Study of changes in the side clearance between vehicles and cable barriers installed along the highway centre

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Abstract. In the years ahead, one of the most important tasks of the government of the Russian Federation is to bring the condition of highways of various categories to standard parameters and ensure their safety. This is reflected in the decrees of the President of the Russian Federation and in national projects, for example, in the national project on “Safe and High-Quality Roads”. In order to ensure safety and reduce damage from road traffic accidents on highways, various measures are used, including the installation of technical means of road traffic organization. These measures include cable barriers, which also have become popular recently. According to numerous studies, this kind of barrier has a positive effect on the passive safety of highways and it reduces the number of accidents with serious consequences that occur as a result of vehicles driving in the oncoming lane. However, the incorrect installation of these barriers (non-compliance with the minimum safety lanes at barriers, improper installation of barriers when the number of traffic lanes changes, etc.) and imperfection of the modern regulatory framework can negatively affect both a driver and the traffic flow in general, leading to the increase in the number of road traffic transport accidents. This is explained by the fact that a driver of a car, being afraid of close movement along the cable barriers at high speed, tries to stay away from the barrier as far as possible, increasing the side clearance between the vehicle and the barrier. However, at the same time, the side clearance between vehicles passing in the right lane (where a driver has limited visibility) or any obstacle on the right (for example, cars standing on the side of the road) sharply decreases. The article considers the results of the study of changes in the side clearance between the centre line of a road in the presence of a cable barrier and in its absence. The measurement results were compared. According to the results of the measurements, the authors gave the recommendations to improve road conditions, safety and the recommendations for further study of this issue.

1. Introduction

The improvement of the quality and safety of highways is one of the priority directions for the development of the road transport industry, which is reflected in the Decree of the President of the Russian Federation No. 204 of May 7, 2018. As a part of this Decree, the national project on “Safe and High-Quality Roads” (NP SHQR) [1] is currently being implemented, according to which it is necessary to reduce the number of places where road traffic accidents (RTA) are concentrated by 85% by 2025 [2].

In order to solve this problem, comprehensive measures are widely implemented such as bringing the network of federal and regional roads to the standard indicators as well as their installation.
According to the legal document [3], one of the ways to reduce the accident rate in the places where road accidents are concentrated is the installation of technical means of traffic management (TMTM). These include the installation of road signs, marking, installation of barriers, etc. The installation of barriers is one of the most effective passive safety measures. Along the highway centre concrete and cable barriers are installed [4]. Barriers and concrete barriers are installed on roads with a minimum width of a central median strip of 5 meters. Cable barrier can be installed with a much narrower safety strip.

Cable barriers have several advantages over other barriers. These barriers need less space, and the cost of repairing them in case of damage is lower. They can be installed both on the highway centre and on road shoulders. In the first case, they prevent vehicles from entering the oncoming lane and prevent serious consequences of an accident associated with an oncoming collision of vehicles. In the case of installing barriers on the road shoulders, they prevent vehicles from overturning when they leave the roadbed. However, due to the sufficient minimum width of the unreinforced part of the shoulder, barrier fences are preferred.

The additional advantage of the installation of such a fence along the centre is convenient operation. In the case of a road traffic accident, the elements can be quickly changed as soon as possible as well as only the damaged segment. During winter operation there are no snow drifts of fences, even with regular heavy snowstorms. However, at the same time, it is difficult to clean the roadway surface with operational vehicles, but this problem arises for any type of fence installed along the centre of highway.

The disadvantages of cable barriers include a lower impact capacity. However, due to the impossible alternative caused by the limited conditions, this disadvantage is compensated by advantages.

On the road shoulders, the installation of cable barriers is carried out in the same way as the installation of barrier fences, taking into account the requirements [5] [6] [7]. However, the rules for the installation of barriers along the centre of the highway are insufficiently studied and are considered only from the point of view of possible deformations (dynamic deflection) after an accident. In this case, the safety strip along the barrier fence should be at least 0.5 meters on each side of the fence (Figure 1) [8].

