THE INFLUENCE OF ALCOHOL CONSUMPTION ON THE REACTION TIME OF DRIVERS

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Abstract: *Each driver should drive according to the actual road traffic law of the state where is he situated currently. The law systems of various states of Europe allow an increased maximal blood alcohol level of driver. As the fact that no small number of road accidents is caused because of the influence of alcohol on the driver, it is necessary to focus the attention of the society on this issue. We will discuss the influence of alcohol to change of the reaction of driver in this article. There will be made practical measure of the length of stopping distance required to stop the vehicle, which also includes distance, which the vehicle passes during the driver's reaction time (this time depends on the level of blood alcohol of driver) while solving this problem. The object of realized measurement is composed by selected drivers which physical and mental condition will be assessed on the base of the findings of the blood alcohol level by the relevant test using an alcohol tester during the whole measurement and following measure of the length of stopping distance required to stop the vehicle at certain blood alcohol levels of driver. The aim of this article is to determine dependencies between the amount of consumed alcohol and the length of stopping distance required to stop the vehicle and thus required to the length of the driver's reaction time.*

Keywords: Alcohol consumption, Driver`s reaction time, Stopping distance

1. Introduction

On the territory of the Slovak Republic is a growing trend in the number of registered motor vehicles. Despite of this fact there is the constant effort to reduce the number of accidents, especially accidents resulting in death or serious injury. A large number of these accidents is caused by driver that has consumed alcohol before driving. That point occurs despite the fact that the Slovak Republic permit zero tolerance of alcohol measured in breath of driver. As for many drivers who cause an accident, breath test showed the existence of an alcoholic drink, we wanted to highlight by this report the influence of alcohol in the driver's body. As most accidents happened in the village and drivers consumed alcoholic beverage before each test, realization of measurements was conducted at a speed of around 50 kmph.

2. Theoretical analysis report

2.1. Distance required to stop the vehicle and the time needed to run over

Distance, which is necessary for the complete halt of the vehicle consists of several parts. There is the same composition for the time required to stop the vehicle. These times are theoretically shown in Figure 1. From the picture it is clear that the car has zero braking ratio during the reaction. and thus the speed of the vehicle is the same as it was before the reaction time.

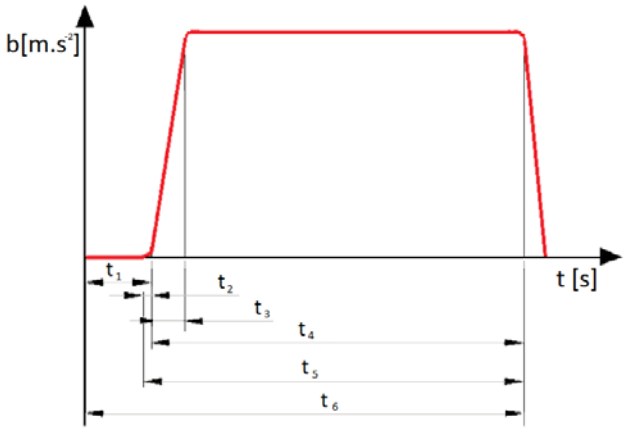

Fig. 1 *Theoretical course of braking deceleration in time from the moment of the impulse for braking the vehicle*

t1 - driver response time [s]

t2 - delay time of brakes [s]

t3 - increased time of braking deceleration [s]

t4 - time of effective braking

t5 - total braking time

t6 - the time needed to stop the vehicle

Response time is the minimum time that elapses from any impulse to any of our sensory organs to our response to this impulse. Conditions, in which will be implemented measuring of the reaction time, will be visual stimulus on the driver's reaction. the reaction time is an essential part of the time required to stop the vehicle, which is influenced by the driver. So if the driver ingested alcoholic beverage and it has an effect on the organism, this change should be reflected on the reaction time of the driver.

The time course of driver´s input consists of several sections:

- Driver´s optical reaction (tr1)- it's time of optical sighting information on which driver has to react.
- Psychological reaction (tr2)- is the time from the optical sighting information to driver´s first muscle response (to lift the feet off the accelerator) so-called decision of driver.
- muscle response (tr3) - is the time from psychological reactions to first driver´s touch with the brake pedal.

