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## TOPOGRAPHIC ANALYSIS OF ACCIDENTS IN MINSK IN TERMS OF ROAD TRAFFIC ACCIDENTS INVOLVING ROUTE VEHICLES

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*The relevance of the topic of this article is the identification of places of concentration of road accidents at stopping points (SP) of regular passenger route transport and the development of specific proposals to reduce accidents at them. In addition, the risk of road accidents on the SP of regular passenger route transport is a socially significant problem that needs to be addressed. An increase in traffic intensity, as well as an increase in the number of vehicles on the road network of cities, leads to an increase in the tightness of interaction between road users and the emergence of road conflicts, which result in the occurrence of road accidents, while a considerable part of which falls on road accidents involving passenger transport.*

**Keywords:** road safety, road traffic accident, regular passenger route transport, stopping point, topographic analysis, causes of accidents.

**Introduction.** The topographic analysis of road accidents is the main type of analysis for assessing the places of concentration of road accidents at the road network of the city and includes a set of different methods for modeling spatial data. The task of topographic analysis is to identify patterns between samples of incidents, taking into account their spatial and temporal characteristics, which can be solved using the analysis of point structures. A topographic analysis of an accident can be implemented in the following options: an accident map, a linear graph of an accident, a large-scale accident scheme. This type of analysis consists in mapping the investigated territory (city, section of the road network) of the accident sites. A road accident map is a map of the investigated territory, at the corresponding points of which symbols of road accidents are applied as they are registered. Areas of concentration of road accidents in settlements include zones of influence of conflict and linear objects – intersections, pedestrian crossings and SP – in which accidents, as a rule, are the result of conflict maneuvering or shortcomings associated with traffic management. A distinctive feature of such areas in settlements is the relatively low speed of traffic and the high intensity of conflicting participants. The length of the areas, as a rule, does not exceed 300 m. The length of the impact zone of route passenger transport SP is determined by the points of the beginning and end of the landing site, increased in each direction by 50 m. The length of the zone, in addition, can be increased by connecting with a pedestrian crossing or with an intersection<sup>1</sup> [1–5].

**Main part.** To identify the streets with the largest number of road accident concentration sites in Minsk, a topographic analysis was carried out along the existing routes served by the rolling stock of the Transport Park No. 4 branch. Figures 1-5 show the location of an accident on the map of Minsk for the period 2019-2023. Circles are plotted on the map of the area, which indicate the places where the accident occurred. The circle also indicates the severity of the consequences of an accident: completely hatched (filled) or painted red – death; half-hatched (filled in) or painted blue – wound; not shaded – material damage.

According to the topographic analysis for 2019 (Figure 1), it can be concluded that the highest concentration of road accidents is presented on the Bobrujskaja and Prityckogo streets. Prityckogo Street is one of the longest streets in Frunzenskij district of the city, its length is 6.5 km. Bobrujskaja Street is located in the central part of Minsk, in parallel to the railway section near the Central Railway Station. The length of this street is 1.3 km. Based on the difference in the lengths of these two streets, the most concentrated in terms of the number of accidents can be called Bobrujskaja Street, on which in 2019 there were 2 fatal accidents, 6 accidents with injuries and 3 accidents with material damage. Next, we will focus on these streets.

A topographic analysis of the accident rate in 2020 (Figure 2) showed that on the Bobrujskaja Street decreased the number of accidents with injuries, but the number of accidents with material damage increased. On the Prityckogo Street increased the number of accidents with material damage and injuries. Fatal accident occurred at the intersection of Prityckogo Street – Kunccevshhina Street.

In 2021 (Figure 3), the number of accidents with material damage and injuries on the Prityckogo Street decreased. Fatal accident occurred at the intersection of Prityckogo Street – Pushkina Avenue. On the Bobrujskaja Street relative to last year, the number of accidents with injuries and deaths has decreased and the number of accidents with material damage has increased.

In 2022 (Figure 4), the number of accidents increased sharply. On the Prityckogo Street there were 6 accidents with injuries and 12 accidents with material damage. On the Bobrujskaja Street number of accidents with material damage remained equal to 5 incidents, the number of accidents with injuries increased to 4.

<sup>1</sup> Капский Д.В. Методология повышения безопасности дорожного движения в городских очагах аварийности: дис. ... д-ра техн. наук: 05.22.10. – Минск, 2013. – 194 л.

