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TUNING OF SHOCK ABSORBERS ON VEHICLE

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Abstract: *The article deals with the tuning of shock absorbers for trucks on a vehicle, and with data collection for later laboratory testing. The used measuring technology is described, too.*

Keywords: ***Shock absorber, tunnig, testing, devetron.***

1. Introduction

Stability of a moving vehicle on the road is influenced by many factors. Weight distribution, speed, road situation and wind are the factors determining the behaviour of a vehicle on the road. Some of these variables can be controlled or changed, determining the way of a vehicle behaviour. If we need to keep control over vehicle stability and its comfort, the undercarriage, suspension springs and especially shock absorbers must be tuned in a way to keep the wheels in a continuous contact with the road, maintaining the vehicle crew´s comfort and favourable conditions for the truck load transport.

Shock absorbers tuning is a complex issue and requires extensive experience and good knowledge of the hydraulic shock absorbers functioning principles. Moreover, such tuning is time consuming and financially demanding process, regarding the need to drive a great number of test kilometers, measuring device installation and, last but not least, a multiplied assembly and disassembly of the absorbers and their re-setting. The danger of displacement sensors and accelerometers present a great risk, not speaking about the damaging of the measuring central and accessories in the proper testing. These components are very expensive.

The testing I participated and described in this article was carried out in October 2010 at company Paccar in Leyland, England. Undercarriage tuning for the new version DAF LF class 3 (N3) was in question.

2. Setting of shock absorbers

Comfort and safety are judged according to the proper vehicle oscillation frequency. A subjectively comfortable, periodically repeated motion of a person (rocking, swinging, oscillating,…) is a motion with its frequency close to human heart frequency or to that of a comfortable human walk. This is the frequency f_0 = 60 min^{-1} = 1 Hz. The proper vehicle suspension frequency ω_0 corresponds to the following equation

$$\omega_0 = 2\pi . f_0 = \sqrt{k/m} = 2\pi \quad (s^{-1}) \tag{1}$$

where $\underline{m}$ is the vehicle weight component over the suspension unit and $\underline{k}$ is the suspension unit rigidity. Mechanical springs mostly have fixed rigidity and linear characteristics. Pneumatic springs have variable rigidity, growing with the increased load according to a non-linear (hyperbolic) characteristics. A higher proper frequency corresponds to a higher suspension rigidity, resulting in a more aggressive driver´s behaviour and contributing to a sport-like character of the driving (bends can be negotiated at a higher speed), being inconsiderate to the transported load.

Soft suspension with a lower proper frequency makes the driver sleep, creating the feeling of higher comfort for the co-travelers and being considerate to the transported load. Shock absorbers have to be in line with the suspension.

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Providing that a shock absorber is tuned softly, that is with a small resistance against the motion, the whole system would oscillate, adhesion between the tire and road surface would get lost and the vehicle would be difficult to maneuver and control. On contrary, if a shock absorber is tuned hard, that is with a high resistance to the motion, the drive is not comfortable for the crew, and the load is in danger. Last but not least, the vehicle can be damaged, e.g. in running over a road pothole.

Attenuation forces setup is carried out by the change in the assembly of valve (Fig. 1, positions 3 and 6), or using disc springs (Fig. 2, position 9), which is more suitable for large trucks. The setup is performed on a shock absorber piston for the making of extension attenuation forces or on a suction valve (Fig. 3, position 6) for the making of compressive attenuation forces. Another factor affecting the attenuation forces is the size of used supports (Fig. 1, positions 2 and 7) at the power plotting boards on the shock absorber piston. For the proper function of a shock absorber it is important that the attenuation at the extension is about 10 times higher than that of compression.

