Road traffic incidents involving pedestrians in areas with limited visibility

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Abstract. In this article, road traffic incidents involving pedestrians are determined by means of research in areas where the visibility of highways is not limited. First of all, it is determined how many meters the driver was from the time the driver saw the pedestrians crossing the road to the place where the accident occurred. Based on the information obtained from the driver, pedestrian and witnesses of the incident, the length of the stopping distance of the car is calculated as So and compared with So<Sa is clear and allows to determine whether the road is technically capable of preventing traffic accidents by applying sharp brakes in time by the driver. As a result of the research, they can come to such conclusions that the driver during the road traffic accident had the opportunity to prevent the road traffic accident, due to his lack of driving skills, i.e. experience, he violated the traffic rules. to clarify what may have been the cause of the incident and to study the collision mechanisms and speed of movement in this case, to study the above cases and to draw conclusions from the research conducted.

1 Introduction

Nowadays, along with the increase in the number of people in the world, the number of vehicles is also increasing day by day, which in turn causes traffic jams on highways and becomes the main problem of vehicle traffic. Every country has laws and regulations to regulate traffic and ensure safe driving. In the last decade, the density of the flow of vehicles on the roads, traffic congestion and the number of road traffic accidents have been increasing.

In order to control traffic and reduce traffic accidents, modern technical means are widely used in our country, i.e. traffic detectors, traffic lights, road signs, and involving road patrol officers.

In recent years, a number of decisions have been made in the Republic of Uzbekistan aimed at ensuring road safety, preventing road traffic accidents, and reducing the number of people killed and injured in them. In particular, the decision of the President of the Republic of Uzbekistan No. PQ-190, adopted on 04.04.2022, "On measures to reliably ensure human safety on highways and drastically reduce the number of deaths" is one of

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them. In the decision, in 2022-2025, guaranteed protection of human life and health from any incidents on highways is defined as one of the priority goals.

According to traffic rules, a pedestrian is defined as a person who is outside the vehicle and is moving on the road without any other activity. Persons driving a non-motorized wheelchair of persons with disabilities, driving bicycles, mopeds, motorcycles, sleds, prams and wheelchairs for children or persons with disabilities, as well as persons using roller skates, non-motorized scooters and other similar means for movement are also considered pedestrians. However, for the examination of a road traffic accident, the term "pedestrian run-over" refers to all people who are repairing the road and all other people who are doing other work on the road, in addition to the above concepts. Because saving the lives of all people on the road and examining the incidents of running over them is one issue. In the examination of traffic accidents, persons working on or near the road are not included in a separate category and are considered pedestrians or pedestrians along with other people. Also, a person on the road must take care of his safety, regardless of whether he is currently working on the road or using it for personal needs. The driver, in turn, must be careful with other road users, protect the life and health of all citizens, and take measures not to endanger them, regardless of whether they appear on the road must see.

In 2022, 9,902 road traffic accidents occurred on the roads of the Republic of Uzbekistan, as a result of which 2,086 people died and 9,606 people were injured. Of these, according to the causes of road traffic accidents, non-observance of the specified speed - 15.8%, failure to install road dividers - 13.6%, barriers (fences) restricting pedestrian movement lack of training - 11.6%, driver's inexperience - 10.6%, and lack of pedestrian crossings - 10.3%.

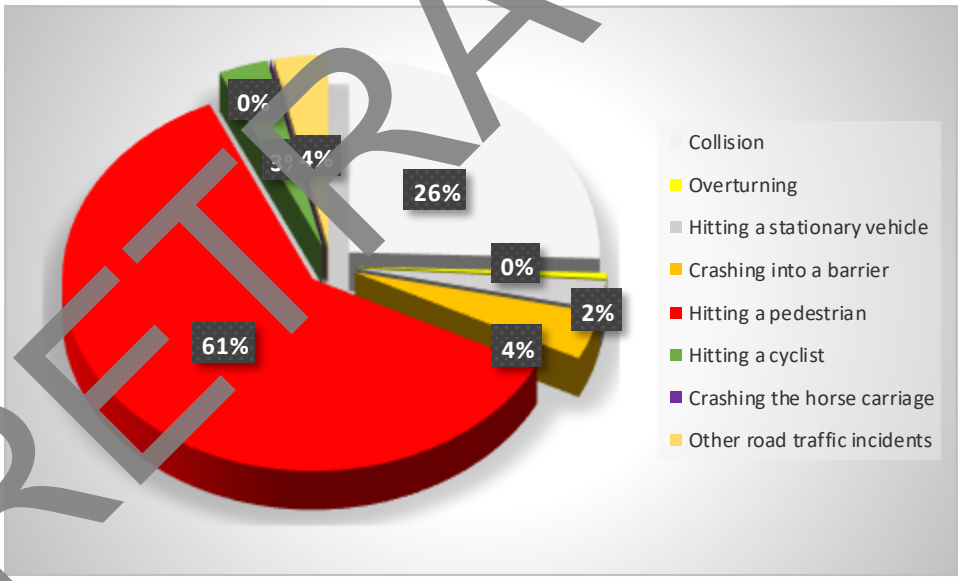

Fig. 1. Analysis of the types of road traffic incidents that occurred in Tashkent in 2023.