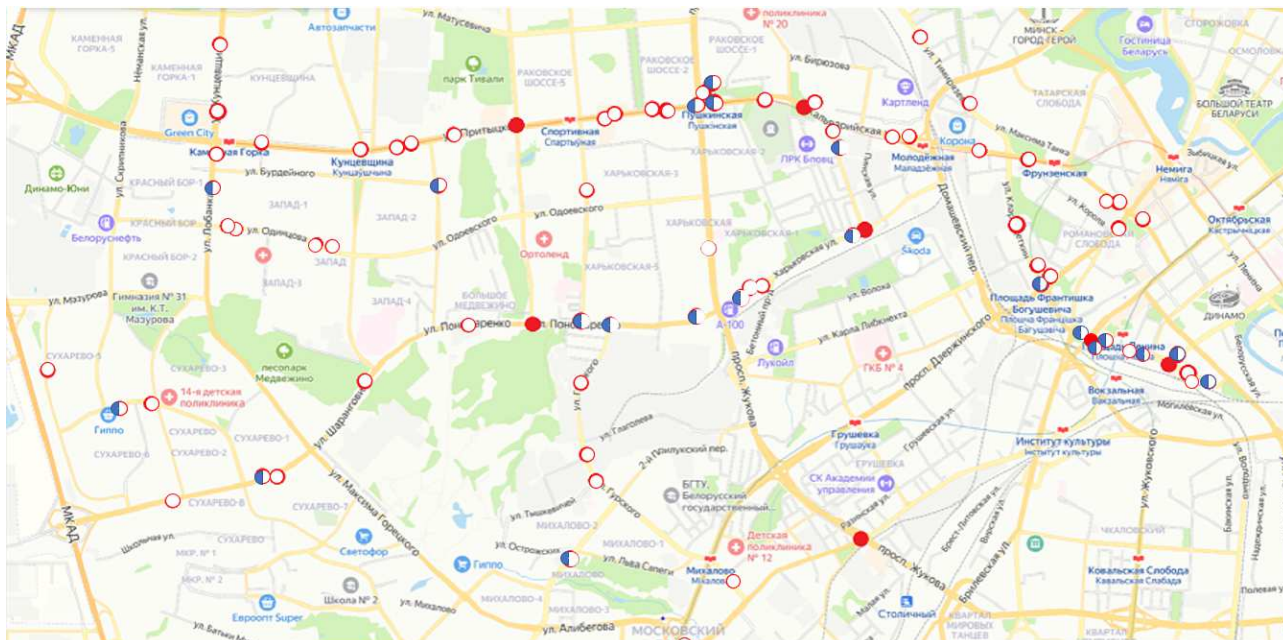


Figure 1. – Accident localization on the map of Minsk for the period January–December 2019

