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Transportation Research Procedia 20 (2017) 212 – 218

Transportation Research Procedia

www.elsevier.com/locate/procedia

12th International Conference "Organization and Traffic Safety Management in large cities", SPbOTSIC-2016, 28-30 September 2016, St. Petersburg, Russia

Reconstruction of Road Accidents Based on Braking Parameters of Category L3 Vehicles

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Abstract

During the last decades, designs of two-wheel motor vehicles (TWMV) have been significantly improved, which is why it is required to bring the analytical tools used to estimate their braking parameters in line with those designs. However, the current expert analysis practice applied to motor vehicle accidents (MVAs) still uses for calculations the values of deceleration time and steady state deceleration for old, domestically manufactured motorcycles which are today rarely used for travel. Both these circumstances require processing, clarification and establishing an updated basis of TWMV deceleration estimate in order to enhance credibility of such estimate used in expert examination of MVAs, i.e. to ascertain the drivers' compliance or non-compliance with traffic regulations, to justify causes of accidents, to determine whether the driver could or could not have prevented a particular MVA.

Peer-review under responsibility of the organizing committee of the 12th International Conference “Organization and Traffic Safety Management in large cities”

Keywords: motor vehicle technical examination; two-wheel motor vehicle; MVA reconstruction; braking parameters; anti-lock braking system

1. Main text

The drawbacks of the existing method commonly used for calculation of TWMV speed at braking established as early as in the 60s of the XX century and still used in the Russian Federation for the purposes of expert examination lie in the fact that TWMV speed is calculated based on braking tracks, which results in a conservative value of the

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Peer-review under responsibility of the organizing committee of the 12th International Conference “Organization and Traffic Safety Management in large cities”
doi:10.1016/j.trpro.2017.01.054

calculated speed [Evtiukov and Vasiliev (2005), Evtiukov and Brylev (2013), Evtiukov and Vasiliev (2008), Evtiukov et al. (2016)].

The experience in expert examination shows that the actual speed of a TWMV by the moment of application of brakes is higher than the calculated one since experts intentionally use conservative, mean values of steady state deceleration and deceleration time to the steady state deceleration [Brylev (2015), Evtiukov and Brylev (2016), Guo et al. (2008), Evtiukov and Vasiliev (2015)].

The existing method of calculation of the vehicle speed, braking distance and stopping distance, deceleration time, time of moving away from the point of impact at the moment of danger occurrence, does not take into account the influence of availability of an anti-lock braking system (ABS), the type of motorcycle braking system and the motorcycle load variable on the TWMV steady state deceleration and the deceleration time [Brylev (2014), Brylev (2015), Evtiukov and Brylev (2013), Evtiukov and Brylev (2015), Evtiukov and Brylev (2016)].

The experience in expert examination shows that within the above context, the method of braking parameter estimation during MVA reconstruction taking into account the above peculiarities of a TWMV design and traffic conditions during application of brakes, provided that such reconstructed MVA is adapted to the whole MVA under examination to the full, makes it possible to bring it in line with present-day TWMV equipment which is capable of significantly increasing the accuracy of the braking parameter estimates and fairness of such estimate [Brylev (2014), Brylev (2015), Evtiukov and Brylev (2013), Evtiukov and Brylev (2015)].

The objective of the study is to define more precisely the method of MVA reconstruction by braking parameters of two-wheel motor vehicles capable of enhancing credibility of the calculations and fairness of the results of forensic studies.

The research subject is braking processes of two-wheel motor vehicles.

Scientific novelty of the research lies in the following results: more precise definition of the method of MVA reconstruction through adjustment of the current regulatory (averaged) values of the steady state deceleration, the deceleration time with consideration of the type of TWMV braking system, load of the vehicle, the type and condition of the road surface, availability of an ABS and the braking mode, i.e. the method comprising the solutions of all the above tasks, which provides for achieving the general objective of the research — determination of an adjusted method of MVA reconstruction by the TWMV braking parameters.

The methodological framework of the research is reconstruction of the mechanisms of motor vehicle accidents involving TWMVs, mathematical and statistical methods of experimental research data processing, experimental research regression analysis, and recommended methods of TWMV braking parameters calculation.

The analysis of the drawbacks of the existing method of estimating such basic parameters as stopping distance of the TWMV (S_o), speed before application of the brakes (V_a), time of moving away from the point of impact (S_y), stopping time (T_o), permissible speed based on the visual range condition (V_{mo}), that are traditionally used at the MVA reconstruction made it possible to determine that when choosing regulatory values of steady state deceleration and deceleration time the type of the TWMV anti-lock braking system, interim load of the vehicle, availability of the ABS are not taken into account despite the fact that they contribute to the values of braking parameters.

The results of a comparative analysis of compliance with the requirements for the values of steady state deceleration and deceleration time approved and recommended by Research & Procedure Development Council for Forensic Automobile Expert Examination at the All-Union Scientific Research Institute of Forensic Examination (VNIISE) of the Ministry of Justice of the USSR and introduced since January 1, 1991 and established by GOST 51.78-2001, and the values obtained during the experimental research show that the value of steady state deceleration and deceleration time of a TWMV is significantly conservative. This is due to the fact that the applied regulatory values were established without due consideration of significant changes in the TWMV design, their reliability and other performance attributes. In the context of the Russian expert examination practice, those new attributes of TWMV designs have not been reflected in the design functions recommended for use during investigation and reconstruction of an MVA mechanism when determining the stopping distance, time of moving away from the point of impact, calculation of the speed at the moment of application of the brakes, the stopping time, and permissible speed based on the visual range condition.