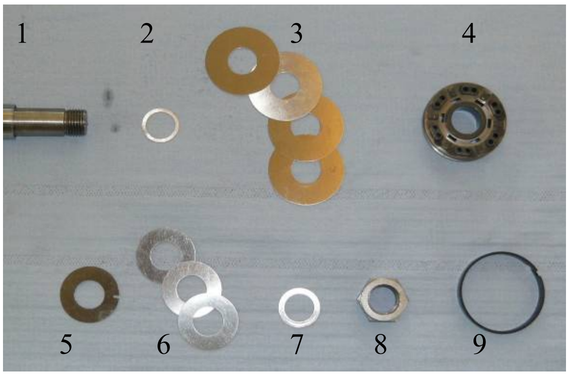

Fig. 1: Piston assembly.
1) piston rod, 2) stay, 3) over piston foil, 4) piston, 5) permanent flow foil, 6) under piston foils, 7) assembly of stay, 8) nut, 9) piston ring.

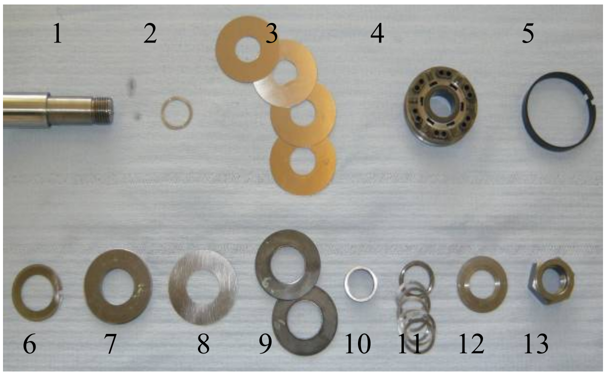

Fig. 2: Assembly of a disc springs piston.
1) piston rod, 2) stay, 3) over piston foil, 4) piston, 5) piston ring, 6) permanent flow foil, 7) board, 8) sliding bearing, 9) disc springs, 10) cervix, 11) distance stay, 12) stay, 13) nut.

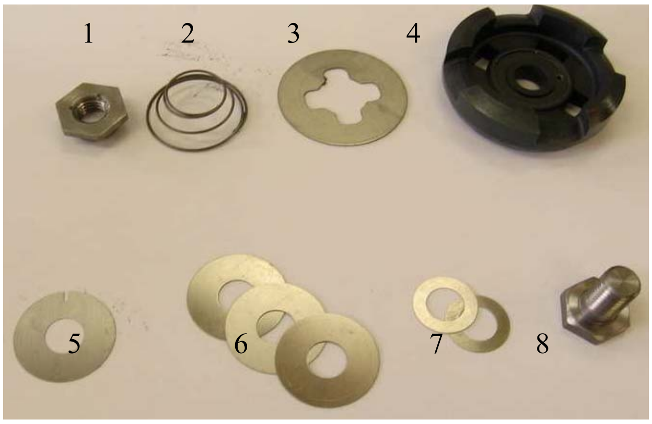

Fig. 3: Base valve assembly.
1) nut, 2) spring of reverse valve, 3) reverse valve, 4) base valve, 5) permanent flow foil, 6) assembly of foil of base valve, 7) assembly of stay, 8) screw.

3. Shock absorbers setting and testing on a vehicle

Telescopic shock absorbers were tuned for truck DAF LF class 3 (N3). The main reason was the setting of attenuation forces for a new front absorbers concept for the vehicle. The truck was equipped with a measuring centre by Devetron, model 501 with an external touch-screen (Fig. 4) and DEWEsoft 7.0.1 RC3 software. In parallel with the telescopic shock absorber a displacement sensor was installed on the front axle, with a measuring range of 500 mm (Fig. 5) and on the rear axle with the range of

300 mm. The vehicle was further equipped with four electric meters, one at each side for unsuspended material (Fig. 6) and one for suspended material was located at the vehicle frame over the axle.

Fig. 4: Measuring equipment.

Fig. 5: Displacement sensor.

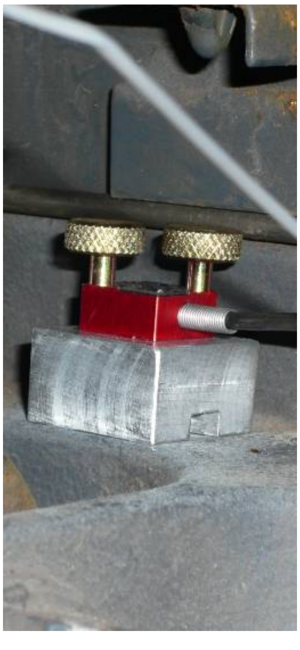

Fig. 6: Accelerometer.

