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A STUDY ON THE ACTUAL DETERMINATION OF THE BRAKING PARAMETERS OF THE VEHICLE BY MESURING THE DECELERATION/ACCELERATION AND THE STOPPING SPACE IN RELATION TO A BRAKE PEDAL TRIGGER SIGNAL, AS COMPARED TO THEIR CALCULATION AFTER THE BRAKING TRACES, AND IDENTIFYING THE DRIVING STYLE OF A DRIVER USING A BLACK BOX TYPE DEVICE

Engineering

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ABSTRACT

This paper presents a "Black Box" device design and accomplished within the research project "Black Box and CRM type platform for risk assessment and mitigation in road traffic" MYSMIS code 115919, the device monitor, acquire and record some functional and dynamic parameters for motor vehicles in order to detect and report traffic risk situations, identifying the driving stile of a driver, violation of legislation as well as the possibility of reconstructing road accidents or special traffic events. The materialization of this equipment resulted from the need to know and to access useful data and information which can help forensic investigators in the case of an accident, insurers in the event of damage, specialists in road safety and traffic monitoring, to medical staff dealing with victims or medical emergencies resulting from road accidents, or even drivers looking to monitor the evolution of an event in which they were directly or indirectly involved as witnesses. All these data can also be saved to an internal eMMC flash memory or to an external micro SDXC card making from this device a data logger. Stored information in black-box memory can be encrypted to ensure the data confidentiality and protect the individual property rights. Stored data can be accessed via a CAN interface using a key and a password. The Black-Box device can be simple integrated in vehicle's electronic control architecture, using provided CAN interface.

KEYWORDS

Black-Box, OBD, CAN

INTRODUCTION

The reconstruction of traffic accidents often requires the determination of the speed of a vehicle immediately before the start of braking, which requires knowing the grip and implicitly the coefficient of friction proper to the tread surface where the event occurred. Because the adhesion of a surface depends on a number of factors including tire type, climatic, environmental conditions and road condition at the time of the event, the correct estimation of the coefficient of friction is a serious problem for any expert. Most of the time the technical experts use one of the following two methods: it adopts a general friction coefficient valid on an extended range of conditions that either are not specified or cannot quantify their own accident reconstruction; or more rarely, performs certain experiments using the same type of tire at the place of the accident to be carried out under the same climatic conditions and condition of the road. But most of the time, these experiments are carried out using another type of vehicle, other tires, or in other road conditions or external conditions due to subjective factors.

As the braking systems of vehicles become more and more technologically advanced, dynamic performances are more subtle and more difficult to highlight. In order to be useful in determining the stopping distances - and thus the braking performance - the results of the measurements must repeatedly have precision below 50 cm.

First, before starting the tests, the brakes and tires must be heated by a series of standard maneuvers, before accelerating the vehicle to a speed above the threshold at which the braking test is to be performed, followed by bringing the transmission to the neutral point. When the threshold speed is reached, press the brake pedal as fast and as tightly as possible.

The stopping distance is determined from the moment when the brake pedal is brought to the lowest point, or from the moment of reaching a preset speed until the speed drops to zero.

The tests are repeated a number of times, finally calculating an average stopping distance.

When evaluating the behavior of the braking system (hydraulic component, electronics and tires), it is compulsory to use sensors attached to the brake pedal to measure the pedal press force.

If only an evaluation of the tire performance is desired, the braking test is carried out between two threshold values of the vehicle speed, the starting speed being set when the car has reached a state of stability during the evolution of the braking process, in order to eliminate the driving time. mechanical-hydraulic braking system response. This type of test allows a very accurate assessment of the performance of tires with similar behavior and construction.

Finally, another type of test in this category measures the deviation of the vehicle's trajectory from the predetermined course due to the application of the brake, allowing the assessment of the maneuverability of the machine under emergency or force braking conditions.

A brake sequence starts when the brake pedal is pressed and ends either when the pedal is released or when the vehicle is stopped. The distinction must be made between the stopping distance and the braking distance, the former being decisively influenced by the driver while the latter mainly reflects the characteristics and performance of the braking system of the vehicle and represents the last and most important part of the stopping distance.