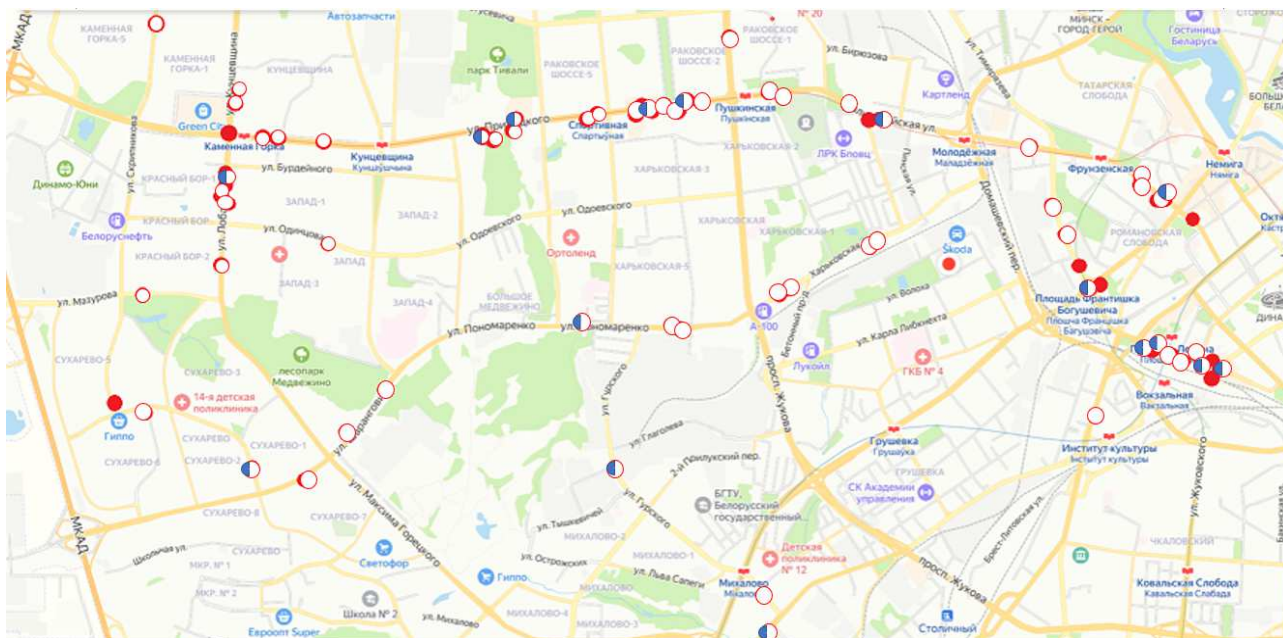


Figure 2. – Accident localization on the map of Minsk for the period January–December 2020



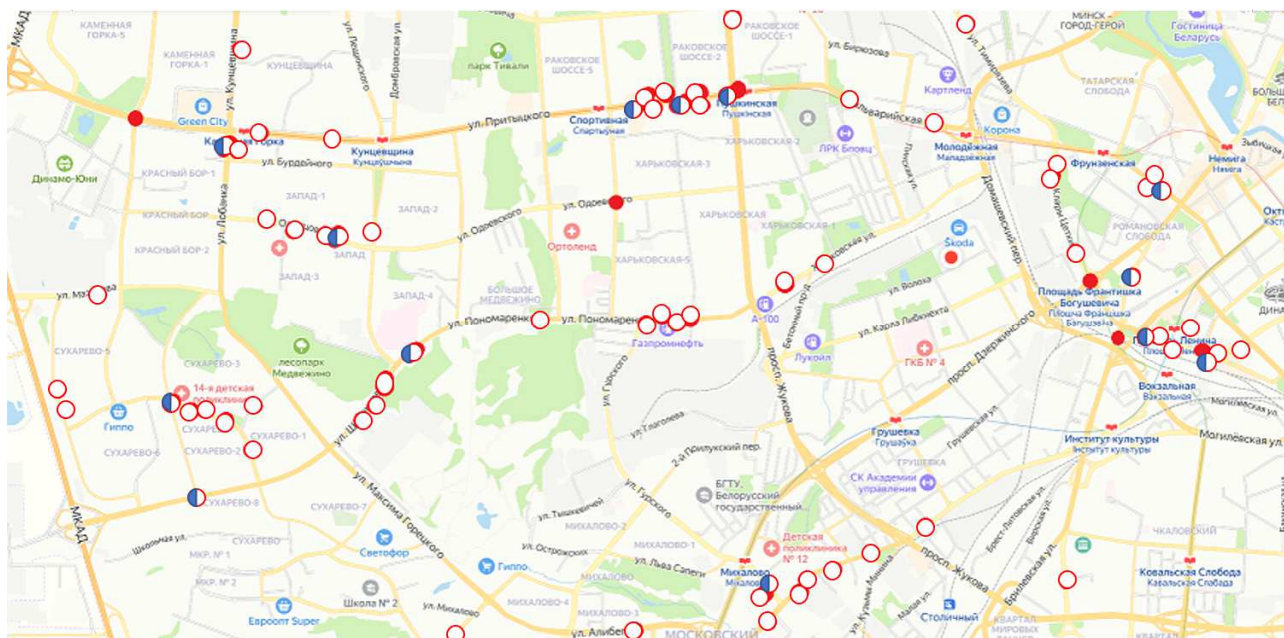


Figure 3. – Accident localization on the map of Minsk for the period January–December 2021

