A STUDY OF THE ABS INFLUENCE ON VEHICLES DECELERATION

ИЗСЛЕДВАНЕ ВЛИЯНИЕТО НА ABS ВЪРХУ СПИРАЧНОТО ЗАКЪСНЕНИЕ НА АВТОМОБИЛИ

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Abstract: *This paper presents a study of the Anti-blocking System (ABS) influence on vehicles deceleration. Studies were conducted in different road conditions and different vehicles. A highly valued test instruments for non-contact speed and distance measurement is represented. The results of this study can be very useful in the expert practice.*

Keywords: ABS, DECELERATION, ROAD SURFACES.

1. Introduction

In vehicle accident reconstruction particularly important stage is determination of the vehicles longitudinal deceleration (tire–road coefficient of friction) for different road conditions and Anti-blocking System (ABS) influence on this deceleration. The longitudinal deceleration is one of the main parameters of the braking system.

Unfortunately the experts, in the calculation of the stopping distance, very often use data for the coefficient of friction from technical press. The data from technical press is for old cars and does not reflect the actual conditions in which the accident occurred. This leads to inaccurate calculations and conclusions about the possibility of drivers to prevent accident by braking. The actual coefficient of friction value depends on road surface, tires, vehicle speed, etc. On the other hand vehicles deceleration is influenced also by ABS, vehicle stopping capability, etc. In judicial practice, due to the different information of evidence and witnesses, often raises questions about the ABS influence on vehicle deceleration and stopping distance.

2. Prerequisites and means for solving the problem

For a study of the ABS influence on vehicles deceleration used VBOX 3i Data Logger and IMU02 (фиг. 1), of a Racelogic Ltd – UK company [4]. VBOX 3i is highly valued test instruments for non-contact speed and distance measurement. The VBOX 3i 100Hz has a very powerful processor ensuring low latency with updates of speed, position and acceleration, 100 times a second. All data is logged to a compact flash card [5].

By connecting the VBOX 3i to the Racelogic Inertial Measurement Unit, a real time Kalman Filter will correct the GPS in areas of poor GPS reception, and will output Pitch, Roll and Yaw values at 100Hz.

Fig. 1. *VBOX 3i 100Hz GPS Data Logger (1) and acceleration sensors IMU02 (2)*

The IMU02 from Racelogic is a full Inertial Measurement Unit that can measure Z, Y and X axis rotational rate (yaw, pitch and roll) as well as X, Y and Z axis acceleration (fig. 2).

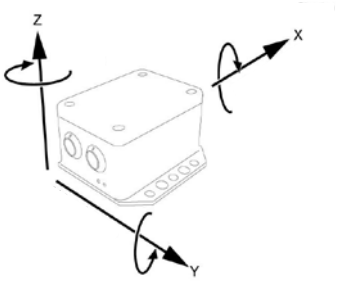

Fig. 2. *X, Y and Z axis acceleration measurement*

The IMU02 is mounted as close as possible to the centre of the vehicle. It is also important to mount the sensor so that it is level with the ground (fig. 3).

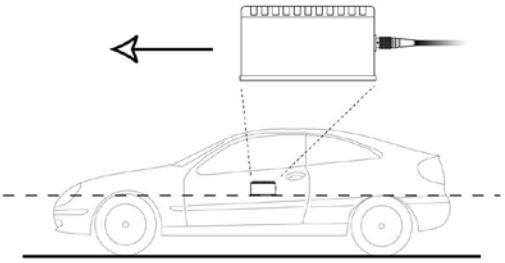

Fig. 3. *IMU02 sensor position*

The IMU02/YAW03 channel data will be recorded along with the existing GPS data in VBOX 3i 100Hz GPS Data Logger on the SD card. Accuracy of acceleration measurement is ±0.01 G [4].

Method of the study involves a series of tests to determine the vehicles deceleration (tire–road coefficient of friction) and ABS influence on this deceleration for dry asphalt road surface, wet asphalt road surface and snow-covered road surface during emergency braking. The studies were conducted by Ford Focus, Citroen Xsara Picasso and BMW 3er with recording equipment VBOX 3i Data Logger and IMU02 (фиг. 1). To determine the influence of the ABS, tests were conducted on all surfaces respectively with ABS and ABS off (fig. 4)

Fig. 4. *BMW 3er ABS off*

3. Results and Discussion

The results of the study were obtained with *VBOX Tools Software*. The VBOX Tools software is a very powerful software analysis package. VBOX Tools has been designed to easy to setup and use, yet very flexible allowing many custom styles of test to be performed, as well as providing templates of common test setups. Processing mode, a ".vbo" file were taken from a compact flash card and loaded into the software, allowing to graph, analyze and replay the data.

