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MEASURES OF SPEED CONTROL IN THE REPUBLIC OF BELARUS

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ЗАХОДИ СТРИМУВАННЯ ШВИДКОСТІ В РЕСПУБЛІЦІ БІЛОРУСЬ

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Calming traffic is one of the main approaches to ensuring safety in city streets and it is based on the concept of speed containment. The aim of this approach is to minimize passing transit flows through the streets of district importance, to ensure the pedestrians and cyclists safety, as well as the impact on the behavior of drivers in urban conditions. City streets should be designed taking into account the restriction of "extra" speed, as well as in accordance with the category and purpose. It is necessary to take into account the functionality of the street, the uniformity of the traffic flow, the appropriateness of the imposed limitations, the predictability of the technical means used to organize traffic.

The main criteria for the use of such an approach, as a calming traffic, can be: accident rate, speed, through traffic, specific traffic conditions.

Keywords: *speed management, traffic organization, speed control measures system.*

Introduction. In the Republic of Belarus over the past 20 years, the number of cars increased by 4 times and exceeded 3 million units. This growth has caused a number of road transport problems associated with an increase in the load on the road network, especially in cities. The speed of the message has decreased, the modes of movement have deteriorated, overloads have appeared, the number of accidents has increased.

The main problem of safety is speed. Anyway speed is connected with all road accidents. First, it is more difficult to react to sudden changes of traffic conditions and to prevent the accident at higher speeds. Secondly, speed affects the severity of the consequences. And first of all it concerns accidents with pedestrians. At a higher velocity, more energy is emitted, and a part of this energy is absorbed by an unprotected human body.

Various methods – road signs, humps, narrowings of a passable part, interruption of a direct trajectory, video control are applied to regulation of the high-speed mode on pieces of streets, more difficult for traffic participants. The limitation informs drivers on the safe speed of the movement under average traffic conditions. According to about 40–50% of drivers move quicker than the set limit. From them from 10 to 20% exceed the set limitation more than on 10 km/h [1]. Also it should be noted that drivers seldom correct towards reduction the allowed speed at temporary deterioration in weather or road conditions. The choice of speed is influenced by motives of the driver, its adoption of risk, the characteristic of the vehicle and the road environment.

It is more effective to apply an integrated approach to solve the problem of exceeding or selecting the wrong speed for existing conditions. A determinate combination of methods is necessary for each typical section of the road and road network. And the speed limits in a particular place should be justified and understandable to drivers. And for violators, which will always be, we need video monitoring and more stringent legal measures. Highly effective and the use of intra-system auto-mobile technologies, which, when collecting data from technical means of organizing traffic, will additionally warn drivers or limit the speed in accordance with the settings. It is also highly effective to use in-system automotive technologies, which, when collecting data from technical means of organizing traffic, will additionally warn drivers or limit speed in accordance with the settings.

According to statistics [7], speed is the cause in more than 10% of accidents from the total number of reported road accidents and about 30% of fatal accidents. An increase in speed at 1 km/h in urban conditions entails an increase in accidents related to speed by 1-4%.

The speed effect. Between the severity of accidents and high speed there is a clear biomechanical relationship. With increasing speed, the amount of energy released increases and, in case of an accident, it will be absorbed by an object with a smaller mass. In the case of pedestrians, the difference in mass is enormous and there is absolutely no external protection to absorb excess energy. On this basis, Swedish scientist G. Nilsson presented the following relationship between the speed and the number of road accidents [5]:

$$A2 = A1*(V2/V1)2 \quad (1)$$

A2 – the number of accidents after speed changes, accidents;
A1 – the number of accidents before speed changes, accidents;
V2 – the average speed after the introduction of changes, km/h;
V1 – the average speed before the introduction of changes, km/h.

At the same time, the dependence of the severity of the consequences on the change in speed was determined by the following formulas:

$$I2 = I1*(V2/V1)3 \quad (2)$$

I2 – the number of accidents with injured after a change in speed, accidents;
I1 – the number of accidents with injured before the change in speed, accidents;
V2 – the average speed after the introduction of changes, km/h;
V1 – the average speed before the introduction of changes, km/h.

$$F2 = F1*(V2/V1)4 \quad (3)$$

F2 – the number of accidents with fatalities after a change in speed, accidents;
F1 – the number of accidents with deaths before the change in speed, accidents;
V2 – the average speed after the introduction of changes, km/h;
V1 – the average speed before the introduction of changes, km/h.

