

Lights of the Vehicles and the Road Traffic Safety

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ABSTRACT---- *The article deals with the issue of lighting of the vehicle and its influence of the origin of traffic accidents in poor visibility, or dark. The first part is focused on the analysis of the accident under different weather and light conditions. The second part introduces the definitions of the basic terms like a illumination distance of headlamps, sight distance from the vehicle and visibility distance, that are closely linked with the issue of lighting of the vehicle and the recognition of the obstacles for poor visibility in the light of the headlamps. The experimental measures have been identified and the specific values of these distances and then numerically and graphically evaluated.*

Keywords--- Illumination distance, visibility, sight distance, headlamp

1. INTRODUCTION

Road transport is inseparable part of every developed company. Except the desired transfer of goods and person afford road transport disadvantage too. Among the largest belongs the emergence of traffic accidents with the result death. The European Union and of course Slovak Republic make the great effort to decrease amount road accident and its results.

On the basis of the information obtained on the web side of the Ministry the Interior, in Slovak republic managed to decrease the number of killed people as a result of road accident from 628 in year 2000 to 345 in 2010. It represents the drop to 54 % of original condition. The European Union in Slovak Republic committed by the year 2020 reduce the number of persons killed in road traffic accidents by half condition in year 2010. For Slovakia this commitment means reducing the number of people killed as a result of traffic accidents in the year 2020 to 172 people. Statistics of the Ministry of Interior of the Slovak Republic report that in 2013 this number decreased to 223 fatalities in a car accident. In this area recorded an increase in 2014 the number of people killed. It is a signal that you need to deal with the situation.

2. ANALYSE

Table 1: The accident rate in Slovakia depending on the visibility [3]

Visibility		the number of accidents	+/-	deaths	+/-	alcohol	+/-
through the day, visibility do not reduced the influence of weather conditions		8680	-361	114	-37	739	-71
through the day, visibility reduced (twilight, dark, ...)		419	57	5	0	64	11
through the day, reduced visibility the influence of weather conditions (fog, snow, rain, ...)		405	-11	6	-6	13	-6
in the night - with the public lighting, visibility do not reduced with influence of weather conditions		2148	-16	23	-15	509	-12
in the night – with public lighting, reduced with influence of weather conditions		198	5	10	6	34	-9
in the night without public lighting, visibility do not reduced with influence of weather conditions		1449	37	61	-17	313	24
in the night without public lighting, reduced with influence of weather conditions		172	-31	4	-4	22	-7
do not identified		115	-38	0	0	2	-4
Visibility	well	8680		114		739	
	worse	4791		109		955	

If we compare the number of traffic accidents resulting in poor visibility, it is obvious that from the total number of accidents is about 1/3 of the time at night or in poor visibility and 2/3 have become through the day. A comparison of the number of people killed is almost balanced, the table 1. A simple calculation can be detected through any 76 accident caused the death of a man, at night this share has declined for each of the 44. an accident. Ride for a reduced visibility is markedly more dangerous.

What is the difference? Because the biggest part of the information obtained the driver through the vision, the difference will be caused due to just this fact. The vehicle moving a certain speed needs to stop a certain path. It consists of a path which vehicle passes during the decision of the driver, path during the delay of the brakes, path of attack brakes deceleration and path of high braking. The decision of the driver includes the time required to make information received from the eyes into the brain of the driver, then followed by the time required to evaluate the situation to the decision to brake. Finally, the driver moves the leg to the driver brakes. From the time, where before him appeared a barrier to stop expires various a long times depending on its concentration on driving, physical and mental condition. The approximate times of decision-making of the driver are listed in table 2. [2] [4]

Table 2: Distance traveled of the vehicle depending on the length of the reaction of the driver [2]

The length of the reaction of the driver [s]	The status of the driver	The path which passes the vehicle [m] at a speed of	
		90 km/h	50 km/h
0,6 – 0,7	attentive, focused, the initiative is expected and is ready to brake	15 – 17,5	8,3 – 9,7
0,7 – 0,9	the driver is attentive, but the initiative is not expected	17,5 - 22,5	9,7 – 12,5
1,0 – 1,2	The driver’s attention focused on other activities that relate to driving (shifting, overtaking, observation of the side of the road...)	25 - 30,0	13,9 – 16,7
1,4 – 1,8	(distracted, having fun with the co-pilot, a highly radio, navigation..)	35,0 – 45,0	19,4 – 25,0
1,6 – 2,4	(indisposed, tired, sick, alcohol ...)	40,0 - 60,0	22,2 – 33,3