The results are processing and presented in two methods. The first one includes determining of the deceleration from the beginning of the increase of the car deceleration to zero car speed (fig. 5).

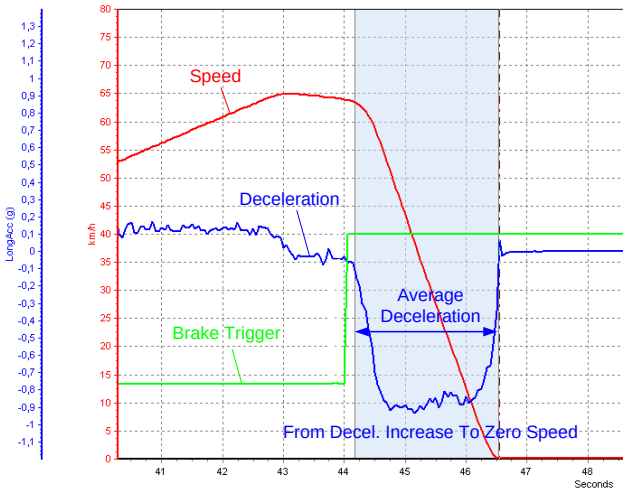

Fig. 5. *VBOX Tools Software - first method*

The second one includes determining of the maximum car deceleration (fig. 6).

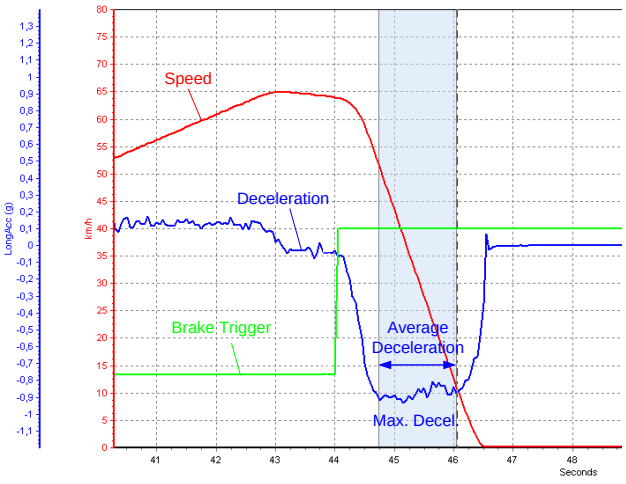

Fig. 6. *VBOX Tools Software - second method*

The Report Generator is the main "numbers engine" in the VBOX Tools software, and is designed to create a highly configurable table of results (fig. 7).

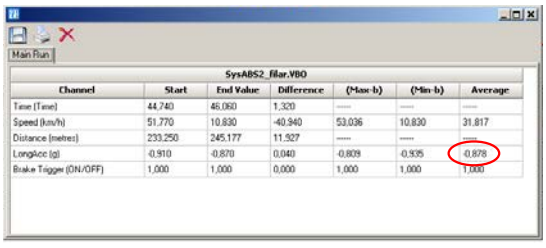

Fig. 7. *VBOX Tools software table of results*

The columns of the table can contain any parameter logged by the VBOX, and may also show maximums, minimums, and averages. The scale and offset of any channel is also configurable [6].

Fig. 8 and fig 9 shows graphically the results for the vehicles longitudinal deceleration and ABS influence for the Ford Focus. Fig. 8 shows the results according to first method of processing and presentation of results (fig. 5). Fig. 9 shows the results according to second method of processing and presentation of results (fig. 6).