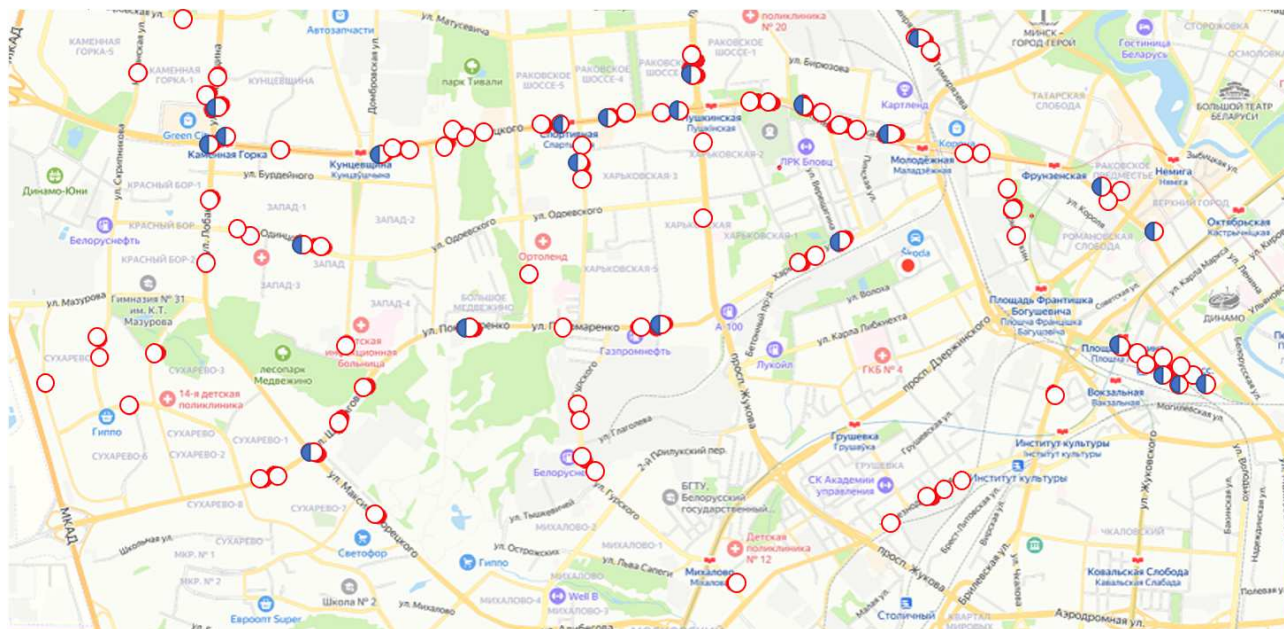
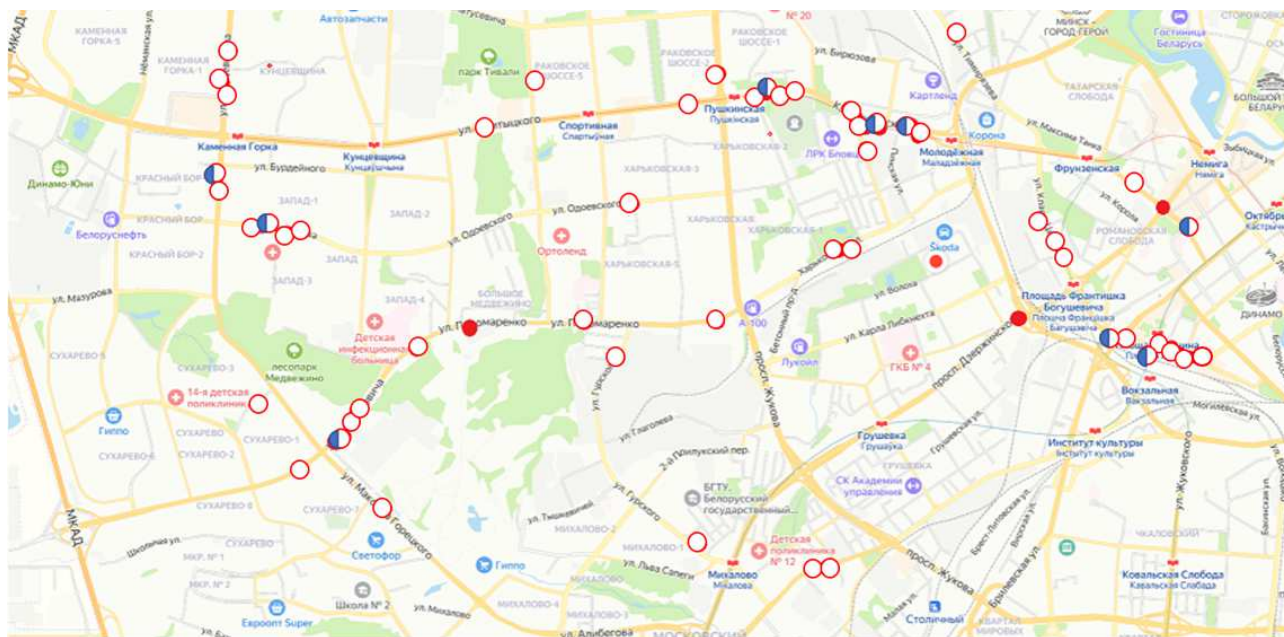