Length of reaction time is various. Even in one and the same person.It changes, for example, depending on his fatigue, ready-to-action and the anticipation of a situation. It varies also depending on time of day. The reaction time varies considerably even in poor visibility depending on the contrast of the observed object, compared to the surrounding environment. Significant impact on the length of the reaction time has also the concentration of alcohol in the driver's blood or ingestion of certain drugs, or other addictive substances.

The total length of the reaction time is the sum of individual sections of the driver's reaction. The duration of individual sections of the driver's reaction time is given in Table 1.

Table 1: *The duration of individual of the reaction time of the driver.*

	The duration		
	lower limit	average	top limit
Optical response:			
a) the driver beforehand directly observed a critical object	0.00	0.00	0.00
driver followed another object:			
b) up to 5 °	0.32	0.48	0.55
c) in the range of 5 °	0.41	0.61	0.70
Psychological reaction	0.22	0.45	0.58
Driver´s muscular reaction	0.15	0.19	0.21

2.2. Alcohol and its effect on the accident rate in the Slovak Republic

In 2012 13,936 traffic accidents happened, in which 296 people were killed, 1,100 were seriously injured and 5,322 were injured easily. Of these 13,936 accidents 1743 accidents were caused by drivers under the influence of alcohol . Overview of road accidents in the Slovak Republic and their consequences for the last 8 years is given in Table 2.

Table2: *Number of accidents in the Slovak Republic for the last 8 years*

year	Number of accidents	Number of easily injured	Number of seriously injured	Number of killed people	Number of traffic accidents caused by drunken driving
2005	59 991	8 516	1 974	560	2 632
2006	62 040	8 660	2 032	579	2 887
2007	61 071	9 274	2 036	627	3 110
2008	59 008	9 234	1 806	558	3 122
2009	25 898	7 126	1 408	347	2 524
2010	21 611	6 943	1 207	345	2 126
2011	15 001	5 889	1 168	324	1 903
2012	13 936	5 322	1 100	296	1 743

The number of all traffic accidents and accidents caused by drunken driving is shown in figure 2.

From Figure 2 it is clear that in the last eight years with decreasing numbers of accidents there is also reduced number of road accidents caused by drivers with alcohol in the breath.

Table 3 shows the number of traffic accidents caused by drivers who had alcohol in the body. The table below shows also numbers of killed, seriously injured and slightly injured persons directly related to traffic accidents caused by drunken driving. Data are presented for years 2007 to 2012, according to sources that were available to the authors.

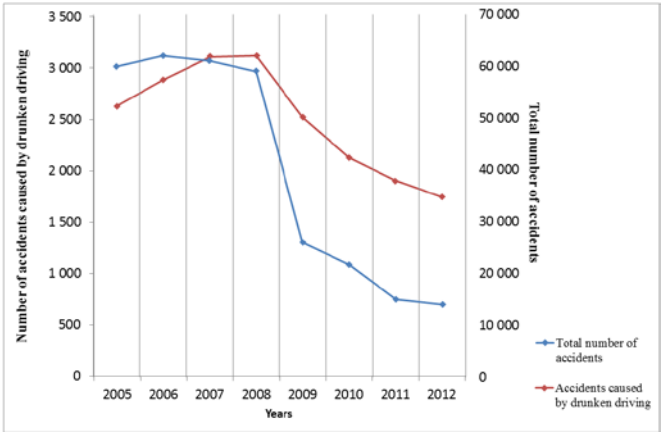

Fig. 2 *Graphical representation of the number of accidents and road accidents to alcohol*

Table3: The influence of alcohol on amount of dead and injured

year	traffic accidents caused by alcohol	dead persons	hardly injured persons	lightly injured persons
2007	3 110	30	248	1 183
2008	3 122	24	209	1 144
2009	2 524	20	163	839
2010	2 126	26	146	812
2011	1 903	34	148	667
2012	1 743	32	136	585

The police registered 1743 traffic accidents in Slovak republic (year 2012) caused by alcohol drunk by driver. These traffic accidents were the reason of dead 32 persons, 136 hardly injured and 585 lightly injured. Fig 3 illustrates evolution of amount dead and seriously injured persons.