These dependencies were refined [2] - the severity of the consequences depends on the initial velocity.

Of course, it is necessary to take into account that in urban conditions it is necessary to maintain a reasonable speed and take into account mobility. But considering only the effect of speed changes on the severity of the consequences and the number of accidents, we obtain the following data (see Table 1).

Table 1

The impact of speed changes on the severity of consequences from accidents

V_2, km/h	80	70	60	50	40	30	20
A_2, accidents	17,8	13,6	10	6,9	4,4	2,5	1,1
I_2, accidents	23,6	15,9	10	5,8	2,9	1,3	0,4
F_2, accidents	31,6	18,5	10	4,8	2,0	0,6	0,1

Note: conditionally A1 = 10 accidents, I1 = 10 accidents, F1 = 10 accidents, V1 = 60 km/h - permitted speed according to the Traffic Rules.

The system approach to speed management in pedestrian crossing areas. Traffic calming measures have been applied for a long time. The range of technical methods and means of calming is extremely wide. It includes: channelization; chicanes; gateway treatments; intersection diverters; on-street parking; round-a-bouts; speed humps; speed tables; street closures; street design alterations; street narrowing; traffic controls; vehicle size restrictions and etc, including combinations. However, it should be noted that Belarus is still taking the first steps to streamline the application of these measures and the calming zones development. For example, in Belarus there is only one ring of a small radius (the Vostochnaya street in Minsk). There is no universal solution when we are choosing a safe speed. Effective speed control requires a comprehensive, systematic, step-by-step approach. The following combination of measures is most often used in the areas of pedestrian crossings [4, 6, 12].

Step 1. Setting limitations. Speed limits should take into account specific characteristics of the road network, be logical and understandable to road users.

Step 2. Informing about speed limits. Appropriate road signs and markings are used to implement this stage. Information on speed limits must be reliable and available under all road conditions.

Step 3. Application of measures of physical and psychological impact. To reduce the level of the conflicts danger between the traffic participants and reduce the speed apply some measures of physical impact in the approach to traffic calming:

humps and bumps of various types and elevated sections of the carriageway (see fig. 1);

dividing lines, street-refuges (fig.2), narrowings of the carriageway, side reserve strips (fig. 3);

Fig. 1. The typical example of the hump's installation in Minsk, Belarus

Fig. 2. Use of guide strips (Minsk, Belarus)

Fig. 3. The typical example of the street-refuge's installation in Minsk, Belarus

zigzags (fig. 4) ;and small-radius roundabouts (fig. 5);

combination of speed control measures.

Fig. 4. The typical example of the zigzags installation in Minsk, Belarus

Fig. 5. The typical example of the small-radius roundabout's installation in Minsk, Belarus

Step 4. Application of video control and legal measures. Any restrictions should be monitored, and in case of intentional violations it is necessary to apply sanctions in accordance with the law.

Step 5. Informing drivers about the reasons for imposing limitations. Any limitations should be logical for each specific section of the road network and correspond to its characteristics. The introduction of measures from steps 1-4 to reduce the speed should be made available to the traffic participants, and it is also desirable to inform the drivers about it after the implementation of certain results.

The setting the speed limits. Until recently, the general approach for the introduction of speed limits, including pedestrian crossings, was the introduction of the V85 limit. V85 is a speed that does not exceed 85% of vehicles. In recent years, when choosing speed limits, we are based not only on the choice of the driver, but also on the analysis of the traffic situation and the characteristics of transport and pedestrian flows, especially on the biomechanical constraints of road users.

In Australia and the USA, the X-LIMITS approach is used to select the limit of speed limits. It consists in collecting data on the parameters of the carriageway, the characteristics of the transport and pedestrian flow (intensity, density, speed, intervals between groups of vehicles and pedestrians, etc.) and features of the site. Further, the obtained data is entered into the computer program and the recommended limit for the speed is calculated.

