

ПРОБЛЕМЫ БЕЗОПАСНОСТИ ДВИЖЕНИЯ НА ДОРОГАХ

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Аннотация. В данном исследовании изучается влияние дорожных условий и факторов окружающей среды на безопасность дорожного движения, уделяя особое внимание сезонным изменениям, видимости, выбору скорости и частоте аварий на национальной дорожной сети Узбекистана. Статистический анализ данных о ДТП за 2020–2023 годы, полученных из Министерства внутренних дел, показывает, что до 28–32% всех аварий происходят в условиях неблагоприятных дорожных условий, а ограничения видимости (туман, снег и темнота) составляют около 18% зарегистрированных инцидентов. В исследовании выявлены критические участки дорог с повышенной аварийностью и представлены технические рекомендации по снижению числа столкновений, связанных с превышением скорости, путем применения сезонного контроля, улучшения обслуживания дорожного покрытия и систем оповещения, учитывающих погодные условия.

Ключевые слова. *безопасность дорожного движения, аварийность, дорожные условия, погода, сезонные факторы, скользкое дорожное покрытие, видимость.*

ROAD SAFETY PROBLEMS

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Annotation. This study investigates the influence of road conditions and environmental factors on road safety, focusing on seasonal changes, visibility, speed selection and accident frequency on the national road network of Uzbekistan. Statistical analysis of accident records from 2020–2023 obtained from the Ministry of Internal Affairs shows that up to 28–32% of all crashes occur under adverse road-surface conditions, while visibility restrictions (fog, snow and

darkness) account for approximately 18% of reported incidents. The research identifies critical road segments with elevated accident rates and provides engineering recommendations for reducing speed-related collisions by applying seasonal control, improved pavement maintenance and weather-responsive warning systems.

Keywords. *road safety, accident rate, road conditions, weather, seasonal factors, slippery pavement, visibility.*

Introduction. Road accidents are rarely caused by a single factor; rather, they result from a complex combination of road conditions, driver decisions and environmental influence. In Uzbekistan, the number of registered motor vehicles increases annually by 7–10%, which has intensified accident occurrence on road sections with poor pavements and limited visibility.

Understanding the quantitative effect of seasonal and climatic factors is crucial for designing safer road networks, especially in mountainous and steppe regions where snow, wind and low visibility significantly reduce vehicle stability. A serious explanation of this issue is given in paragraph 10.1 of the Traffic Rules [6], according to which if there is a danger of a collision that the driver can detect, he must take all possible measures to reduce the speed until the car stops. This reduces the significance of the driver's fault and increases the significance of the incident road conditions.

Data and Methods. Data sources:

- official accident database (2020–2023)
- traffic police statistics
- weather observation reports
- field measurements on selected road segments

Indicators analyzed:

- accident frequency
- seasonal distribution
- friction coefficient
- visibility distance

- vehicle speed
- wind velocity
- Evaluation methods
- descriptive statistics
- regression analysis
- correlation between surface condition and crash frequency
- assessment of critical road sections

To assess road-surface risk, the coefficient of adhesion (μ) was used:

$$\mu = \frac{F_{adh}}{F_{norm}}$$

Lower values of μ correspond to higher accident probability, especially during winter months.

Results and Discussion. The unsatisfactory condition of the coating (32%) leads to a decrease in the coefficient of adhesion and an increase in the braking distance of vehicles, and in some cases there is a risk of skidding.

1. Seasonal influence. Analysis shows that accident rates increase by:

- 32% in winter
- 21% in autumn
- 14% in spring
- compared to summer baseline values

Loss of friction due to snow and ice is the main contributing factor.

2. Visibility reduction. Road sections with limited visibility (fog, snowstorm, darkness) demonstrate accident probability increase of **18–23%**, particularly in mountainous regions.

3. Impact of pavement conditions. Poor pavement condition contributes to:

- 32% of skidding accidents
- 68% of increased braking distance
- up to 24% higher rear-end collision probability

4. Side wind effects

Cross-wind measurements indicate that at wind speeds above 20 m/s, high-profile vehicles have a significantly increased overturning risk. Simulation results show:

Vehicle speed	Dangerous wind velocity
60–80 km/h	15 m/s
100 km/h	10 m/s
120 km/h	5 m/s

5. Road geometry. Curvature, longitudinal slope and narrowed lanes lead to collision increase by 12–17% during snow accumulation.

Drivers typically compensate by lowering speed; however, insufficient warning, lack of maintenance and poor signage generate additional crash risk.

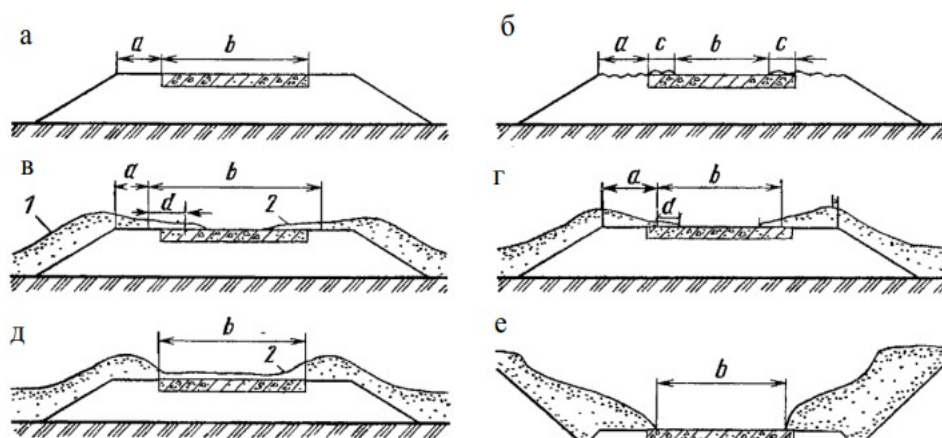


Figure 1. Road use at different times of the year:

a-in summer; b-on roads that have not been repaired in spring and autumn, in winter on regularly cleared snow areas in the absence of roadside intervention; г-if there are obstacles on the roadside, d-if the road is not completely cleared of snow, or there are snow piles on the roadside; e-in potholes; a-the actual width of the roadside; b-the width of the used carriageway; C-the lines of the pavement contaminated in spring and autumn; d-the lines of compacted snow or ice; 1-loose snow; 2-compacted snow or ice.

Conclusion. The findings demonstrate that seasonal and environmental factors significantly increase road-accident probability on national highways.

Road-surface conditions, visibility limitations and cross-wind effects must be considered when planning maintenance schedules and traffic-safety measures.

To improve safety, the following strategies are recommended:

- winter-specific speed limitations,
- seasonal friction-enhancing pavement treatments,
- installation of weather-adaptive traffic signs,
- strengthening of wind-protection on elevated roads
- continuous monitoring of critical segments.

Further research should involve simulation models and long-term datasets in order to develop predictive safety algorithms.

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