According to the results of the analysis, 63% of the types of traffic accidents on the road correspond to pedestrian collisions and 26% to vehicle collisions (Figure 1).

2 Methodology

Collisions are very common in areas with limited visibility. Thus, approximately 60% of all traffic accidents involving pedestrians occur in conditions where the driver can see the pedestrian at a distance and there is nothing to prevent him from correctly assessing his actions. Therefore, there are no reliable reasons that prevent the driver from taking the necessary safety measures in time. However, often the driver continues to drive without slowing down when he sees a pedestrian and slows down only to avoid a collision.

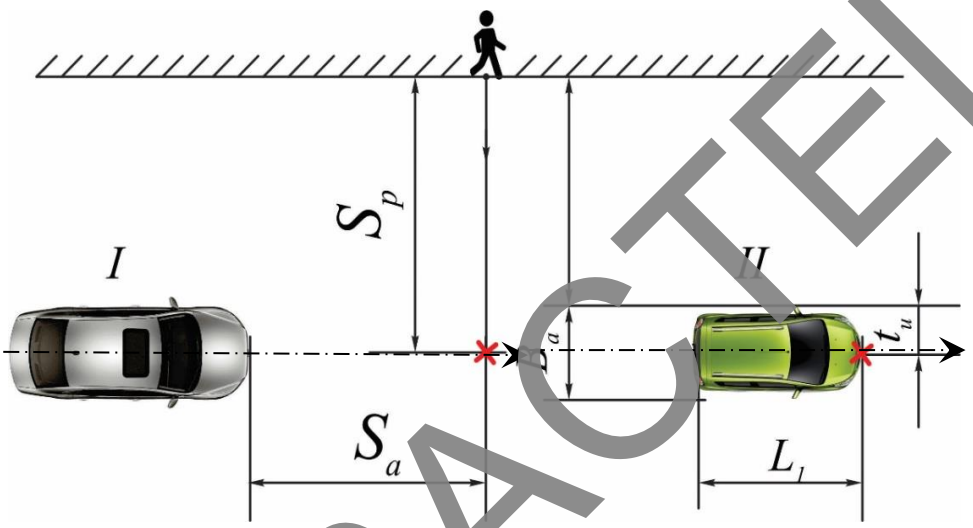

Fig. 2. a — variant a-/-//-2, b — variant a-//-4 collision schemes with uniform movement of cars.

Figure 2 shows a diagram of a traffic accident, during which a car moving at a constant speed hits a pedestrian with its front end. Here, the direct driver shows the place of collision between the car and the pedestrian during the movement (the place of impact). A special sign is placed on the road where the car hit the pedestrian (impact spot). When a dangerous situation occurs, the position of a car and a pedestrian is indicated by the number I, and the position of the car after stopping is indicated by the number II. Since the driver hit the pedestrian without braking, the car may have been stopped in any position on the road after the collision.

When investigating a road traffic accident that occurred with a pedestrian, first of all, it is determined how many meters away Sa was from the car to the place of the road traffic accident at the time when the driver saw the pedestrian crossing the road. . Based on the information received from the driver, pedestrian and witnesses of the incident, the length of the stopping distance of the car is calculated as S_o and compared with $S_o<S_a$.

At the same time, it can be concluded that the driver would have stopped the car before reaching the pedestrian lane by braking sharply in time. Therefore, the driver had a technical opportunity to avoid a crash or road traffic accident. At the same time, some experts come to the opposite conclusion: $S_o \geq S_a$. However, the results obtained on the basis of such calculations cannot be considered final. There may be situations where a driver may have time to let a pedestrian pass by braking in time (moving at the speed of V_a) because it takes more time to move the car on the same part of the road . The braked state is compared to the same movement. The greater the initial speed of the car, the greater the time it takes for the car to brake and the distance it takes to walk. Therefore, it is more likely to avoid hitting a pedestrian.

