle *VW Golf III 1,9 TDi*. On the vehicle have not been altered dampers at least *60 000* km.

In one of the last measurement before changing of the rear shock absorbers on the device working on the principle of EUSAMA, where it was carried out by measurement with overinflated tire and underinflated tire, spilled oil filling of the left rear shock absorber. The measurements have been completed and have been achieved more interesting results. For these purposes, there were used three different diagnostic equipment to enhance the objectivity of measurements.

Table 3: Diagnostic equipment

Device	Principle	Method of measurement
MAHA MSD 3000	*THETA*	*the entire axle at once*
MAHA SA – 2 – D	*EUSAMA*	*each wheel separately*
BOSCH SDL 260 S 10	*EUSAMA*	*each wheel separately*

In the following sections are presented the results that describe above:

a) State of shock absorbers in the ordinary course of vehicle load

b) State of shock absorbers in the overinflated tire or underinflated tire

c) State of shock absorbers in different load axles

d) State of shock absorbers after exchange shock absorbers on the rear axle

a) State of shock absorbers in the ordinary course of vehicle load

The vehicle was subjected to measurements of three diagnostic equipment's. From the results is evident that the front axle is on average the same results under the principle of EUSAMA and under the principle of THETA.

Rear axle is under principle THETA in 100% condition. According to the principle EUSAMA is the rear axle at the level of about 63%. The results of measurements on devices MAHA and BOSH the same principle of EUSAMA the difference showed on the right rear damper 13%.

Table 4: *State of shock absorber before exchange shock absorber on the rear axle*

Device	Left front	Right front	Weight front axle
MAHA MSD 3000	0,23	0,20	729 kg
MAHA SA – 2 – D	71%	69%	706 kg
BOSCH SDL 260 S10	71%	68%	797 kg
Device	**Left rear**	**Right rear**	**Weight rear axle**
MAHA MSD 3000	>0,30	>0,30	468 kg
MAHA SA – 2 – D	63%	70%	445 kg
BOSCH SDL 260 S10	60%	57%	446 kg

b) State of shock absorber in the overinflated tire or underinflated tire

The overinflated tire and underinflated tire is a relatively common occurrence during operation of the vehicle. This can distort the measured values the positive and negative direction. It was conducted diagnostics of the shock absorbers, where on each axle has increased and then decreased the prescribed tire pressure about 0,5 atmosphere. Afore this test was a leakage of oil filling the left rear shock absorber. The measured values are recorded in the table number 5. The measurement is carried out on the device BOSCH SDL 260 S10 principle of EUSAMA.

Table 5: *Comparing the shock absorber in the overinflated tire and underinflated tire*

	Left front	Right front	Weight front axle
Standard measurement	71%	68%	829 kg
Overinflated tire about 0,5 atm.	64%	65%	826 kg
Underinflated tire about 0,5 atm.	76%	73%	836 kg
	Left rear	**Right rear**	**Weight rear axle**
Standard measurement	11%	57%	537 kg
Overinflated tire about 0,5 atm..	3%	48%	538 kg
Underinflated tire about 0,5 atm.	19%	62%	537 kg

According to the results of the overinflated tire about 0,5 atmosphere resulted in a negative. On the front axle dropped the value about 3% - 7%, on the rear axle dropped about 8% - 9%. Underinflated tire showed positive, where values grew on the front axle about 5% - 6% and on the rear axle about 5% - 8%. This phenomenon could affect changing the radial stiffness of tire, so when a larger tire pressure radial stiffness is growing, and thus increases the resonance amplitude of axle. By contrast, less pressure decreases radial stiffness of tire, and thereby reducing the resonance amplitude. Therefore the results were at overinflated tire in the negative direction and at underinflated in the positive direction opposite result when prescribed inflated.

c) State of shock absorber in different load axles

Principle of EUSAMA shows a distorted results in lighter vehicles measurements. When peak to peak a vehicle axle with less weight on the axle load there may be a break in contact with the tires and platform, and it causes the measurement uncertainty. The first testing of all primal shock absorbers we moved weight out of the front axle to the rear axle. After changing the rear shock absorbers we test with moved weights reiterated. The measurement was carried out on the device BOSCH SDL 260 S10 principle of EUSAMA.

Table 6: *Comparison dampers when transferring weight between the axles before the exchanging rear shock absorbers*

	Left front	Right front	Weight front axle
Standard measurement	71%	68%	829 kg
Weight transfer to the rear axle	67%	65%	745 kg
	Left rear	**Right rear**	**Weight rear axle**
Standard measurement	11%	57%	537 kg
Weight transfer to the rear axle	27%	60%	615 kg

It is obvious that will relieve the already heavy front axle about 84 kg due to the difference in the negative direction only about 3% - 4%. Rear axle has been overcast about 78 kg, what caused the slightly worn shock absorber difference 3%, When a damper with leaking oil filling it was 16%.

