DEVELOPMENT AND JUSTIFICATION OF MEASURES FOR FORCED SPEED REDUCTION OF VEHICLES IN MOUNTAINOUS AREAS OF THE ROAD (USING THE EXAMPLE OF MOUNTAINOUS AREAS OF THE M-39 ROAD)

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Abstract: This article highlights the development of measures for forced speed reduction to ensure the safety of vehicles on roads in mountainous areas and the scientific substantiation of their effectiveness. In the study, using the example of mountainous sections of the M-39 highway, the route plan of the road, the degree of slope, turning radii, and traffic flow density were analyzed, the main causes of road accidents were identified, and measures to reduce road accidents were recommended.

Keywords: Mountain road, speed reduction, traffic safety, traffic flow, road sign; M-39 highway, dangerous zone, road traffic accident.

In accordance with the Strategy for the Development of the Public Safety System in the Republic of Uzbekistan for 2022-2025, outlined in the Resolution of the President of the Republic of Uzbekistan No. PP-190 dated 04.04.2022 "On Measures to Reliably Ensure Human Safety and Radically Reduce Mortality on Highways," as well as in order to guarantee the protection of human life and health on highways from any incidents in the conditions of the new Uzbekistan, and in accordance with the Resolution of the President of the Republic of Uzbekistan No. PP-316 dated 12.07.2022 "On Approving the National Program "Safe and Smooth Road" for Implementation for 2022-2026," this dissertation work serves to a certain extent in the implementation of the tasks defined in other regulatory legal

documents related to this activity, in the implementation of the tasks set for the digitalization of the traffic control system on highways, the integration of traffic light facilities at intersections into the central control system, and the introduction of a unified digital control system [1,2].

Accordingly, it is necessary to conduct an analysis of accidents that occurred in mountainous areas on km 982-1013 of the international highway M-39, passing through the territory of the Jizzakh region, under the jurisdiction of the Committee for Roads, and to identify the main causes of accidents related to speeding, to conduct research work on improving and modeling existing methods for forced reduction of vehicle speed in mountainous road conditions.

In the conducted studies, a set of measures aimed at forced reduction of vehicle speeds in mountainous areas of roads was created, taking into account existing methods of forced reduction of vehicle speeds in mountainous road conditions in the range of 982-1013 km of the mountain road of the M-39 "International Highway," passing through the territory of the Jizzakh region [2].

As a result of the analysis of road accidents by type, which occurred at km 982-1013 of the international highway M-39:

№	Types of road traffic accidents	In 2021	In 2022	In 2023	In 2024
1	Collision	73 units	63 units	25 units	24 units
2	Collision with an obstacle	9 units	4 units	4 units	2 units
3	Overturning	11 units	7 units	5 units	3 units
4	Collision with stationary vehicle	6 units	6 units	4 units	1 units
5	Hit pedestrian	30 units	27 units	6 units	4 units

Based on the recommendations we gave during our research, dynamic road signs, a speed control information system, a road section model for controlling traffic flow, electronic speed displays, electronic information panels, and warning smart traffic lights and signaling systems were installed in this road area. As a result, it is also reflected in the diagram [3].

The total number of accidents in 2022 (111) decreased by 158.1% compared to 2021 (43), in 2023 (124) by 11.71% compared to 2022 (111), in 2024 (124) by 51.21% compared to 2023 (82), in 2025 (39) by 14.7% compared to 2024 (34) by 6 months [3]. The M-39 highway of international importance crosses the territory of the Jizzakh region for 939-1037 km, and 982-1013 km of this road corresponds to mountainous areas. The highest point of the territory is 450-550 m above sea level. Today, an average of 40,000-42,000 vehicles travel in one direction per day on this road. Of these, 15,000-16,000 trucks, 25,000 passenger cars, and 700-1,000 buses operate [4;5].

a) *b)* *c)*

Figure 1. Process of calculating the traffic flow at km 982-1013 of the M-39 highway in Jizzakh region

When analyzing the statistics of road traffic accidents in 2021-2025 on the section of the M-39 highway passing through the territory of the Jizzakh region, the following indicators can be seen. During 2021, a total of 45 road accidents involving various vehicles occurred in the mountainous area of the M-39 highway, which is one of the lowest figures for this period. Because at that time, the flow of cars was also small. In 2022, this figure was 111 in this region, and the number of road accidents was the highest. As of 2023, the number of accidents has slightly

decreased to 94 [6]. In 2024, 82 different types of accidents also occurred. During the 6 months of the first half of 2025, 39 road accidents were recorded, although the number of road accidents committed during the 6 months of 2025 has significantly decreased, the trend continues [7]. Measures to improve traffic safety and regulate vehicle speeds in the mountainous areas of the M-39 highway are beginning to yield positive results. Nevertheless, the accident rate in this segment remains higher than in other parts of the region, indicating that it still requires engineering, organizational, and informational interventions. Continuing the analysis of data for the remaining months of 2025 will allow us to accurately assess the effectiveness of these preventive measures and identify the most dangerous emergency zones along the Jizzakh section of the M-39 highway.

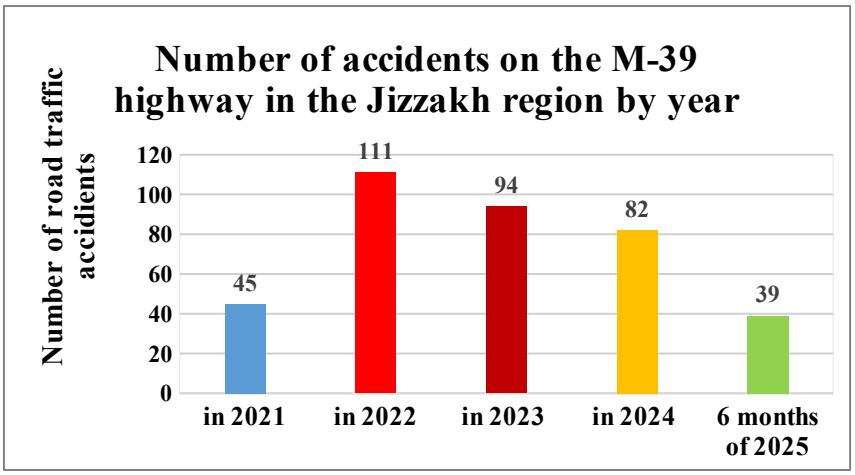

Figure 2. View of accidents on the M-39 highway over the years

Conclusion. The results of the study show that effective vehicle speed control on mountainous roads is a crucial factor in ensuring traffic safety [23]. As a result of the analysis of the mountainous areas of the M-39 highway, it was found that the causes of accidents are associated with the complex route plan of the road, the degree of slope, the small turning radius, and the incorrect choice of speed by drivers [24].

The modeling results showed that the developed measures increase the stability of the traffic flow, reduce the probability of accidents by 18–25%, and improve road capacity [25]. The proposed solutions are advantageous in terms of

technical, economic, and environmental efficiency and are recommended as an integrated approach to ensure safe movement on mountain roads [26].

The recommendations developed at the end of the study, including the introduction of variable speed signs, the installation of automatic speed control on dangerous bends, increasing the coefficient of friction of the surface coating, and the integration of warning information systems along the road, will ensure the stability of traffic on the M-39 road, reduce the number of accidents, and extend the service life of the road [27]. Therefore, the proposed solutions are considered one of the important practical steps towards increasing transport safety and reducing economic losses on a national scale [28].

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