

PASSENGER CARS BREAKING AFTER TYRE PUNCTURE BY TIRE DEFLATION DEVICE IN THE CASE OF STANDARD AND RUN ON FLAT TYRE TYPE

PIOTR STRYJEK¹, GRZEGORZ MOTRYCZ², JERZY GRZESIAK³

Military Institute of Armoured and Automotive Technology

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Summary

Operation of stopping the driver that don't subordinate to the police order is very difficult and danger. Hazard can concern both the officer, halted person and third party persons. In the scope of tests there have been done series of controlled runs over the road spike strip with different speeds, beginning from typical town traffic speed, up to the speeds characteristic for driving on motorway. It has been tested not only the car behaviour during the moment of tire puncture, but also stability and driveability when driving with already failed tire. It has been done comparison of standard tyres and Run On Flat tyres, that enables driving without pressure. For both tyre types have been done tests of breaking effort and realized four drives up to complete destroying the tyre shoulder. This test aimed to test usefulness the Run On Flat tyres for police vehicles. The job has been realized within a framework of research – developing project nr OR00000911, "Elaborating the technical requirements and range of necessary equipment for police vehicles, on the base of tests of standard demonstrations" carried out by Military Institute of Armoured and Automotive Technology in cooperation with Firm AMZ, Kutno.

Keywords: police vehicles, vehicle breaking with failed tyres, Run On Flat, stability and driveability.

¹ Okuniewska 1 Str., 1 05-070 Sulejówek, Poland, ph.: +48 22 681 10 44, e-mail: piotr@stryjek.eu, fax: +48 681 10 73

² Okuniewska 1 Str., 1 05-070 Sulejówek, Poland, ph.: +48 22 681 10 44, e-mail: grzegorz.motrycz@witpis.eu, fax: +48 681 10 73

³ Okuniewska 1 Str., 1 05-070 Sulejówek, Poland, ph.: +48 22 681 10 44, fax: +48 6-811-073

1. Introduction

Operation of stopping the driver that don't subordinate to the police order is very difficult and danger. Hazard can concern both the officer, halted person and third party persons. It is connected not only with the moment of tire puncture in halted vehicle but also with continuing the driving after the tyre puncture. Vehicle without the air pressure in the tyres is very difficult in driving and it's stability is very restricted.

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In the scope of tests there have been done series of controlled drive over the road spike strip with different speeds. It has been tested not only the car behaviour during the moment of tire puncture, but also stability and driveability when driving with already damaged tire. It have been tested not only the car behaviour during the moment of tire puncture but also the behaviour when driving with already damaged tire. There have been carried out the comparison of standard tires and Run On Flat (RSC) tyres that enable driving without air pressure.

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Police vehicles very often drive as privileged vehicles achieving high speeds in open road traffic. Therefore parameters connected with the vehicle stability and driveability should be very high. The vehicles should be either accommodated to overcome typical urban and land obstacles, which can encounter during pursuit on the hardened and gravel road. RSC tyres characterize strengthened sidewalls and ply design. This features cause that tyres of this type could be the optional equipment for police vehicles. Tyre of RSC type theoretically should be more resistive to mechanical damage, thus improving police vehicles mobility.

2. Stopping vehicle by the use of road spike strip

Assembly of the road spike strip consists of the series of thin sharp tipped tubes. When vehicle is driving over the spike strip, follows the penetration the tube into tyre and purposeful draw up the tube from the spike stripe (Fig. 1 and 2). It has a purpose to speed up the process of tire deflation. In the case when spike stripe had been assembled of uniform solid spikes, that additionally, after the vehicle drive remain in the stripe, the tyre puncture could be self sealed, and the effectiveness of the pressure drop in the tyre could be very low.

It has been tested the vehicle breaking distance for vehicles with good and punctured tyres. Tests have been done with good tires, one punctured tire and two punctured tyres of front axle. The tests have been carried out for speeds 60 and 80 kph. In this place it is to emphasize that exists some random number of tyres punctured during the drive thru.



Fig.1 and. Fig 2.View the spikes drawn into the tyre and the spike strip after driving over test.

In most cases it is to estimate, that failure/pressure drop will undergo two wheels of front axle. However in dependence of front and rear wheel track and in some extent from driving speed, can come to failure of rear wheels, one or all.