In Europe, the Vision Zero approach is used [8], [9]. It assumes that the upper the speed limit will be such that it is possible to exclude accidents with the dead and significantly reduce the number of accidents with the injured. However, it is necessary to balance the safety, mobility and environmental impact of speed on the state of the environment. Speed should also reflect the function of the road.

The informing about speed limits. First, any information on the limitation must be available to the driver under any road conditions. Secondly, any limits must be justified.

Traffic signs and markings are commonly used to inform about speed limits. Also, innovation systems can be used.

The application of physical and psychological impact measures. The speed of the road must match the category of street or road. In certain places - residential areas, pedestrian crossings, etc. - measures of physical and psychological influence are applied – humps or bumps, narrowing, street-refuges, rings of small radius, portal constructions, etc. Most European countries for such sites apply a speed limit of 30 km/h [11,12,14].

Physical impact measures are applied when entering a low-speed zone to adapt drivers to the proposed traffic conditions. Measures of psychological impact give the feeling to drivers that they enter the territory with special conditions.

Table 4 shows the relationship between the installation of unevenness in the pedestrian crossing zone and accidents.

It is known that the use of humps provides a reduction in the number of accidents both with victims and with material damage [3,10,14]. However, in the course of the research it was found an increase in accidents of varying consequence. This circumstance can be explained by the following reasons.

Firstly, there is no strict division into the local (residential, low-speed) and city-wide (trunk, high-speed) networks in many cities of Belarus. Many residential streets are used for transit, high-speed traffic - the differentiation of the road network is conditional.

Because of this, the displacement of transit traffic from residential streets and its redistribution to high-speed streets (including continuous traffic) does not occur. It should be noted that the city streets are being reconstructed rather slowly. This does not provide a reduction in the accidents number with an increase in intensity. Secondly, in some city where the streets have heavy traffic and the passenger traffic it has been achieved a sufficient reduction only for cars. In some cases, not only passenger transport did not reduce the traffic speed on humps, but also cars At the same time, studies have found that 6–10% of drivers do not make decisions on reducing their driving speed when driving through humps. Thirdly, in some cases, humps are applied on highways with four or more lanes, where their use is clearly in contradiction with the fundamental tasks of road transport - improving the quality and reducing the cost of transport services, as safety, efficiency, environmental friendliness and sociology, but not only on safety. There were also cases of an increase in the accident rate due to a sharp deterioration in traffic conditions after a comfortable, high-speed traffic to the humps zone. It should be noted that today we are looking for other ways to improve safety, including reducing speed in certain places, within the required limits and at the right time, for example, with the help of flexible traffic light control with mandatory automatic video monitoring. In addition, on such streets with medium and high load, there was an additional specificity associated with the formation and resorption of bloking before humps. This is due to the fact that the saturation flown on humps is significantly less than on a flat surface, respectively, 0.33 and 0.55 v/sec. When driving through the hump of dense packs of cars, the arrival interval of which is close to 2 second, and the departure interval is 3 second blocking is started. And in the presence of an unregulated pedestrian crossing near artificial irregularities, for the same reason queues are formed and grow noticeably faster, and they dissolve much more slowly. It causes traffic delays and additional stops (from a speed of about 20 km / h). There have been cases when a transport-pedestrian overload occurred on humps, causing the formation of long non-dissolving vehicle queues (from 10–15 minutes to several hours). These features exacerbated the process of interaction between traffic and pedestrian flows. Fourthly, the hump forces drivers under the threat of loss of controllability or car breakdowns to forcibly and constantly reduce speed, regardless of the traffic situation. This causes objective disturbance of drivers and passengers, i.e. "Social" costs. In addition, the vigilance of drivers is dulled. Fifthly, there are difficulties associated with the lack of an unequivocal priority of pedestrians when crossing the roadway through an unregulated pedestrian crossing. The transition of the roadway at a pedestrian crossing in the unregulated mode consists of three parts (stages) - the exit to the roadway, the intersection itself and the end of the crossing. The current Rules of the Road give pedestrians an advantage in two phases out of three, namely, in the actual transition and at the end of the transition. At the same time, a pedestrian can begin the transition of the roadway only when he is convinced of the safety of the exit, i.e. if he does not force the driver of the approaching vehicle to slow down or stop. Many pedestrians simply ignore this. And in conclusion, it should be noted that it was established that the use of humps in historical trends in the reduction of accident rates was not secured.