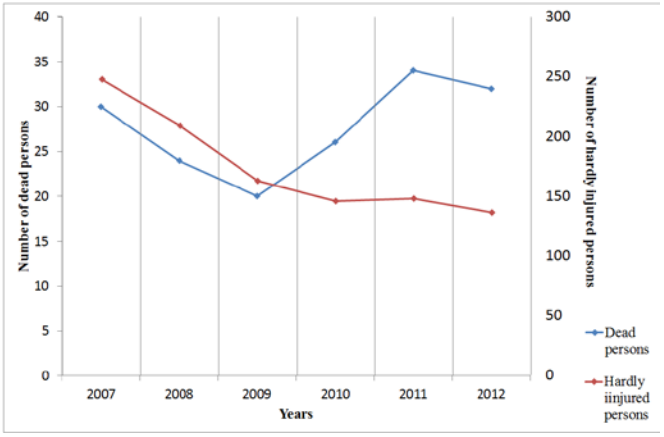

Fig. 3 *The influence of alcohol on amount of dead and seriously injured persons*

The curve shows decreasing trend of amount of seriously injured in the Slovak Republic. The curve has a slightly increasing trend in the number of fatalities. This number of fatalities is very undesirable, because Slovak Republic strictly requires road transport fatalities reduction in its legislative (National plan of safety). It is necessary to focus attention on the partial development of accident and the related fatalities.

2.3. Influence of alcohol on visual sense of drivers

When the driver drinks, alcohol occurs to different changes in human body. Loss of drivers body control and vision is dangerous. These defects are called "tunnel effect", which you can see on Figure 4.

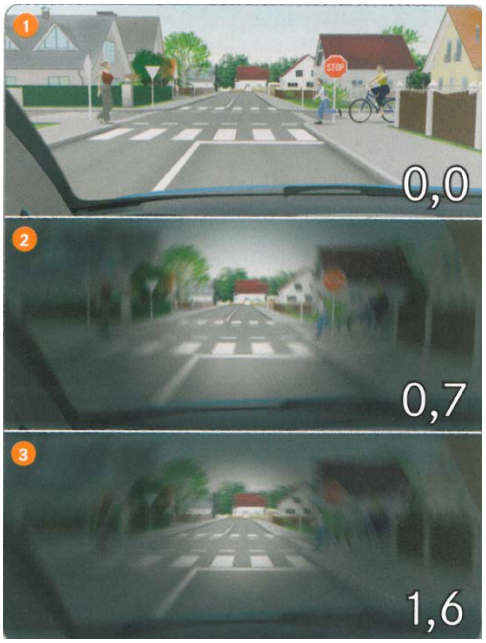

Fig. 4 *Tunnel vision, depending on the measured quantity of alcohol in the driver's body*

Worse driver´s vision has these effect:

- reducing the ability to recognize or fully seen barrier near the vehicle
- reducing vision of the red color (etc. brake lights, red light on traffic lights)
- decrease of peripheral vision and orientation
- increase self – confidence
- willingness to take risks (increased aggression)
- decrease of the flexibility of driver´s eyes for changes in light intensity
- disruption of motor functions of the body (problems while driving vehicle, problems with changing gears, mistakes in the controlling pedals, etc.)
- decrease of auditory perception

Several effects are demonstrated on our measurements, which were realised on Department of Road and Urban Transport on University of Žilina.

3. Analysis and results of measurements of the driver's reaction time

This article was prepared on the basis of several measurements. The measurements were made on airport in village Rosina. There were policemen and rescue service. Measurements were made with vehicle of driving school, which had auxiliary pedal. The instructor of driving school sat beside for driver´s safety if driver doesn´t stop vehicle, because he won´t respond on barrier.

Base information about measurements:

- 5 people were attended of measurements (3 adult men, 2 adult women)
- each had driving licence and practice with driving vehicle
- nobody before measuring drink alcohol
- the measurement was made on two vehicles of driving school with auxiliary pedals.
- the first measurement was slalom, influence of alcohol drink on driver´s reaction..
- the second measurement was made thanks of cameras, which were inside vehicle. The result was on driver´s reaction time. The camera recorded the reaction of the driver's feet on impulse of stop vehicle. This measurement was realized through measurement distance thanks on stop vehicle, which is included of distance moved for driver´s reaction time.
- they drank 0,04 liter of alcohol (alcohol content 37,5 %)
- measurement conditions: sunny weather all time, road was dry
- The vehicle went speed approximately 50 km.h-1 while second vehicle stayed on opposite side. This vehicle lighted up distance light.