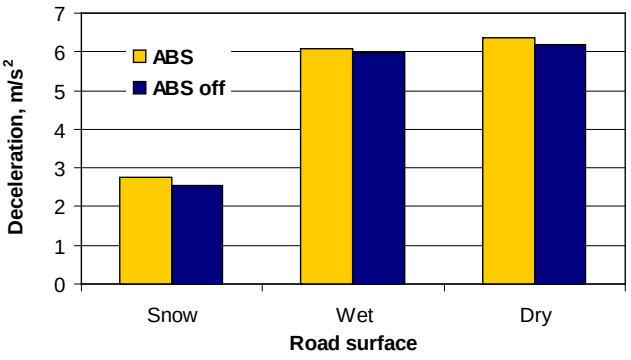

Fig. 8. *Average longitudinal deceleration for Ford Focus*

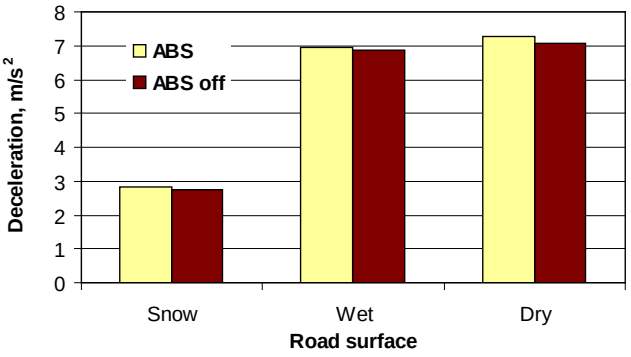

Fig. 9. *Maximum longitudinal deceleration for Ford Focus*

The Ford Focus results, according to first method of processing (fig. 8) shows that the deceleration on dry asphalt for ABS and ABS off are respectively 6,38 m/s^2 and 6,18 m/s^2. For the wet asphalt – 6,08 m/s^2 and 5,98 m/s^2 and For the snow-covered surface - 2,75 m/s^2 and 2,55 m/s^2. The results, according to second method of processing (fig. 9) shows that the deceleration on dry asphalt for ABS and ABS off are respectively 7,26 m/s^2 and 7,06 m/s^2. For the wet asphalt - 6,97 m/s^2 and 6,87 m/s^2 and For the snow-covered surface - 2,84 m/s^2 and 2,75 m/s^2.

Comparing the ABS deceleration with ABS off deceleration (Fig. 8) follows: for dry asphalt - 3,1 % decrease; for wet asphalt - 1,6 % decrease; for snow-covered surface - 7,3 % decrease.

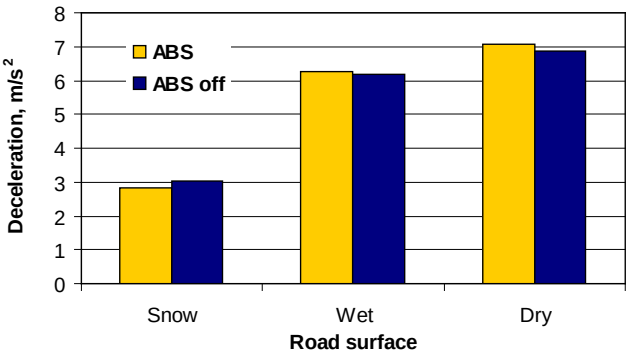

Fig. 10. *Average longitudinal deceleration for Citroen Xsara Picasso*

Fig. 10 and fig 11 shows graphically the results for the average and maximum longitudinal deceleration and ABS influence for the Citroen Xsara Picasso.

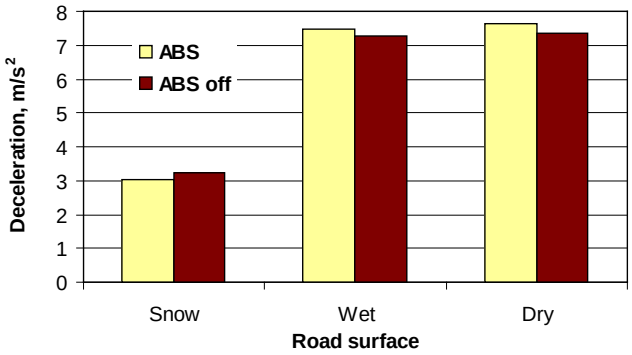

Fig. 11. *Maximum longitudinal deceleration for Citroen Xsara Picasso*

The results (fig. 10) for the ABS deceleration and ABS off deceleration dry asphalt are respectively 7,06 m/s^2 and 6,87 m/s^2. For the wet asphalt – 6,28 m/s^2 and 6,18 m/s^2 and for the snow-covered surface - 2,84 m/s^2 and 3,05 m/s^2. The results (fig. 11) shows that the deceleration on dry asphalt for ABS deceleration and ABS off deceleration are respectively 7,65 m/s^2 and 7,36 m/s^2. For the wet asphalt – 7,46 m/s^2 and 7,26 m/s^2 and for the snow-covered surface – 3,04 m/s^2 and 3,24 m/s^2.

