The Change of the Safe Motion Speed at Night-Time

Mykola Bojkiv[1], Bogdanna Chudijovych[2]

[1]Transport Technology Department, Lviv Polytechnic National University, UKRAINE, Lviv, S. Bandery street 12, E-mail: bojkiv.mykola@gmail.com

[2]Transport Technology Department, Lviv Polytechnic National University, UKRAINE, Lviv, S. Bandery street 12, E-mail: danochkachudiovuch@gmail.com

Abstract* – *The research of the motion speed at night-time, when a driver falls under the influence of dazzled state caused by the opposite cars headlights, is analyzed in the paper. It is established that the dazzled state duration influences the motion speed, causes the motion unsteadiness of the whole traffic flow and makes the motion safety worse.

Key words – night-time, dazzled state duration, safe speed, safe distance, eyesight adaptation.

I. Introduction

The motion in the dense traffic flow claims extra attention and high concentration from the driver. During the motion in the dense traffic flow the driver of the vehicle which is moving in front ("leader driver") specifies many factors. Because of the road visibility restriction in front of the leader-car during the motion in the dense traffic flow, the driver of the vehicle which is moving behind cannot easily predict the reasons of probable speed reducing or emergency stop.

II. Night-time traffic problems

The statistics of accidents indicates that it is necessary to pay more attention to investigation of the drivers' emotional state at night-time for the purpose of better prediction of their behavior under low light conditions. The authors carried out the investigations of duration of driver's reaction at night-time, the results of which states that the reaction is closely related with his vision sensitivity. The low level of brightness range at night causes the wrong actions related with safe motion speed choosing [1]. The specific danger may occur when a driver is dazzled by the opposite cars headlights as a result of which the visibility suddenly becomes worse or sometimes even vanishes. The process of adaptation or restoration of vision (eyesight) functions after dazzling may vary within wide range of time and reach several seconds. During this time the car, which has even small speed, passes a large distance.

The worsening of the vision conditions causes the increasing of reaction time especially at night-time. It takes the driver about 2.5-3 seconds to bring into operation the vehicle braking system at night. This fact causes the increasing of the value of vehicle stopping way and requires an extra attention of the driver when choosing the safe motion speed. In a general sense, the motion speed at night must ensure the vehicle stop on the path length, which is visible due to its headlights.

The investigations states that the time of adaptation of driver's eyesight is considerably influenced by duration of dazzling. Dazzling is dangerous phenomenon even when its duration is too small but with increasing of its duration the danger intensifies [2].

On the basis of results of investigations of traffic modes during periods of morning and evening twilight the special hypothesis was formed with a help of Weber-Fechner law. The hypothesis states that on the basis of this law there exists a feedback between the horizontal light exposure during periods of twilight and motion mode and its safety [3]. Based on this fact the value of critical illumination intensity from the viewpoint of reducing of average motion speed of the vehicles is calculated and equals 50 lux.

In the conducted investigations the calculated dependencies of safety distance from the safe motion speed state that the largest influence on the safety distance is exerted by the duration of the driver's reaction when the motion speed is small [4]. In other words, under conditions of restricted visibility the calculation of safe motion modes should be carried out taking into account psychophysiological features of the driver.

More efficient method of the motion speed regulation is optical orientation of a driver which creates the conception of traffic conditions complication. Purposeful road planting, positioning of orientation posts (poles) create the conception of narrowing or widening of road carriageway, which cause reducing or increasing of the motion speed. The scientific substantiation of these methods were devised by E.V. Havrylov in his theory of interaction between a driver and traffic environment. It has considerable complications related with poor theoretical treatment of appraising of signal values of objects of driver's perception field. Experimental pattern of this appraising associates it with specific traffic conditions. The change of motion conditions causes large errors of appraising of admissible motion speeds [5].

The special feature, which complicates the perception of traffic situation when using headlights, consists in the fact that the increasing of motion speed of a car causes the reducing of road visibility range (distance). Because of the fact that this distance is one of the most important indicators of the motion safety which determines the speed modes of car motion under complicated conditions, that is why the investigation of motion speed changing at night-time, when a driver falls under the influence of dazzled state caused by the opposite cars headlights, was carried out. We will consider the change of motion speed during the period of driver's dazzling as speed flexibility.

III. Research of speed changes at night-time under conditions of dazzled state

The feature which complicates the perception of traffic situation when using headlights consists in the fact that increasing of car motion speed causes the reducing of visibility of the road. Because of the fact that visibility is one of the most important indexes of motion safety and determines the speed modes of the car motion under complicated conditions, that is why the investigation of

motion speed changing at night-time was carried out on the road of international importance. Under this conditions a driver often falls under the influence of dazzled state caused by the opposite cars headlights. The duration of dazzled state was varying within the range of 1-4 seconds and the process of dazzling was random and took its place when the traffic motion speed varied from 20 to 110 km per hour.

In the Fig. 1 the dependence of elasticity of motion speed from dazzling duration is presented. The maximal decreasing of the traffic motion speed was observed when the motion speed mode of the traffic flow was larger than 70 km per hour.

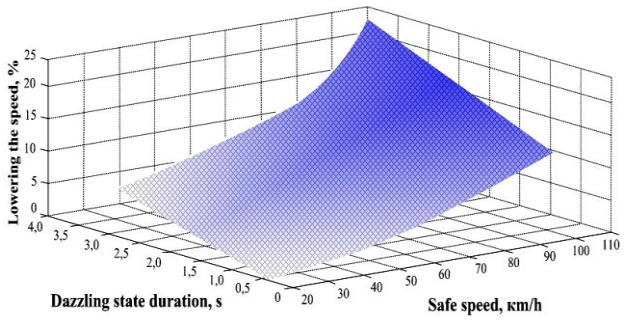

Fig. 1. Dependence of the motion speed change from dazzling state duration

By analysing of the obtained investigation results of motion speed changing under the dazzling conditions it was determined that increasing of average speed by 20% the speed elasticity increases by about 10%. Also we may state that even nonessential dazzling causes motion disproportionate of the whole traffic flow when the average speed of a vehicle in the traffic flow increases over 70 km per hour. Under real conditions, when the motion speed equals 60 km per hour and tha dazzling duration equals 2 seconds, the distance which the car passes under the conditions of dazzling is about 33.5 m.

Conclusion

The decisive factor for a driver when moving at night-time under the conditions of dazzling is his functional state, which influences the operation of eyesight analyzer concerning adaptation and restoration of vision (eyesight) after dazzling. Also we may state that even nonessential dazzling causes motion disproportionate of the whole traffic flow.

Due to increasing of motion speed of vehicles and infraction of safe motion distance at night-time it is necessary to take into account the increasing of duration of driver reaction under the dazzling conditions when choosing and calculating the safe motion modes.

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