3 Results

In the study, Lasetti [1] and Spark [2] cars were analyzed when they hit a pedestrian. At the place of the road traffic accident, the road is asphalt, flat, dry, horizontal, illuminated by the sun at night - documents of the road traffic accident. A Lacetti car with 2 passengers, unloaded and in technical condition, was moving at a speed of 22 m/s, and the car hit a pedestrian 0.5 m in front of the left part. The width of the road is 11.5 meters. The pedestrian moved 6 meters towards the scene of the incident at a speed of 2 m/s according to the table.

The following conditional symbols are used in performing mathematical operations [3-19]

* - multiplication; 2 - squaring; / - to be; 0.5 square root extraction;

T - the driver's reaction.1.0 s,

j - The deceleration rate of the Lacetti car is 7.19 m/s^2;

V_a - The speed of movement of the Lacetti car, 22 m/s;

l_x- Distance from Lacetti's car to the point where it hit the pedestrian with its left side, 0,5 m;

V_p - the speed of movement of the pedestrian, 2 m/s;

S_p - the distance traveled by the pedestrian to the scene of the accident, 6 m.

L_a - The overall length of the Lacetti car 4,7 m.

B_a - Overall width of the Lacetti car 1,8 m.

The Lasetti car started to cross the street from right to left at a distance of 6 m from the right border of the traffic section, with a specific speed of 22 m/s, and a pedestrian at a speed of 2 m/s. The total width of the car is B_a = 1.8 m., the amount of maximum downward deceleration on this road, j=7.19 m/s^2, the driver's reaction. T=1.0 s, let's look at some options.

The pedestrian was hit by the right side of the car, the place of impact was located 0.5 m from the front of the car.

From the driver's point of view, the walking time is calculated as follows.

$$t_{vp} = \frac{S_p}{V_p} - \frac{l_x}{V_a} \quad (1)$$

$$t_{vp} = \frac{6}{2} - \frac{0{,}5}{22} = 2{,}98 \text{ s}$$

The time T, during which the driver has the opportunity to observe the movements of pedestrians, is several times more than the time required to activate the braking system. Therefore, the driver acted incorrectly in this case from a technical point of view and did not use the brakes. he had all the possibilities at his disposal, traffic accidents were not prevented. Therefore, we continue to count.

Determining how many meters away the car was from the road traffic accident.

$$S_a = \frac{S_p V_p}{V_p} - l_x \quad (2)$$

$$S_a = \frac{6 * 22}{2} - 0{,}5 = 65{,}5 \text{ m}$$

This is the length of the car's stopping distance,

$$S_o = TV_a + \frac{V_a^2}{2j} \quad (3)$$

$$S_o = 1 * 22 + \frac{484}{2 * 7{,}19} = 55{,}6\ m$$

By the sudden braking of the car, the stopping distance is S_o=55.6 meters, and the distance from the scene of the road traffic accident with the pedestrian is S_a=65.5 meters, so the driver is far from the pedestrian's lane before, it was technically possible to prevent a road traffic accident by sudden braking of a car.

We check the possibility of safely crossing the vehicle lane. If the driver had braked in time, the pedestrian would have crossed the lane of traffic, and the road would have had the technical opportunity to stop before the pedestrian reached the lane of traffic to prevent the accident.

$$S_{pn} = S_o - S_a \quad (4)$$

$S_{pн}$=55,6 – 65,5= – 9,9 м

If the driver of the Lasseti car stopped the road traffic accident before reaching 9.9 m by applying sharp brakes in time and had the technical possibility to prevent the road traffic accident.

Vehicle speed when crossing a pedestrian crossing

$$V_n = \sqrt{2S_{pn}j} \quad (5)$$

$$V_n = \sqrt{2 * 9{,}9 * 7{,}19} = 11{,}9\ m/s,$$

the driving time of the car

$$t_{dn} = T + \frac{V_a - V_n}{j} \quad (6)$$

$$t_{dn} = 1 + \frac{22-11{,}9}{7{,}19} = 2{,}4\ s,$$

pedestrian traffic during this time

$$S_n = V_n * t_{dn} \quad (7)$$

S_n= 11,9*2,4= 28,56 м,

safe interval

$$\Delta_\delta = 0{,}005 L_a V_n \quad (8)$$

$$\Delta_u = 0{,}005 * 4{,}7 * 11{,}9 = 0{,}28\ m,$$

safe transition state

$$S_n > (\Delta_u + B_a) + \Delta_u \quad (9)$$

S_n=28,56 м>(0,28+ 1,8+0,28)= 26,2 м.