The path to stop of the vehicle can be determined according to the following equation:

$$s_z = (t_R + t_O) \cdot v + \left(v \cdot t_N - \frac{b \cdot t_N^2}{4} \right) + \frac{v_N^2}{2 \cdot b}$$

Where:

s_z - path to stop the vehicle [m],

t_R - reaction time of the driver [s], the vehicle moves the unchanged speed,

t_O - the time delay of brake [s], the vehicle moves the unchanged speed,

t_N - the time of attack of the brake effect [s], at the start of the deceleration of the vehicle equal to 0 m/s², at the end of the period of time the vehicle reaches the full secondary braking deceleration,

b - the full secondary braking deceleration [m/s²],

v - the initial speed at which the front of the vehicle discovered the reason for the brake [m/s],

v_N - the speed of the vehicle after completion of the attack of the brake effect [m/s].

The vehicle in mode low beam, the maximum distance effectively illuminated area of the road corridor in the movement of the vehicle is equal to approximately 45 – 65 m. Identifying the objection the driver is not specific only the intensity of the light, but the ability of object to reflect light from the headlamps of the vehicle and the contrast object towards surround. Contrast is the difference brightness between object and background of object.

Brightness is a measure of visible light the way that receives the eye of driver. The decisive factor is the threshold of contrast, in which the object is still visible. This parameter is the most important among all the other. Between the lit part

of the road and any object must to arise a difference of brightness - the contrast of the value that was already for the human eye sensible. What is the value of the contrast greater, the subject of the human eye is better visible.

The ability to identify specific object the driver of vehicle is most cases determinate by the photometric characteristics of object eventually the clothes of object and the road over which is moving. For example, a figure dressed in white reflects all incidents light and is very well visible. A figure dressed in black absorbs all incidents light and therefore it is not possible to see it. The driver can recognize only in the background of other subjects, until is effectively illuminated the road behind the object. Figure 1 shows the possibility of detection of objects depending on the contrast of dress with the surroundings. [1] [5]

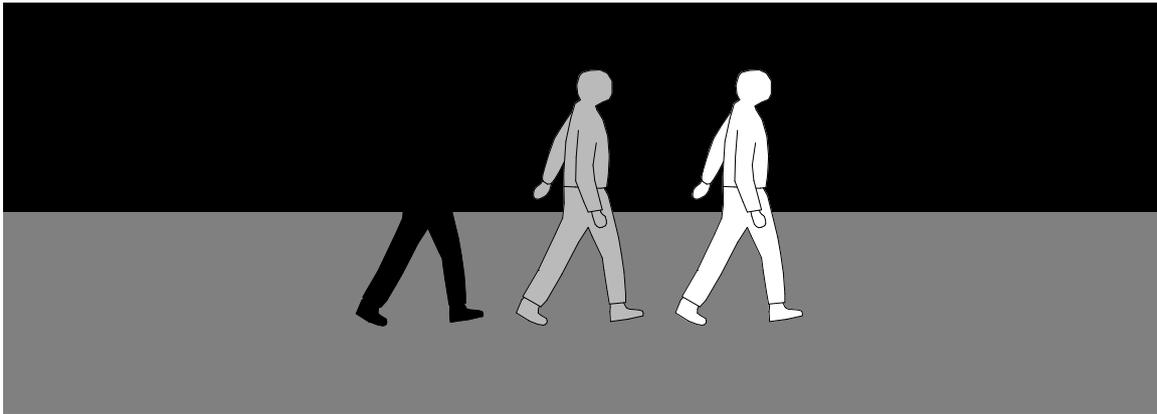


Figure 1: The possibility of detection of objects depending on the contrast dress [1]

If the road is not totally black arises between the figure and the road light interface, the contrast the object towards a lighted road. Only if the combination of the size of the area where is a lighting interface and values of contrast are sufficient to the perception of the human eye, it means that they are satisfied the technical conditions for the recognition of object can driver recognize the object. Therefore the fact that a pedestrian is located in the area of illuminated road of the headlamps of vehicle does not mean, that driver can him actually recognize. [1] [5]

Figure 2: Visibility on the object depending on the dress [1]

Figure 2 describes the influence of clothing on the visibility distance in darkness. Distance C describes visibility on the pedestrian dressed in black, distance A on the pedestrian dressed in brown and distance D describes visibility on the pedestrian dresses in white.