Each driver had made 11 measurement on vehicle A and 11 measurement on vehicle B when drivers drank alcoholic drink. At the beginning the measurement was made with two vehicles and two drivers without alcohol in breath.

Fig. 5 *Measuring the amount of alcohol in breath*

The measurements were ascertained two results. First result was test with vehicle A and second result was test with vehicle B. First measurement was realized with two vehicles with drivers without alcohol in breath at the beginning.

Test abilities were realized with the vehicle A thanks to slalom forward and backward between conics.Results are included in tab 4.

Test measurement of distance necessary to stop the vehicle was realized on the vehicle B.

Two cameras were installed in vehicle. One camera was installed on frontal area of the vehicle. This camera is recording light signal, which driver gets from vehicle on the opposite side of the road. (fig. 6 up) The movement of driver´s foot was recorded by the second camera. (fig. 6 down)

Fig. 6 *Data from cameras in vehicle B*

Measured values and outputs of measurements:

Table4: Influence of consumed alcohol on number of knocked down cones

	ride direction	1. Driver	2. Driver	3. Driver	4. Driver	5. Driver
0,00 l of alcohol	forward					
	backward					
0,04 l of alcohol	forward				1	
	backward					
0,08 l of alcohol	forward					
	backward					
0,12 l of alcohol	forward					
	backward				1	
0,16 l of alcohol	forward					
	backward				1	
0,2 l of alcohol	forward	1				
	backward				1	
0,24 l of alcohol	forward			2		
	backward			1	2	1
0,28 l of alcohol	forward					
	backward					
0,32 l of alcohol	forward					
	backward			2	1	
0,36 l of alcohol	forward					
	backward	2	1	1	2	
0,4 l of alcohol	forward			2		
	backward	1		2	2	1
0,44 l of alcohol	forward			1		
	backward			1		1

Table 4 shows that with increasing amount of alcohol consumed by drivers is the growing number of cones knocked down. With the increasing amount of alcohol consumed by driver decreases orientation and responsiveness to external influence is reduced . The driver with alcohol in blood can´t see the change of cones. The driver threw down cones and he didn´t know about it. This conclusion may be told on base data outside cameras, which recorded collision of vehicle with cones.

Dependence between the measured amount of alcohol in the breath of the driver and his reaction time is shown in Figures 7 to 12.

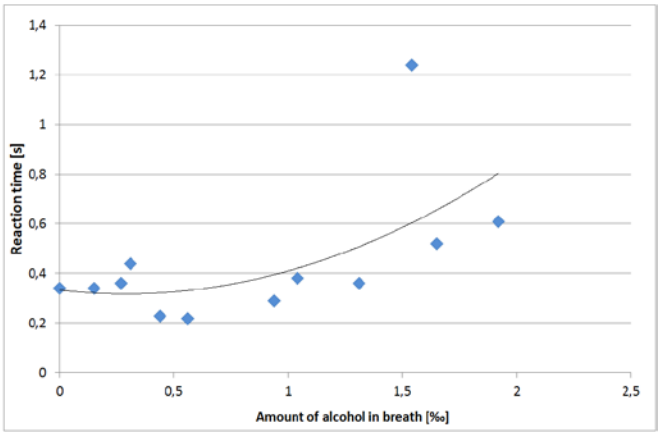

Fig. 7 *Dependence of the impact of the quantity of alcohol in the breath to the reaction time of the first driver*

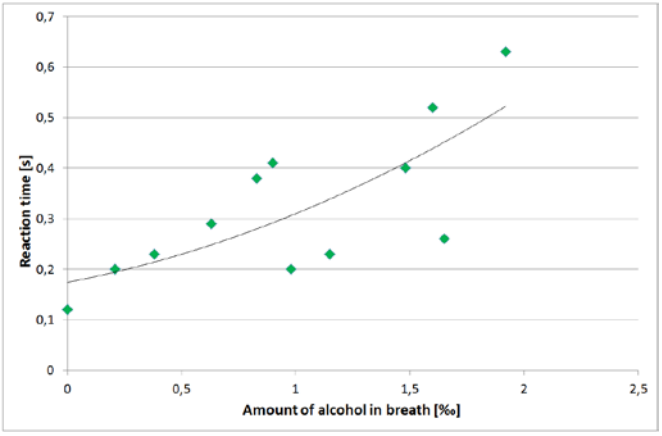

Fig. 8 *Dependence of the impact of the quantity of alcohol in the breath to the reaction time of the second driver*