Fig. 12 and fig 13 shows graphically the results for the average and maximum longitudinal deceleration and ABS influence for the BMW 3er.

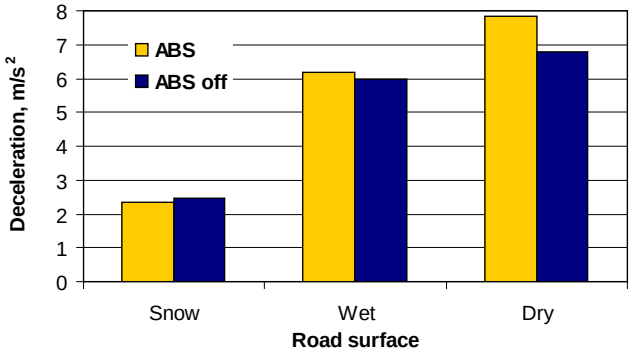

Fig. 12. *Average longitudinal deceleration for BMW 3er*

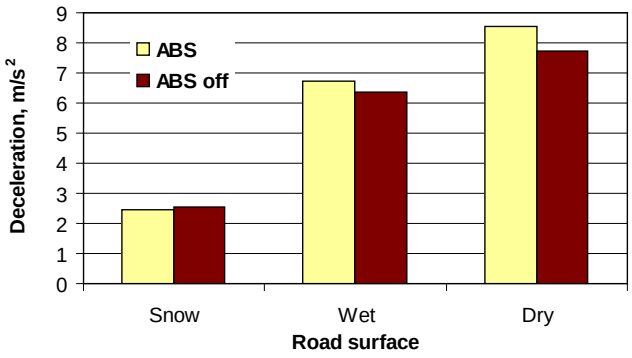

Fig. 13. *Maximum longitudinal deceleration for BMW 3er*

The results (fig. 12) for the ABS deceleration and ABS off deceleration dry asphalt are respectively 7,85 m/s^2 and 6,77 m/s^2. For the wet asphalt – 6,18 m/s^2 and 5,98 m/s^2 and for the snow-covered surface - 2,35 m/s^2 and 2,45 m/s^2. The results (fig. 13) shows that the deceleration on dry asphalt for ABS deceleration and ABS off deceleration are respectively 8,53 m/s^2 and 7,75 m/s^2. For the wet asphalt – 6,72 m/s^2 and 6,37 m/s^2 and for the snow-covered surface – 2,45 m/s^2 and 2,55 m/s^2.

Comparing the ABS deceleration with ABS off deceleration (Fig. 12) follows: for dry asphalt – 13,8 % decrease; for wet asphalt - 3,2 % decrease; for snow-covered surface - 4,3 % increase.

All study for wet asphalt were conducted immediately after stops raining. Pressure in car tires had limits specified by the manufacturer. The speed of the car from which the starting braking was in the range of 50 - 60 km/h.

The results of this study indicate that the ABS longitudinal deceleration influence of these cars is greatest for dry conditions. It is in the range of from 2,7 % to 13,8 %. for wet asphalt this influence is negligible – up to 3,2 %. For snow-covered surface for two cars ABS off longitudinal deceleration is greater. The results indicate that further research is needed to determine the ABS longitudinal deceleration influence for snow-covered surface.

4. Conclusion

As a result of this study can be made the following conclusions:

- Were obtained values for average and maximum longitudinal deceleration for different cars and different road conditions.

- Comparing the ABS average deceleration with ABS off deceleration follows:

For Ford Focus: dry asphalt - 3,1 % decrease; wet asphalt - 1,6 % decrease; snow-covered surface - 7,3 % decrease.

Citroen Xsara Picasso: dry asphalt – 2,7 % decrease; wet asphalt - 1,6 % decrease; snow-covered surface - 7,0 % increase.

BMW 3er: dry asphalt – 13,8 % decrease; for wet asphalt - 3,2 % decrease; for snow-covered surface - 4,3 % increase.

6. References

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