

Effect of Road Surface Equality on the Driver's Functional State

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Abstract – The driver is a key element in the system of interaction "driver - vehicle - road - environment". About 70 - 90% of all failures falls on errors of this subsystem. One of the main indicators that reflect the willingness of the driver to the professional activity is its functional state. The aim of this work is to identify the dependence of values of the driver's functional state of road surface equality. Therefore were analyzed the methods and means of assessing the quality of the roadway, determined the characteristics of the functional state of the driver, and conducted field researches and desk studies for determination of driver's index of activity of regulatory systems in different driving conditions (satisfactory and poor road surfaces).

Key words – road surface equality, driving conditions, functional state, index of activity of regulatory systems, electrocardiogram.

I. Introduction

The transport process is carried out by interaction of the vehicle and the driver in certain driving conditions. One of the main problems is to determine the relationship regularities of road and driver. That is why the task of traffic organization with taking into account psychophysiological state of the driver is an actual problem for the transport system. A special role plays dependence of driver's psychophysiological state on road surface equality and proper use of technical means of traffic management.

The road impact on traffic safety is divided into two parts - a constant that defines the geometry of the track and roadbed, and a variable that depends on the weather and the season. Road affects the traffic conditions through the the elements of the track, the quality of the road covering. Properly designed road is one of the conditions that creates safe conditions for drivers [1].

II. Analysis of literature

The existing network of roads is characterized by poor transport and operational condition. According to the State Agency of Ukraine roads (Ukravtodor), as of 2013 about 80% of the road network require urgent repairs, major repairs and reconstruction - more than 60% of road bridges and level of deterioration of road construction is 43.7% [2].

One of the consequences of the poor state of road conditions is plenty of accidents each year that take place on the ukrainian roads and kill thousands of people. The main causes of accidents that occur due to road conditions are:

- structural defects of the road;
- slippery and unequal surface;
- the absence of fences, roadway markings, sidewalks, pedestrian paths;

- insufficient width and the poor state of roadsides;
- in many cases, the absence of signs on dangerous parts of roads;
- improper maintenance of roads, including winter;
- insufficient lighting;
- creating movement delays by public transport due to lack of stop pockets; narrowing of roadways by cars, building materials, etc [3].

Diagnosis of highways state includes four main stages that are usually performed successively [4]:

- preparatory work;
- field examination;
- office processing of received information;
- formation (update) of automatic bank of road data.

The functional state (FS) is an integral complex of characteristics of functions and qualities of a person that directly or indirectly contribute to the implementation of activity. It affects the degree of man's fatigue and his ability to work and is formed under the influence of systems that implement an immediate impact on the activity effectiveness [5].

Different methods of analysis of heart rate variability (HRV) use qualitative and quantitative evaluation criterias. Sometimes there are contradictions in the interpretation of data that are obtained on the basis of different assessment methods of heart rate. Therefore, methods of cumulative indexes assessment of HRV are actual. R. Baevsky proposed an index of activity of regulatory systems for complex assessment of heart rate (IARS), which is calculated in points on the basis of statistical parameters, histogram parameters and spectral analysis. IARS value is expressed in conditional points from 1 to 10 [6].

Based on the analysis of IARS can be diagnosed following FS:

- state of optimum (working) tension of regulatory systems (IARS – 1-2);
- state of moderate tension of regulatory systems (IARS – 3-4);
- state of expressed tension of regulatory systems (IARS - 4-6);
- state of overstrain (IARS – 6-8);
- state of exhaustion (asthenia) of regulatory systems (IARS – 8-10).

These indexes can be determined using hardware-software system "KardioSens" that is designed to record the electrocardiogram (ECG) in the outpatient and inpatient conditions, process and analyze results of observation, form medical conclusion based on the results of research [7].

III. Research

Research of change of IARS was conducted on route city Lviv - village Deviatyr, which passes through the city Rava-Ruska, a total length is 73.9 km. This section of road is characterized by smooth road surface from Lviv to Rava-Ruska, roadway from Rava-Ruska to Deviatyr has poor state with considerable irregularities, dents, absent road markings and road signs.

IARS is obtained using the device KardioSens and processed in software environment KardioLab. Table 1 shows the maximum and minimum values of index.

TABLE 1

VALUE OF IARS AT THE BEGINNING AND END OF THE MOVEMENT ON THE ROUTE LVIV - DEVIATYR

Part of the route		Value of IARS, points	
		minimum	maximum
Lviv - Rava-Ruska (satisfactory road surface)	beginning of movement	1	5
	end of movement	3	6
Rava-Ruska - Deviatyr (poor road surface)	beginning of movement	1	6
	end of movement	3	8

Dependence of change of IARS is shown in Figures 1 and 2. In this research took part drivers who guided a vehicle in continuous motion.

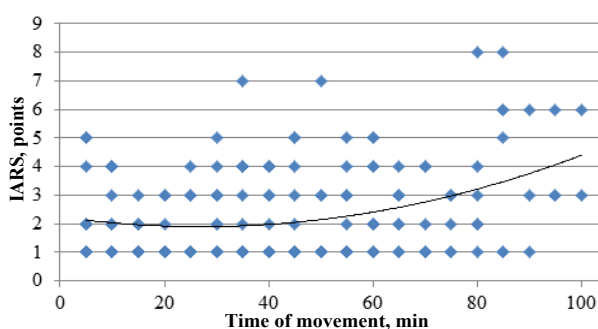


Fig. 1. Change of value of IARS on satisfactory roadway

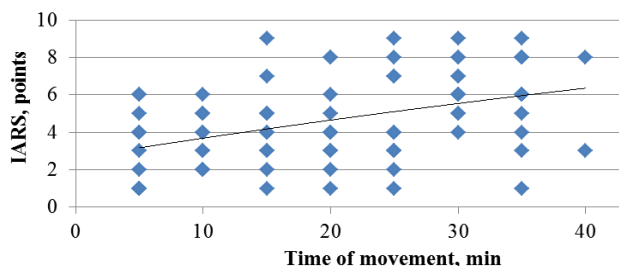


Fig. 2. Change of value of IARS on poor roadway

Figure 1 shows that during motion on satisfactory road surface IARS at first slightly decreases, demonstrating driver's addiction to guiding a vehicle. Further growth of IARS is caused by the accumulation of fatigue.

Sharp change of index on the road with poor surface is caused by the fact that the driver is in a state of high emotional stress. He constantly needs to change the speed,

often slows down, as much as possible focuses on driving avoiding dents and counter vehicles.

Conclusion

So, the result of the research are established patterns of change of driver's FS while driving on roads with different road surfaces.

The value of IARS on the roadway with satisfactory road surface is in the normal range, that's expectation is 2 points. And during the motion on the unsatisfactory roadway the expectation is 5 points. This indicates that the worsening of traffic conditions causes a large number of negative factors such as vibration, dents, absence of road signs and road markings provided by dislocation. All this leads to complications of working conditions. Driver often has to track the state of the roadway for a long time, to change the trajectory and speed mode.

Therefore, to avoid the negative impact of such type external factors on the driver's functional state, it is necessary to improve the technical and operational indicators of highways, information support of road users and conduct necessary repairs in time.

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