Irrespectively to test configuration, breaking the vehicle equipped with ABS was stabile, driver didn't have to make great correction by steering wheel, and breaking distance wasn't considerably different from breaking distance of the vehicle with good tyres (Fig.3). In the case of failure the two wheels of steering axle, the vehicle was less sensitive to the steering wheel control, what was the smaller problem in the case of breaking along strait line, but caused great problem for driver, when breaking on curve or his efforts to continue driving.

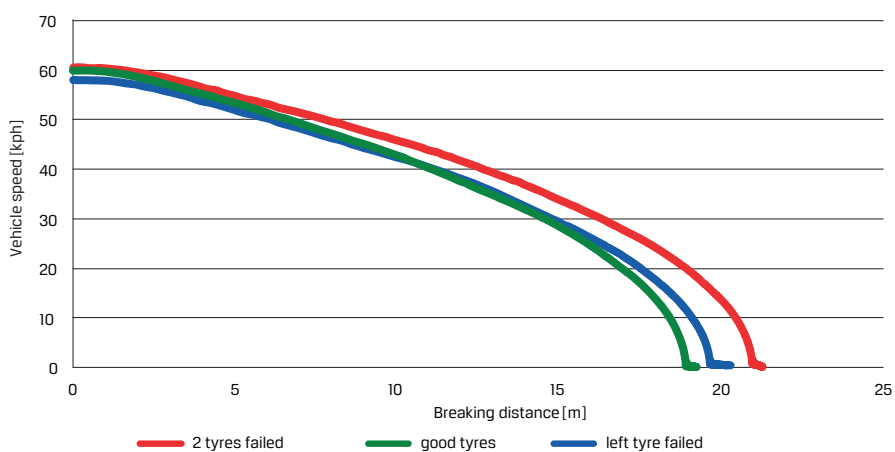


Fig. 3. Breaking distance diagrams for vehicles with good tyres and vehicle with failed front axle tyres.

Driving over the spike strip have been done with speeds 60, 100 and 140 kph. In the all tests the vehicle behave stabile in the moment of tyre puncture. The driver didn't feel in some exceptional way the moment of driving over the spike strip. Time, that elapsed to full tyre deflation was about 3 s. During this time, when in tyres was full pressure, vehicle was fully driveable However after the pressure drop it comes to considerable loss of driveability. The vehicle become oversteer and practically it's control was limited to minimum (fig. 4 and 5).



Fig. 4 and Fig. 5. The view of car driving thru spike strip and effort to driving trough the curve with punctured front wheel tyres (vehicle strongly oversteer).

Thus very danger is period after driving over the spike strip, when driver doesn't realize yet, that within a while the vehicle will be practically uncontrollable. During the first period, when it is still air in the tyres, he can be convinced, that the spike strip didn't make any effect. However after about 3 seconds, vehicle discontinue to be controllable. It is especially danger when after driving over the road spike strip the driver will intent to make a turn in built up area.

Thus in practice the road spike strip should be placed in order to after the driving over spike strip the road configuration should force driving the vehicle in straight line. The spike stripe shouldn't be placed just before the road curve. It creates the situation, where the driver won't be able to turn the vehicle, and falling out the road will create the hazard for other road participants.

3. The use of Run On Flat tyres in police vehicles

To test the resistance of wheel rim and tyre to the drive with lowered pressure, there had been done driving and breaking tests for standard tyres and tyres with reinforced shoulders Run On Flat type (denoted by Goodyear as RSC). Reinforcements in the sidewalls of this tyres enable, as to the producers, driving without pressure distance 80 km with speed 80 kph. Thicker shoulder should either protect the vehicle wheel rim and tyre against mechanical damage.

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For each tyre type it have been done about 10 following each other breaking tests from the speeds 60 and 80 kph, and realized about 5 km drive with intensive acceleration and violent manoeuvres. The drives were done on the asphalt road, without significant damage and losses. In spite of low distance travelled, it come to total damage of standard tyre (fig6). The RSC type tyres didn't show any external signs of wear.

Though that the RSC type tire didn't show any signs of defects the external shoulder, the analyse of its structure after disassembling the tire from wheel rim showed it's quite substantial internal damage – substantial material loses (Fig. 7). After the test the tyre wasn't able to further use.



Fig 6. Comparison the visible external tyre wear of standard tyre(on left) with RSC type tyre.



Fig.7. View the wear of internal side of RSC type tire.

