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ANALYSIS OF FACTORS INFLUENCING TRAFFIC SAFETY ON MOUNTAIN ROADS

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Abstract
This article addresses the critical need to enhance vehicle traffic safety on mountain roads during hazardous conditions, with a focus on the Kamchik Pass as a case study. The research highlights the urgency and relevance of improving traffic safety in mountainous terrains, where unique challenges such as steep gradients, sharp curves, and weather variability significantly increase the risk of accidents. The scientific novelty of this study lies in its approach to analyzing and proposing methods to improve traffic safety under these conditions. Key findings emphasize the importance of targeted interventions and their practical implications for reducing accident rates and ensuring safer travel. The research also underscores the scientific and practical value of implementing safety measures tailored to the specific characteristics of mountain roads.

Keywords: Mountain roads, traffic safety, Kamchik Pass, vehicle movement, accident prevention, road safety analysis, transportation safety, infrastructure improvement, traffic flow management, road safety measures.

Introduction

Mountain roads present unique challenges to traffic safety due to their complex topography, variable weather conditions, and often high traffic volumes. The Kamchik Pass, one of the most critical mountain routes in Uzbekistan, exemplifies these challenges. Serving as a major transportation artery connecting the Fergana Valley with other regions, the Kamchik Pass experiences significant vehicular traffic, including passenger cars and heavy-duty trucks. However, its steep gradients, sharp curves, and narrow sections make it a high-risk area for road traffic accidents, particularly during adverse weather conditions.

Ensuring the safety of vehicles on such mountainous roads is a pressing concern. Accidents in these regions not only pose a threat to human life but also disrupt economic and social activities. Despite numerous safety initiatives, the frequency of accidents remains high, highlighting the need for a systematic approach to understanding and mitigating the risks.

This study aims to explore the factors influencing traffic safety on mountain roads, with a specific focus on the Kamchik Pass. By analyzing key parameters such as road design, traffic flow, and environmental conditions, this research seeks to identify the primary causes of accidents and propose effective safety measures. The findings are expected to contribute to the

development of scientifically grounded strategies to enhance traffic safety and reduce accident rates in hazardous mountain terrains.

The main part

Determination of the speed of traffic flow on highways in the Kamchik Pass of the Republic of Uzbekistan A373 and the theoretical study of speeds in dangerous sections. identification, improvement of traffic safety of vehicles using emergency access road, types of emergency access road and Analysis of the existing ones in the Kamchik pass, regulatory requirements for the access road for catastrophic situations, development of a method for determining the distance between the installation of safe stopping roads in the event of a disaster (accident) of a truck on a continuous slope by calculation, MATLAB /Introduction that provides safe extinguishing of the kinetic energy of cars in the event of catastrophic (accident) movement based on the Simulink simulation model issues of improving the method of determining the length and slope of the road were considered.

Dangerous sections of the road were identified using the analysis of accidents that occurred in Kamchik Pass in the last three years and the methods of safety and fatality coefficients.

Regression was analyzed according to the causes of accidents that occurred in Kamchik Pass:

Y – number of YTH;

X_1– an accident caused by speeding;

X_2 – accidents caused by drivers falling asleep;

X_3– accident caused by insufficient visibility;

X_4– accident related to braking system;

X_5 – accidents caused by weather conditions;

X_6 – an accident caused by the longitudinal slope of the road;

X_7 – an accident caused by the radial curvature of the road.

$$Y = 0,6\,X_1 + 0,2\,X_2 + 0,26\,X_3 + 0,3\,X_4 + 0,295\,X_5 + 0,37\,X_6 + 0,42\,X_7. \quad (1)$$

The results of the analysis based on statistical data show that the highest number of accidents occur in the Kamchik Pass due to the increase in speed. The results of the research are aimed at reducing accidents caused by the increase in speed of vehicles and the failure of the braking system, the longitudinal slope of the road, the radial curvature of the road, insufficient visibility, and the influence of weather conditions.

Even in adverse weather conditions, there are cases of high-speed traffic, and as a result, traffic accidents occur. Taking these into account, it is important to determine the speed of movement, taking into account the weather conditions and the condition of the pavement, to ensure the safety of movement in such turns. The following mathematical model determines safe driving speeds for roundabouts in adverse weather conditions.

Loss of stability of the vehicle can be observed in the form of overturning, sliding to the side and skidding of the leading wheels. The overturning and sideslip situations are represented by the overturning critical speed and the sideslip critical speed. The coupling coefficient was taken as follows.

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Table 1. Coefficients of adhesion according to the condition of the road surface

Indicator	Dry road	Wet road	Snowy road	Frozen road
Coefficient of mixing	0.75	0.4	0.25	0.12

Speed limit signs on highways cannot indicate safe driving speeds in various weather conditions. Research shows that the coefficient of adhesion of wheels to the road varies depending on the condition of the road surface in different weather conditions. From the theory of cars, it is known that the critical speed for the loss of stability of cars (in terms of sliding) depends on the turning radius of the road and the coefficient of adhesion.

Therefore, to determine the critical speed of the cars for the loss of stability for different conditions of the road surface and different turning radii of the road in different weather conditions, the road in different weather conditions before each road turn. by using sensors that determine the condition of the pavement and variable electronic boards that calculate critical speeds and display them on a screen can be provided.

On continuous slopes, vehicles move under the influence of the following forces when the brake system is in a faulty state. The resultant driving force equation is:

$$F_h = F_n - F_i - F_f - F_{v,} \quad (2)$$

Fh-resultant force driving the car:

$$F_h = M_a J_a \quad (3)$$

J_a-linear acceleration of the car;

M_a is the mass of the car;

Force of air resistance acting on f_v-car:

$$F = KxFxV_a \quad (4)$$

K-coefficient of overcoming air resistance;

F-the face of the car when viewed from the front;

V_a is the speed of the car at the given moment.

F_i - the force of resistance to acceleration of the car (inertia force):

$$F_i = Ma \cdot j_a \cdot \delta_{rpm} \quad (5)$$

Taking into account the effect of the force of rotating masses coefficient. Based on the above formulas

Conclusion

1. Factors affecting the safety of vehicles on mountain roads were analyzed. As a result of the analysis, the climatic condition of the mountain road, the causes of traffic accidents, the structure of traffic, the speed of vehicles and the safety of cars on dangerous road sections were considered.
2. The speed of safe movement of vehicles on the dangerous road sections of the Kamchik Pass in different weather conditions was determined and a method of their implementation was developed.
3. Based on the MATLAB/Simulink simulation model, a method for determining the distance between the installation of safe stopping lanes in the case of a truck disaster (accident) on

continuous slopes was developed. On continuous slopes, when the slope of the road is 5-12%, it was determined that the distance between the installation of FHUKY varies in the range of 250-800 meters.

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