The braking sequence is characterized by a series of moments defined on an ideal diagram as in Fig. 1. On this diagram are visualized in relation to the time, the graphs of the vehicle's speed and deceleration, the distance traveled, as well as a signal generated by the brake pedal press (trigger, angular variation, or force of push). Optionally, the variation of pressure in the braking pipes represents valuable information regarding the response times of the studied braking system.

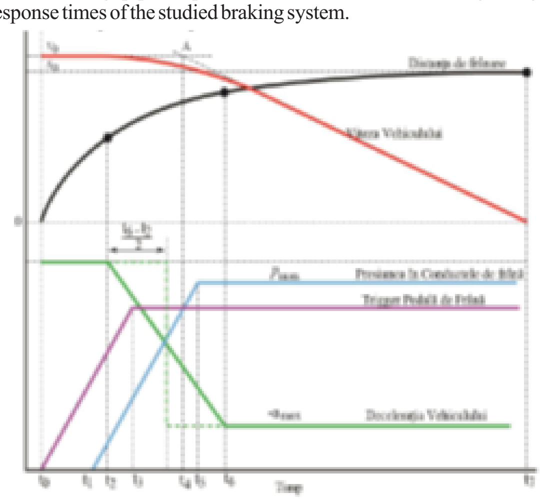


Fig.1 The braking sequence ideal diagram

On a real diagram as shown in Fig. 2 obtained in the tests with the mobile laboratory a series of time intervals can be modified or more difficult to highlight. One of the important parameters in a braking maneuver is the response time of the trb system defined as the elapsed time between the moment of the pedal press, t0 and that of the pressure generation in the brake pipes t1. It cannot be highlighted without the variation of pressure in the braking system (see Fig. 19), but even then it is difficult to determine. Another important parameter is the time when the brake fluid pressure reaches a maximum and stable value, tpb =t5-t1.

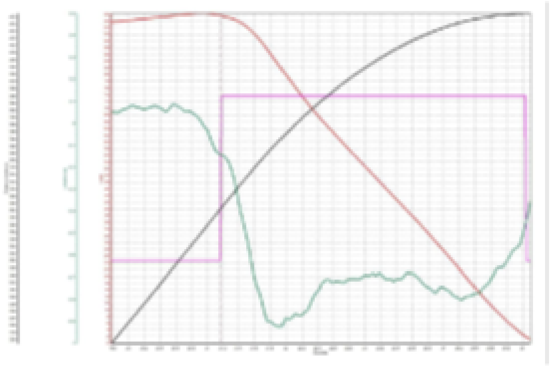


Fig.2 The braking sequence real diagram

The estimation of the friction coefficient is based on the difference of kinetic energy lost by the vehicle during braking and which is equal to the mechanical work of the locked wheels that slide on the asphalt over a distance corresponding to the stopping space.

Mathematically, this physical law is expressed by the relation: $12 \cdot m \cdot vi2-12 \cdot m \cdot vf2 = \mu \cdot m \cdot g \cdot Ls$

where: m represents the mass of the vehicle
v i - initial speed
v f - final speed - friction coefficient L s - braking distance between v i and v ff.

Eliminating the mass and considering the final speed zero (complete stop of the vehicle) results in an estimation of the coefficient of friction can be made with the relation: $\mu = vi22 \cdot g \cdot Ls$

Considering the speed in km / h, and g = 9.81 m / sec2 the formula becomes: $\mu = vi, km/h\,2254.27 \cdot Ls$

In case there is a tilt of the tread (ascending-ramp or descending - slope) with an angle of the previous formula is changed as follows: $\mu = vi2-vf22 \cdot g \cdot cosa \cdot Ls \pm tga$

Where the value + is for the negative slope (descent), and the value - for the climb.

The calculation accuracy of the friction coefficient depends first of all on the accuracy of the measurement of dynamic braking parameters (stopping distance, total real time of effective braking, deceleration, speed). It must always be done series of successive tests, the coefficient of friction being an average value of the measurements.