For the correct identification of a pedestrian in poor visibility are needed such conditions that the visual perception of driver was such a significant, after processing this perception the driver evaluate the pedestrian as visible. For the visual perception of the driver is important threshold contrast between a pedestrian and its surround and the size of the visual angle of pedestrian. The threshold contrast and visual angle of the driver are influenced by factors such as the level of adaptation of vision, the speed perception of the driver, the physical or mental state of the driver.

Weather conditions greatly affect the process of vision of the driver. During rain changes the color of the road, it becomes darker and change the conditions related the contrast emergented among the road and pedestrian. Vision of driver influences the occurring fog too; it consists of small drops of water. These droplets scatter the light beam, which causes the objects and their background on the road are worse illuminated. During the snowfall is light reflector reflects from the white flakes, what causes the formation of a larger amount of light that returns back into the eye of the driver and the deteriorating conditions of vision.

Experimental measure of illumination distance and visibility distance

The first experimental measure was found specific values of illumination and consecutively based on this value was dedicated the maximum distance of illumination of selected types of headlamps. Implementation of the second measurement was found individual distances of visibility on pedestrian dressed in various clothes.

Comparison illumination distance of headlamps and visibility distance on pedestrian

Measure distance of visibility on pedestrian waged in mode of high beam on the vehicle Volkswagen Passat Combi, because in the evaluation is considered the maximum distance of illumination 100 m of its headlamps. As a source of light in the headlamps was used bulb type H1. Figure 3 graphically describes a comparison illumination distance and visibility distance on the pedestrian with the driver with healthy eyesight.

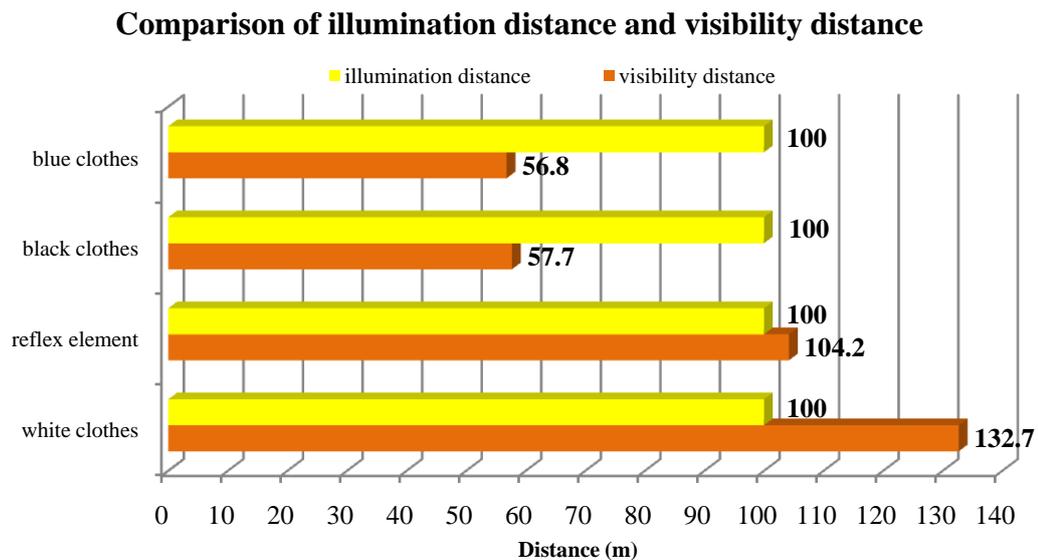


Figure 3: Comparison of illumination distance and visibility distance

Source: author

By the comparison illumination distance and visibility distance on the pedestrian dressed in white is seen, the driver saw a pedestrian on a longer distance than is the illumination distance that illuminate the road in the corridor of vehicle movement. Among the white clothing of pedestrian and dark field there is a high contrast, therefore the pedestrian is visible at a relatively long distance. Difference illumination distance and visibility distance is 32,7 m.