If the pedestrian has traveled a distance of 12.7 meters at 2.5 km/h at a speed of 2.5 km/h, the driver of the Spark car is driving at 30 km/h and brakes in time to avoid hitting the pedestrian. was prevention technically possible?

The road traffic accident happened during the day, the road is asphalt, flat, dry, horizontal. The driver of the Spark model car was driving without passengers, without cargo and at a speed of 30 km/s, and the car hit a pedestrian in front of it without braking. The pedestrian moved 12.7 meters towards the scene at a speed of 2.5 km/h.

The following conditional symbols are used in performing mathematical operations:

* - multiplication; `2 - square up; / - to be; `0.5- square root extraction;

t_1 - Spark car driver reaction time 0,6 s;

t_2 - Spark vehicle brake activation delay time 0,1 s;

t_3 - Spark car deceleration amount increase time, 0,35 s;

j - The amount of deceleration of the Spark car 7,2 m/s^2;

V_a - Spark car speed, 30 km/soat;

V_p - the speed of movement of the pedestrian, 2,5 km/h;

S_p - the distance traveled by the pedestrian to the place of the incident, 12,7 m.

In a road traffic accident, a Spark vehicle driver with or without the technical ability to prevent a road traffic accident by braking is halted by comparing the car's braking distance S_o and its distance from the vokea location at the time of danger to movement S_a.

$$S_o = (t_1 + t_2 + 0{,}5 * t_3) * \frac{V_a}{3{,}6} + \frac{V_a^2}{25{,}92 * j}$$

As a result of the research, the calculations of the stopping distance of a Spark car driver traveling at a speed of 30 km/h according to the speeds are shown in Table 1.

How far the Spark car driver was from the scene of the accident when the pedestrian moved 12.7 meters is determined as follows:

$$T_n = 3{,}6 * \frac{S_n}{V_n}$$

$$S_a = \frac{V_a * T_n}{3{,}6}$$

As a result of the performed actions, how far the Spark car, which was moving at a speed of 30 km/h, was from the scene of the accident is given in Table 1.

Table 1. The scene of the accident

V_a, km/h	S_a,m	S_o,m	To the technical possibility
30	152.4	12.1	**He has**

Comparison of the results of the above operations showed that So < Sa.

4 Conclusion

Therefore, this road had a technical possibility to prevent the accident by stopping the Spark car under the driver's control in time from the moment of danger to traffic.

Thus, if the driver brakes quickly and sharply, the road would have a technical possibility to prevent a traffic accident. Although the car drivers did not stop in the pedestrian lane ($S_p > (\Delta_y + B_a)$), the car drivers stopped before reaching the pedestrian lane when they braked without changing the same direction and speed. s and pedestrians would be able to get out of the way of cars.

As a result, based on the calculations, we come to the conclusion that in the current situation, the driver had a technical opportunity to prevent a road traffic accident with a pedestrian, but the drivers did not use this opportunity.

By looking at the above scientific studies, scientific researches, the causes of accidents in more than 80 cases of collisions in the areas of the road where visibility is not limited, drawings and reports and explanatory letters, video tapes of road traffic incidents , observed and studied, about 20 studies were conducted and conclusions were drawn. Taking into account the above situations, scientifically based, we gave two road traffic accidents as an example, from them, we came to the conclusion that the Lacetti car, moving at a speed of 79.2 km/s, was 6 meters away from the place of the road traffic accident on foot. When starting the movement at a speed of m/s, Lasetti's car was at a distance of S_a=65.5 meters from the place of the traffic accident, and if the driver of the Lasetti's car braked in time, he had the opportunity to stop at a distance of S_o=55.6. So, if we compare the situation $S_a > S_o$, the Lasetti car had a technical possibility to prevent the road traffic accident.

From the above studies and researches, we can conclude that in the analysis of the types of road traffic incidents in the Republic of Uzbekistan, the most 44.9% were pedestrian collisions and 31.2% were collisions. coming into conflict. When we studied more than 80 road traffic accidents, in 91% of the cases, the drivers did not have a limited view of the road, which led to tragic situations even when it was technically possible to prevent the road traffic accident.

Having scientifically studied these situations where visibility is not limited, we have come to such a conclusion that the situations in which drivers cause road traffic accidents accounted for 91% percent, and in the future, the road in situations where visibility is not limited in order to reduce traffic accidents, first of all, taking into account the culture, ethics and aesthetics of driving vehicles, the situations in which there is a danger to the movement, retraining and upgrading the skills of drivers and pedestrians who are the cause of road traffic accidents We suggest that they organize training courses and teach traffic rules in schools.

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