The estimation method presented is more accurate when the quality of the tread surface is homogeneous and similar over the entire portion of the braking test, and its inclination is perfectly horizontal. At the same time, it is necessary to deactivate the ABS system that eliminates the locking of the wheels by braking and determines lower dynamic coefficients than the static ones (the completely locked wheel).

The tests were carried out over several days on a straight section of road, perfectly horizontal, relatively recently paved and rarely circulated, with dry roads, when the braking tracks could be accurately highlighted and measured following the tests for the wet road to be later. prepared and accomplished in the functions of the first results obtained. It is known that on the wet road the braking traces are usually not visible.

For each test, the mobile laboratory was accelerated at speeds of around 80-100 km / h, after which the acceleration pedal was released, and the brake pedal pressed under emergency braking and kept in this state until the laboratory stopped.

In Fig.3 you can see the visible traces left by the Mobile Laboratory in a braking test due to the deactivation of the ABS system and the locking of the wheels.

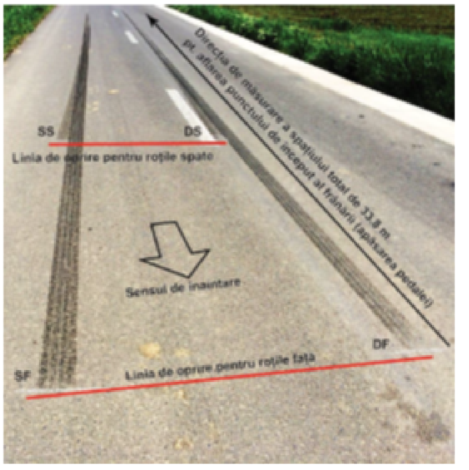


Fig. 3 Braking traces with ABS de activated

In order to determine the difference between the length of the space determined by the GPS device and the braking tracks, the procedure is performed as follows, the method being graphically illustrated in Fig.4

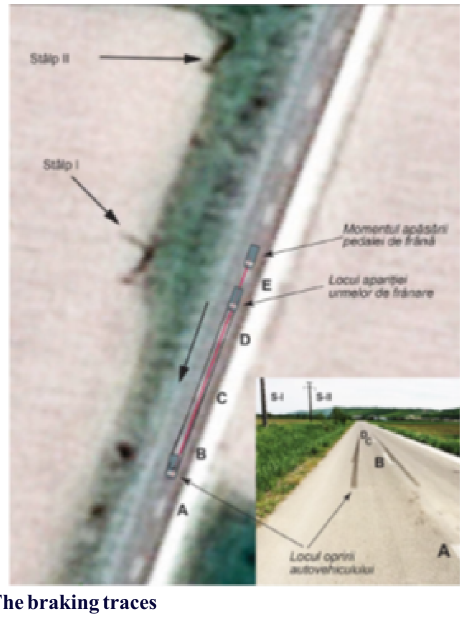
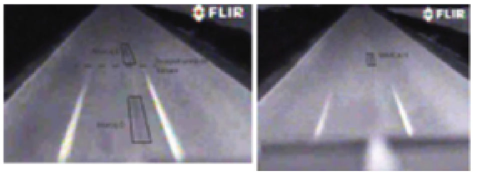


Fig.4 The braking traces

It can be observed that it is almost impossible to specify the exact beginning of the braking footprint, especially when the road already has a number of previous traces left by other vehicles, or the road is dirty. For this reason, in addition to the direct reading using the graduated wheel and the laser roulette, we also used a F lir Find Path type thermal chamber, which can highlight the braking traces due to the heat transmitted by the tire to the asphalt by friction. It is very important to identify on the spot the spot where the brake pedal was pressed compared to the beginning of the braking steps. As with them, the traces of heat are much weaker only partially noticeable in the case of wet roads.

The thermal camera allows to display all the points of an image that have the same temperature in a certain color or shade of gray (for the black and white camera). Thus, in addition to the brake tracks that have a higher temperature and appear in lighter colors, the white marks of separation of the two bands that appear darker in color can be detected due to the cooler temperature of the area given with white paint compared to asphalt. warmer, unmarked.