As in the case of pedestrian wearing a white, the visibility distance on the pedestrian with reflective element placed on the ankle is longer as the illumination distance. Again, this is due to fact, that the reflective element reflects light very well at a low intensity of light, then even at an intensity lower than 1,5 lx. Another factor is, there is again a high contrast between the background and reflective elements on the ankle pedestrian.

In the case of a pedestrian dressed in black and in blue jeans is the visibility distance on the pedestrian significantly lower than the illumination distance of headlamps. As the black and blue clothing absorbs all the light of headlamps is necessary, than the pedestrian approached on the shorter distance to the vehicle, so that the driver can him identified as definitely visible. To this is necessary, than was created behind pedestrian effectively lit field. Visibility distance on the pedestrian in black is in this case about 42,3 m longer, then is the illumination distance of headlamps.

In the following table gives the values of the measured intensities of illumination of the road, with various light sources in the headlamps.

Table 3: The measured values of the illumination distance and visibility distance

	Mode of headlamps	Sight distance (m)	Illumination distance (m)
BMW	high beam	160	170
	low beam	40	90
Audi A4	high beam	80	100
	low beam	30	60
Passat	high beam	80	100
	low beam	40	60

Source: author

From the measured values listed in table 3, it is evident that the distances of illumination and visibility is not identical and are significant differences among them. The smallest difference of these distances is in mode beam headlights BMW vehicles using a halogen lamp H1 and it is 10 m. In the mode of low beam by using a xenon lamp DS1 this difference is up to 50 m. The low beam illuminate the road within the distance 90 m, but only 40 m of this section is illuminated effectively, thus the value of 1.5 lx at a certain height of the road, by an experimental measurement of the pedestrian area of the heel, that is about 2 cm above the ground plane.

Illumination distance of high beam the vehicles Audi A4 and Volkswagen Passat by the using of halogen lamp H7 is the same, corridor over the vehicle is illuminated at a distance of 100 m, while 80 m of this distance is effectively illuminated. Illumination distance of low beam are by both vehicles 60 m. Difference is in the sight distance, where the sight distance of vehicle Audi A4 is 30 m and vehicle Volkswagen Passat represents a distance 40 m.

3. SUMMARY

For the safety of road vehicles are imposed more and more requirements. Lighting of vehicles is the most important thing at night and in poor visibility. A headlamp of the vehicle illuminates distance in the corridor of movement in front of the vehicle. It is necessary to perceive, that even when the space for the vehicle is illuminated only a part of the road is illuminated effectively. On the basis of experimental measurements were found out the specific values of the intensity of illumination of the road and consequently they was intended distance of illumination of road, distance of sight from the vehicle and distance of visibility on the pedestrian dressed in various clothes.

In the case of pedestrian dressed in black clothes is the visibility distance 57,7m. An illumination distance headlamp of the vehicle Passat Combi in mode of high beam is 100 m. between these distances is the difference 42,3m. Distance to stop a vehicle moving at a speed of 90 km/h on a dry surface 72,71 m and on wet surfaces 90,61m. This means that in the case of pedestrian moving on the road dressed in black is the distance to stop a vehicle longer than visibility distance on the pedestrian and it can get to the collision with the pedestrian. From the above calculations and measures is obvious that photometric properties of clothing, the speed of the vehicle and the condition of the road surface significantly affect the occurrence of a traffic accident. It is also necessary to realize, that even if the headlamps of vehicle illuminate space over the vehicle, it is not guaranteed that the driver identifies the potential barrier at a distance of illumination the road and also if is able to stop the vehicle on this distance.

This contribution/publication is the result of the project implementation:

Centre of excellence for systems and services of intelligent transport II,
ITMS 26220120050 supported by the Research & Development Operational Programme funded by the ERDF.



Agentúra
Ministerstva školstva, vedy, výskumu a športu SR
pre štrukturálne fondy EÚ

" We
support
research
activities

s in Slovakia. Project is co-funded from sources EÚ"

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