Figure 4. – Accident localization on the map of Minsk for the period January–December 2022

By 2023 (Figure 5), it was possible to reduce the total number of accidents involving route vehicles in Minsk. On the Prityckogo Street there were 5 accidents with material damage and 1 accident with injury. On the Bobrujskaja Street there were 4 accidents with material damage and 2 accidents with injuries.



**Figure 5. – Accident localization on the map of Minsk in the period January-December 2023**

Based on the topographic analysis for the studied period from 2019 to 2023, it can be concluded that only with the participation of route vehicles were registered:

1. Fatal accident: the Bobrujskaja Street – 5 accidents; the Prityckogo Street – 3 accidents;
2. Accident with injuries: the Bobrujskaja Street – 18 accidents; the Prityckogo Street – 16 accidents;
3. Accident with material damage: the Bobrujskaja Street – 19 accidents; the Prityckogo Street – 48 accidents.

Taking into account the length of the streets, the greatest concentration of accidents entailing serious consequences (injury and death) was identified on the Bobrujskaja Street, where the objects of mass attraction are the Central Railway Station and Central Bus Station.

The general analysis of accidents shows that the main causes of accidents are:

- 1) speeding – the driver does not have time to adequately respond to a rapidly changing road situation;
- 2) non-compliance with the requirements of road signs and traffic lights;
- 3) violation of the rules of operation of the vehicle, because of which it is in unsatisfactory condition;
- 4) non-observance of the distance between moving vehicles;
- 5) improper maneuvering: when overtaking with leaving the oncoming lane, when avoiding obstacles or standing vehicles, when crossing intersections (especially roundabouts), when advancing with moving to the leftmost lane, when rebuilding, etc.;
- 6) non-compliance with the work and rest regime;
- 7) insufficient professional training, little experience in driving a vehicle.

**Conclusion.** The main causes of road accidents caused by drivers of urban passenger transport are non-observance of a safe distance and lateral interval, violation of the rules for maneuvering and passing intersections, incorrect choice of speed and inattention.

Another reason is the irresponsibility of drivers. Many accidents occur due to the fault of drunk drivers. However, now in the Republic of Belarus, the number of accidents committed while intoxicated by drivers is decreasing. At the moment, the Republic of Belarus has one of the toughest measures of responsibility for drunk driving, in comparison with neighboring countries and other CIS states.

An important thing is the violation of the speed limit. The higher the speed, the more serious the consequences of an accident. The situation of a collision with an SP can be, both when the driver does not cope with the control, and when he himself becomes injured due to the fault of another participant in the movement, and in case of unsatisfactory technical condition of the car. Video cameras are designed to deal with gross violations of the speed limit.

Another problem is the correct location and equipment of the SP themselves. The equipment of SP with landing sites, pavilions, racks for the installation of stop signs, etc., as well as the maintenance of sites and structures should be carried out by the owners of roads and streets. Current repair of public transport on the Bobrujskaja Street, which

belongs to the Oktyabrskij and Moskovskij districts of Minsk, is under the economic jurisdiction of unitary enterprise “Remavtodor of the Oktyabrskij district of Minsk” and unitary enterprise “Remavtodor of the Moskovskij district of Minsk”, respectively (as well as the replacement of stopping pavilions).