Table 7: *Comparison dampers when transferring weight between the axles after the exchanging rear shock absorbers*

	Left front	**Right front**	**Weight front axle**
Standard measurement	74%	73%	817 kg
Weight transfer to the rear axle	72%	69%	743 kg
	Left rear	**Right rear**	**Weight rear axle**
Standard measurement	73%	65%	516 kg
Weight transfer to the rear axle	72%	63%	591 kg

The removal weight of the front axle about 74 kg was the difference in a negative direction about 2% - 4%, what is approximately the same as in the previous measurements of the same shock absorbers in the same device. Rear axle has been charged about 75 kg. Surprisingly, this result at this device has moved towards the negative, where to test the shock absorbers at the load caused the deterioration about 1% - 2%.

d) State of shock absorber after exchange on the rear axle

In this test are compared a shock absorbers on a vehicle before and after changing the rear shock absorbers for a new (SACHS), including the imposition of the shock absorbers (KYB). This test should show what kind of improvement occurs after changing the worn rear shock absorbers under the absolutely new shock absorber in the context of the entire axle testing.

Table 8: *State of shock absorber before and after exchange on the rear axle*

Device	**Left front**	**Right front**	**Weight front axle**
MAHA MSD 3000 Before exchange	0,23	0,20	729 kg
MAHA MSD 3000 After exchange	0,22	0,21	764 kg
MAHA SA – 2 – D Before exchange	71%	69 %	706 kg
MAHA SA – 2 – D After exchange	72 %	67 %	713 kg
BOSCH SDL 260 S10 Before exchange	71 %	68 %	797 kg
BOSCH SDL 260 S10 After exchange	74 %	73 %	817 kg
	Left rear	**Right rear**	**Weight rear axle**
MAHA MSD 3000 Before exchange	>0,30	>0,30	468 kg
MAHA MSD 3000 After exchange	>0,30	>0,30	457 kg
MAHA SA – 2 – D Before exchange	63 %	70 %	445 kg
MAHA SA – 2 – D After exchange	73 %	76 %	454 kg
BOSCH SDL 260 S10 Before exchange	60 %	57 %	446 kg
BOSCH SDL 260 S10 After exchange	73 %	65 %	516 kg

4. Conclusion

All those measurements have shown, what impact have different factors to the overall result of the diagnosis of automobile shock absorbers. Even small changes in the inflated tire, or loaded the vehicle when measurements can distort the result and affect the assessment of the status of the shock absorber, what can adversely affect the safety of the vehicle not just for his crew, but also for other road users.

References

[1] FREIWALD, A. *Diagnostika a opravy automobilov I*. Bratislava : Kontakt plus, 2009. 280 s. ISBN 978-80-88855-83-5

[2] MAJEROVÁ, Z.- VRÁBEL, J. *Environmentálne problémy v doprave = The environmental problems in transport*. In: Podniková ekonomika a manažment [elektronický zdroj] : elektronický vedecký časopis o ekonomike, manažmente, marketingu a logistike podniku. - ISSN 1336-5878. - 2013. - Č. 1 (2013), online, s. 70-74.

[3] SKRÚCANÝ, T. *Diagnostika stavu prevodového ústrojenstva pomocou valcovej skúšobne výkonu*. In: Technická diagnostika strojů a výrobních zařízení DIAGO 2014 [elektronický zdroj] : sborník konference. - ISSN 1210-311X. - Ostrava: VŠB - TU, 2014. - CD-ROM, s. 278-286.

[4] JAN, Z. – VÉMOLA, A. – ŽDÁNSKÝ, B. Automobily. Brno : Akademické nakladatelství Cerm, 2003. 266 s. ISBN 80-7204-262-9

Tento článok vznikol v nadväznosti na riešený projekt spolufinancovaný zo zdrojov EÚ s názvom „Moderné metódy výučby riadiacich a diagnostických systémov motorových vozidiel, ITMS 26110230107.“

This article was created in response to tackle a project co-financed by EU's "Modern teaching methods of control and diagnostic systems of motor vehicles, ITMS 26110230107"

Operačný program VZDELÁVANIE

Agentúra Ministerstva školstva, vedy, výskumu a športu SR pre štrukturálne fondy EÚ

Európska únia Európsky sociálny fond

Moderné vzdelávanie pre vedomostnú spoločnosť/Projekt je spolufinancovaný zo zdrojov EÚ