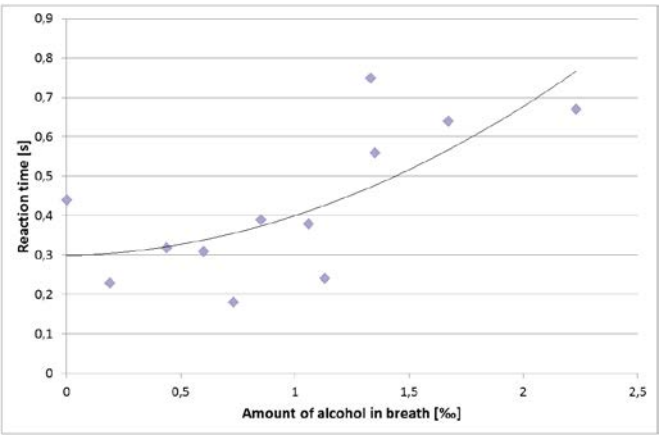

Fig. 9 *Dependence of the impact of the quantity of alcohol in the breath to the reaction time of the third driver*

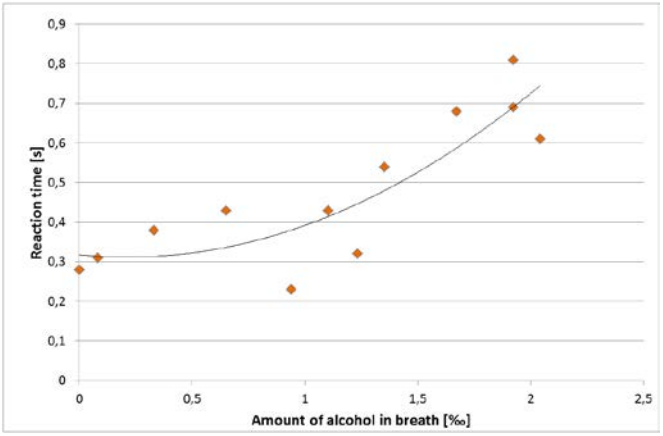

Fig. 10 *Dependence of the impact of the quantity of alcohol in the breath to the reaction time of the fourth driver*

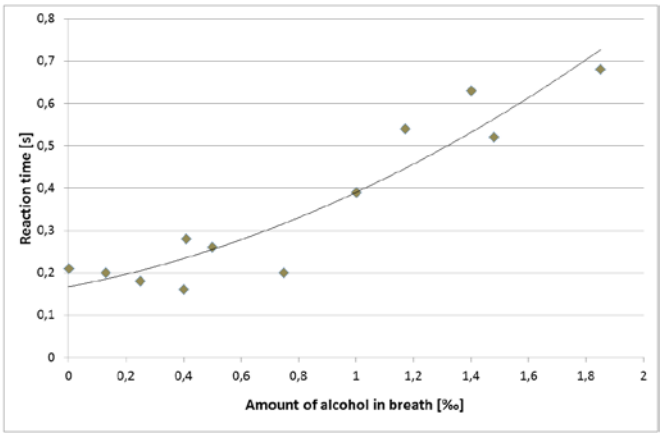

Fig. 11 *Dependence of the impact of the quantity of alcohol in the breath to the reaction time of the fifth driver*

The figures show how the reaction time of each driver is changing due to growing amount alcohol in blood. From figures 7 - 11 we can see, that the reaction time of drivers is increasing about twice to approximately 1.5 ‰ of alcohol measured in the breath of the driver.

4. Conclusion

The tunnel vision should be created when driver drinks alcohol. The driver is losing peripheral vision. This confirms the results of measurement on vehicle A. All drivers have reacted at the impulse, which they saw in a straight line in front of them (it was placed directly in the tunnel, which drivers saw). Peripheral vision wasn´t necessary. Increase reaction time of each driver was caused by the influence of alcohol. The reaction time also increases with the amount of consumed alcohol. We can see this on the trend curve. For Some drivers within about 0.5 ‰, this trend curve does not increase, but it is stagnant. This fact may be the base for more solutions of problems with alcohol consumed by drivers.

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