![Figure 1. Installation diagram of cable barriers on the highway centre](image)

As the analysis of the literature shows, this value is not justified from the point of view of the psychological perception of this fence by drivers. If the safety lane is insufficient, emergency situations may arise, leading to the increase in the number of road accidents. In addition, on highways, the technology of both posts setting (often the distances between the posts and the degree of tension of the cables are not observed) and the technology of the application of markings along the highway centre at the fence are not generally observed. In addition, there are problems of the installation of a cable barrier on the highway centre when the number of traffic lanes changes (an additional lane for turning left, advance lane, etc.). As a rule, on existing roads of the 1st and 2nd categories, due to the limited width of the roadway, the width of the roadway is not increased during the installation of cable barriers. It is necessary to take into account that it is recommended to install road signs “obstruction”
and “detour right” in front of the barrier fence according to the recommendations of legal documents [3, 8]. All this affects the side clearance while the vehicle is moving.

2. Research
Side clearance is the required distance between a vehicle and an obstruction (or other vehicle) which allows free maneuvering on the road. The non-compliance results in the increase in the number of road accidents and reduces safety on the road in general.

In this paper the authors try to find out how does the installation of the barrier fence affect the side clearance between the vehicle and the cable barrier on two sections of the four-lane road: without a barrier fence and with installed cable barrier. The observation of the movement of cars was carried out using a drone quadcopter. In order to collect data from a transport facility, a section of a road with a minimum load level and the same permitted speed was studied. The work was carried out by an unmanned aerial vehicle PHANTOM-4. The control of this drone was carried out in manual mode. Figure 2 shows fragments of shooting road sections.

![Figure 2](image1.png)

**Figure 2.** Measurement diagram of side clearance in the area with the installed cable barrier (left) and with a double solid line of marking (right)

3. Research results
Based on the research results, cumulative curves were created for the accumulated frequencies (proportional frequencies). As a result of statistical processing of the data, the distribution curves were obtained (Figure 3) from which it follows that:

- with cable barriers, the side clearance was 1.53 meters with 85% coverage, 1.20 meters with 50% coverage, 0.89 meters with 15% coverage;
- in areas with a double solid line, the side clearance was 1.27 meters with 85% coverage, 0.98 meters with 50% coverage, 0.72 meters with 15% coverage.
The increase in the side clearance at different was:
• 0.26 meters with 85% availability;
• 0.22 meters at 50% safety;
• 0.17 meters at 15% safety;

4. Conclusion
Thus, according to the results, the following conclusions can be made:
• With the installed cable barriers, the side clearance between the vehicle and the cable barrier increases by 15 - 30 cm. This indicates a different perception of the road conditions by a driver. It is necessary to note that with the increase in the left side clearance, the right one decreases by the same value, which can cause a possible accident, since vehicles moving on the right fall into a zone of less visibility. In addition, the possibility of collisions of vehicles with obstructions on the right, standing vehicles, etc. increases.
• In the presence of axial barriers, it is necessary to increase the width of the roadway with a central dividing strip or reduce the permissible speed. It is necessary to take into account that widening of the central dividing strip should be provided only by the increase of the width of the roadbed. It is unacceptable to consider the decrease in the width of the hard shoulder and other parameters of the transverse profile to the smaller dimensions provided in this legal document [7]. In the case of the reduction of the width of the shoulder, road accidents are possible which are associated with emergency stop of vehicles. In the case of the decrease in traffic lanes, it is necessary to reduce the permitted speed of vehicles and limit the advance of cars by trucks.
• Further studies of the traffic flow with the installed cable barriers are required. It is also necessary to find out how does the trajectory of vehicles change when advancing and does the number of advancing vehicles increase or decrease.
• It is necessary to consider additional measures related to road safety with the installed barriers along the highway centre, for example, such as “noise” markings, reflectors built into the markings, etc. Additional technical means of traffic management will help drivers to feel more confident when driving along cable barriers at high speeds and performing various maneuvers.
• It is necessary to analyze the accident rate on the road sections with installed cable barriers, to find out the nature of the accident, the damage and the severity of injuries in order to take them into account during the determination of safety measures on the road.

References
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