Additionally it has been observed very dangerous phenomena. This tyres keep the good driving stability only while driving in strait line. During dynamic drive on curve it comes to slide the tyre from the wheel rim (Fig.8) and dangerous situation of considerable worsening the adhesion of particular axle. Effect of sliding out the RSC type tire from wheel rim is exceptionally danger in the case of the vehicle rear axle. Vehicle presents then very high oversteering, difficult to master by the driver (Fig.9).

It is so dangerous phenomena , that in the case of standard tyre failure (Fig 10 and 11) it comes quickly to it completely slide out or damage and the same the necessity to stop the vehicle. Therefore the driver don't have physical possibility to continue the drive. In the case of RSC type tyre, driver convinced of possibility to continue the driving, can drive long distance with speed up to 100 kph and in the moment of violent drive into road curve will be surprised by a vigorous vehicle reaction by the high speed.

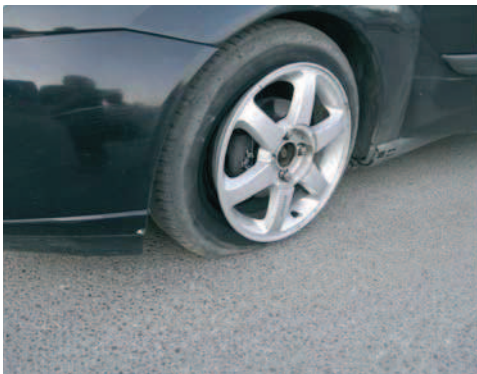


Fig.8. View the RSC type tyre – tyre bead undergone considerable shift on the wheel Rim.



Fig.9. View of the car during drive on failed RSC tyres on rear axle (film frame).



Fig. 10. and 11. View of the standard tyre damage after driving without pressure.

4. The wheel resistance to impact loads

In the scope of the project it has been tested the resistance vehicle wheels to mechanical damage. Police vehicle wheels should be show very high resistance to typical town obstacle, as banquetts or loses in the roadway. Tests of wheel rims and tyres resistance to impact loads have been done using special obstacle, designed in the scope of project (fig.12). The obstacle height has been determined as 10 cm, the value similar to road banquetts.



Fig.12. View of the obstacle for testing wheel rims and tyres to impact loads and vehicle under test.

The test consist of two driving over the obstacle with speed 50 kph with the use of one piece of tested wheel. For the tests within the project it have been selected some combinations of the wheel rims and tyres, namely:

- a) aluminium wheel rim and steel wheel rim with the same tyre type (Fig.13);
- b) different types of aluminium wheel rims;
- c) the same type of aluminium wheel rim with tyres with different tyre profile (Fig.14);
- d) steel wheel rims with tyres with different tyre profile.

The detailed test results will be used for works upon requirements for chassis for police vehicles. However on the present stage it can be stated, that in the effects of failures analysis of described in the paper tyres of RSC type, they have good resistance to mechanical defects.

However it is to notice that the tests results very often were ambiguous. For instance it has been stated that high profile tyre considerably protects the wheel rim against the damages. But the tyre alone can be more sensitive to the cord cutting. In the case of tyres with low profile (profile 40 – 55) it is the higher probability the damage of wheel rim. It however depends on the tyre design and its shoulder rigidity. Therefore during the tests similar damages have been observed for tyre 205/40R16 as for 205/55R16, besides the first tyre with lower profile characterized distinctly more rigid shoulder.



Fig.13. Comparison the defects of aluminium wheel rims with the same tyre types.

Fig. 14. Comparison defects of one type wheel rims by different tyre profile.

Within the project have been done another tests, for instance breaking efforts of police vehicle equipped with different type of friction linings Results of the tests will be published after finishing the project and elaboration final requirements according to the effectiveness of breaking systems.

5. Statements

Halting the vehicles by police using road spike strip is effective. After the drop down the pressure in tyres, vehicle becomes low driveable and further drive is very difficult. It is to remember, that road spike strip should be placed in a such way that the driver will have enough time to realize that vehicle's driveability worsens and that there is proper strait road segment to halt the vehicle. The RSC type tyres enable driving without pressure in tyres, practically it is possible only with low speed and on the strait road. In the case of acting onto tyres strong side forces, it comes to its slide from the wheel rim and abrupt falling down the driveability of the vehicle.

References

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