The main document regulating the parameters of the landing site is CS 3.03.06-2022 “Construction standards of the Republic of Belarus. Streets of settlements”, approved and put into effect by decree of the Ministry of Architecture and Construction of 25.03.2022 No.39. This regulatory document spelled out the main necessary parameters for the arrangement of SP buses and (or) trolleybuses and trams. Regarding the equipment of waiting pavilions, the document regulating their arrangement is the “List with requirements for standard stopping pavilions, benches, refuse bins and other small architectural forms for Minsk”. Waiting pavilions are located at a distance of at least 3 m from the side of the carriageway. However, this rule is not observed everywhere – often due to cramped conditions, SPs are located much closer to the roadway. The prescribed 3 m will not be able to protect people waiting for transport from a car flying onto the sidewalk. By standards, the waiting pavilion should be equipped with<sup>2,3</sup>:

- road signs indicating the place of stopping vehicles, in accordance with the traffic rules;
- linear transport route indicators;
- seats for passengers;
- glazed information boards for posting information on the operation of ground urban passenger transport;
- glazed panels for placing advertising products.

On SP, the dimensions of which do not allow placing pavilions of standard structures, small architectural forms are installed (benches, plates with a schedule).

Sidewalks in the city are protected by high curbs, trees or shrubs, columns limiting the arrival of cars. Stopping places of regular passenger route transport are not protected by anything other than a road curb, which in some places is located lower than usual for the convenience of passengers and is practically not an obstacle for cars. Thus, it turns out that modern SPs are responsible for the comfort and awareness of passengers, but not for their safety.

Thus, one of the most emergency streets is the Bobrujskaja street in Minsk, namely the places of concentration of road accidents located in the SP districts along this street. It houses auto and railway stations, which are visited daily by a huge number of people from other cities and countries. Thus, SPs within train stations are crowded places where a large number of passengers are simultaneously awaiting the arrival of public transport. Such passenger traffic on the SP should correspond to both the number of public transport and the route schedule (frequency of their arrival). Thus, at peak hours, SP along the Bobrujskaja street becomes a zone of increased danger.

An accident at public transport stops is a tragedy that affects not only the injured passengers, but also the entire infrastructure of urban traffic. Accidents at stops often result in injuries to passengers waiting for transport, as well as drivers and pedestrians nearby. Cars, infrastructure elements (stopping pavilions, traffic lights) are damaged, which requires significant costs for their restoration. After an accident, traffic on a section of the road can be difficult or completely blocked, which leads to congestion and delay in public transport. Improving the design of the SP, and most importantly the waiting area, can significantly reduce the risk of accidents at public transport stops, creating safer conditions for all road users. Understanding and compliance with traffic rules and mutual respect for drivers and pedestrians is also a guarantee of safety and prevention of such tragic incidents.

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<sup>2</sup> СН 3.03.06-2022. Строительные нормы Республики Беларусь. Улицы населенных пунктов: утв. постановлением М-ва архитектуры и стр-ва от 25 марта 2022 г. № 39. – Минск: Минстройархитектуры, 2022. – 56 с.

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**ТОПОГРАФИЧЕСКИЙ АНАЛИЗ АВАРИЙНОСТИ В Г. МИНСКЕ  
В РАЗРЕЗЕ ДОРОЖНО-ТРАНСПОРТНОЙ АВАРИЙНОСТИ  
С УЧАСТИЕМ МАРШРУТНЫХ ТРАНСПОРТНЫХ СРЕДСТВ**

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*Актуальность темы данной статьи состоит в выявлении очагов аварийности на остановочных пунктах (ОП) маршрутного пассажирского транспорта регулярного сообщения и выработка конкретных предложений по снижению аварийности на них. Кроме того, риск дорожно-транспортных происшествий на ОП маршрутного пассажирского транспорта является социально значимой проблемой, требующей решения. Рост интенсивности дорожного движения, а также увеличение численности транспортных средств на улично-дорожной сети городов приводит к повышению тесноты взаимодействия участников дорожного движения и возникновению дорожных конфликтов, следствием которых является возникновение дорожно-транспортных происшествий, при этом немалая часть из которых приходится на дорожно-транспортные происшествия с участием пассажирского транспорта.*

**Ключевые слова:** *безопасность дорожного движения, дорожно-транспортное происшествие, маршрутный пассажирский транспорт регулярного сообщения, остановочный пункт, топографический анализ, причины аварийности.*