The vehicle ran through the pre-determined route of roughly 30 miles (about 48 km), while recording the data from individual sensors. The testing route was divided into several sections: an urban section with a low-quality surface (potholes, wavy road) and a speed section where the vehicle kept reaching a maximum construction speeds. After driving through the indicated section, the current shock absorbers setting data collected by the test driver and his feelings of the vehicle behaviour were recorded. Data was saved in digital format without breakeven as d7d file, which is special file of Dewetron company. Consequently, the data collected were compared with the measured data (Fig. 7).

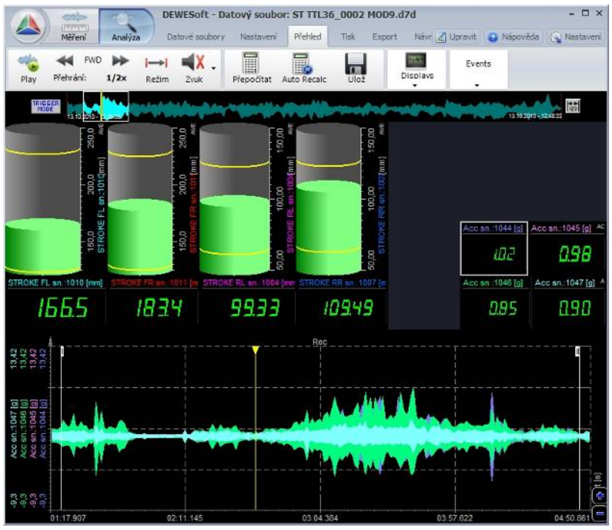

Fig. 7: Measured values in Devesoft.

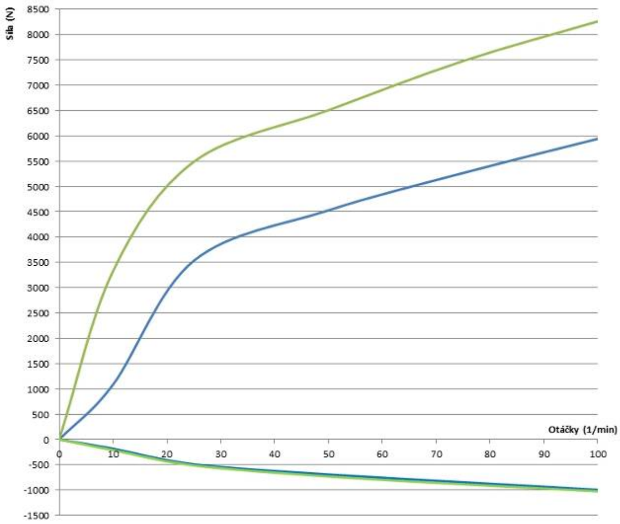

Fig. 8: Setting limits of shock absorbers.

Minimum and maximum attenuation values were calculated before the proper testing and then verified by the test drives (Fig. 8). After each test drive and the measured data analysis, the shock absorbers were removed from the vehicle, disassembled, re-tuned and re-installed for the next testing.

This procedure was repeated until the required tuning and the best compromise between the driving properties of an empty and fully loaded vehicle were achieved. In this event, the shock absorbers have been disassembled, re-tuned and re-installed about forty times.

All the data collected from all the measuring outcomes were thoroughly filed by reason of laboratory measuring and for working-life testing of a shock absorber.

4. Conclusions

The above indicated shock absorber testing and tuning presents only a rough description of the problem. Despite shock absorbers seem to be a simple topic at first sight, in fact it is a complex issue requiring extensive theoretical and practical experience and expensive background with different testing situations, prototype workshop and other facilities.

At present, the new trends in the field encounter the controlled type of shock absorbers even at trucks and trailers. Company BRANO a.s. proceeds this way, concentrating on several different systems of telescopic shock absorbers control systems.

Acknowledgement

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