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CONCLUSIONS

The use of the GPS device only by the triangulation method is not precise enough for very precise determinations of speed and braking space because it is influenced by numerous disturbing sources;

Use of mobile phone, car browser, tablet, etc. which have refresh rates below 5 Hz is not recommended for such tests and determinations, the errors introduced are very large. However, external GPS devices with acquisition speeds of at least 10 Hz can be used which can be coupled to Smart phone devices via Bluetooth.

The use of professional GNSS equipment and the Doppler effect on each satellite to measure the target speed at refresh rates of 50-100Hz allows to achieve precise measurements of the braking distance in the order of centimeters;

For accuracy of results it is advisable to use a measurement trigger signal from the brake lights, hydraulic block or a sensor placed on the brake pedal. The purpose of the trigger signal is to detect the moment when the brake pedal is pressed and to signal the start of the stop distance test.

The use of MEMS inertial measuring devices brings a benefit to the measurements due to the increased accuracy in measuring the dynamic parameters of the vehicle (ax, ay, az, Mx, My, Mz), especially in areas where the level of the received GPS signal decreases, and the level of measured noise increases.

The accuracy of the time measurement with GPS devices is unmatched, only inertial devices with sampling rates of 1 Ms / sec being able to approach that accuracy.

REFERENCES:

[1] Xunnian, Yang, Guozhao, Wang, 2010 Planar point set fairing and fitting by arc splines Computer-Aided Design 33 (2001) 35-43, Elsevier, http://www.math.zju.edu.cn/cagd/publications/2001_cad_yang.pdf;
[2] Deutsch, Paul Design of Horizontal Curves, http: //www. ugpti. org/dotsc/ engcenter/downloads/HorizontalCurves.pdf
[3] Baybura, T., Baykal, O., The Investigation of the Effect of the Vertical Alignment geometry on the Lateral Change of Acceleration, 2005, Engineering Surveying Symposium, ITU-Istanbul;
[4] Baybura, T., Geçki Düşey Geometrisinin Yanal Sademeye. Etkisinin Araştirilmasi, Feb.12 2001, PhD Thesis, İstanbul Teknik Üniversitesi;
[5] Baykal, O. (1996). "Concept of Lateral Change of Acceleration." J. Surv. Eng 10.1061/(ASCE);
[6] McCrae, J., Singh, K., Sketching Piecewise Clothoid Curves, 2008, EUROGRAPHICS Workshop on Sketch-Based Interfaces and Modeling (2008);
[7] Meek D., Walton D.: Clothoid spline transition spirals. Mathematics of Computation 59, 199 (July 1992), 117–133;
[8] Nutbourne A. W., McLellan P. M., Kensit, R., Curvature profiles for plane curves. Comput Aided Des. (1972), 176–184;
[9] Gaiginschi, R., Reconstrucția și Expertiza Accidentelor Rutiere, 2009, Editura Tehnică, București
[10] Zomotor Adam, "Fahrwerktechnik: Fahrverhalten", Vogel Buchverlag, 1991, ISBN 3-8023-0774-7;
[11] Mitschke M., Wallentowitz H., „Dynamik der Kraftfahrzeuge“, Springer Verlag, 2004, IV Edition, ISBN 3-540-42011 -8;
[12] Robert Bosch GmbH Ed. „Safety, Comfort and Convenience Systems”, Bentley Publishers, 2oo6, ISBN 0-8376-1391-4;
[13] Breuer B., Bill k., “Brake Technology Handbook”, First English Edition, SAE International, 2008, ISBN 978-0-7680-1655-0, SAE Order No. R-367;
[14] Limpert R., “Brake Design and Safety”, Second Edition, SAE International, 1999, SAE Order R-198, ISBN 1-56091-915-9;
[15] Gillespie T., “Fundamentals of Vehicle Dynamics”, SAE International, 1992, SAE Order R-114, ISBN 1-56091-199-9;