The video monitoring contributes to reducing the number of potential violators and has proven itself in many countries. When using the video control system, police control and the application of legal measures are intended to be used only in cases of intentional violations of limitations. The effective way to reduce the speed in emergency sections of the road network is to inform the road users about the reasons for the limitations and the effect obtained from the measures taken. The explanation of the introduction of countermeasures helps to reduce the amount of intentional violations.

Speed humps is "the last tool of a set of tools designed to improve traffic safety." At low loads, it reduces the accident rate with victims by about half, increases the accident rate without victims, by about 10% and reduces the overall accident rate by about 15%. Accident on Speed humps remains, since it eliminates only one of a multitude of reasons - it reduces movement speed. In this regard, it is less effective than traffic light regulation, in which accidents with injured people are reduced by a half order. Research has shown that the Speed humps causes economic and environmental losses - from $ 6,000 / year in yard areas, to $ 650,000 / year on main streets, and reducing the accident rate by $ 1 of its estimated socio-economic value leads to an increase in losses 20-120 dollars in the economic and environmental aspects. In addition, it causes significant social losses due to its rejection by both drivers and passengers.

Based on the above, it is recommended: 1. To allow the installation of Speed humps: in residential areas and yard territories equal to them, where the speed of movement is legally limited to 20 km / h or less; as an exception, for example, when descending in front of a school - on two-lane local streets with traffic intensity not more than 120 auto / h in total in both directions.

2. To prohibit the installation of Speed humps: on the streets with three or more lanes; on two-lane streets with the movement of trucks and route passenger transport or with traffic intensity over 120 cars / h in both directions. When justifying the improvement of traffic safety, it is necessary to foresee at the same time as a decrease in the accident rate and an increase in the aggregate quality of road traffic, assessed by the magnitude of the total accident, environmental and economic losses in road traffic [12-14].

Conclusion. The traffic calming use provides of reduces the accidents level. In some cases, an increase in accidents was established due to various organizational and managerial causes in the Belarus conditions. There is also a need to assess the effectiveness of speed control measures, taking into account the traffic specifics in order to improve the overall traffic quality (safety, efficiency, ecological compatibility and sociology). It is necessary to exclude the use of humps on highways using alternative solutions. Also it is necessary to develop proposals for improving the Rules in terms of transferring priority from a pedestrian to the driver and vice versa.

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Капський Д.В., Коржова А. Методи стримування швидкості в Республіці Білорусь.

Стаття присвячена методам усвідомлення швидкості руху, які є одними з основних підходів до забезпечення безпеки на міських вулицях і засновані на концепціях безпеки. Це є підставою мінімізації прохідних транзитних потоків по вулицях районного значення, забезпечення безпеки пішоходів і велосипедистів, а також вплив на поведінку водіїв у міських умовах. Вулиці міста повинні бути спроектовані з урахуванням швидкостей, а також у відповідності з категорією та призначенням. Необхідно враховувати функціональність вулиці, рівномірність руху транспорту, призначення обмежених можливостей, що використовуються для організації руху. Основними критеріями з використанням такого підходу, як сповільнений трафік, можуть бути: рівень аварійності, швидкість, умови руху.

Ключові слова: *система відкриття дверей, залізничний транспорт, аналіз міцності, комп'ютерне моделювання.*

Капский Д., Коржова А. Методы сдерживания скорости в Республике Беларусь.

Эта статья посвящена методам успокоения скорости движения, которые являются одним из основных подходов к обеспечению безопасности на городских улицах и основаны на концепции сдерживания скорости. Целью этого подхода является минимизация проходящих транзитных потоков по улицам районного значения, обеспечение безопасности пешеходов и велосипедистов, а также влияния на поведение водителей в городских условиях. Улицы города должны быть спроектированы с учетом ограничения скорости, а также в соответствии с категорией и назначением. Необходимо учитывать функциональность улицы, равномерность движения транспорта, целесообразность наложенных ограничений, предсказуемость технических средств, используемых для организации движения. Основными критериями использования такого подхода, как успокаивающий трафик, могут быть: уровень аварийности, скорость, условия движения.

Ключевые слова: *управление скоростью, организация движения, система мер контроля скорости.*

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