

Obstacle in road traffic and its impact on the safety, flow and economy of road traffic on land roads

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Abstract. In road traffic, an obstacle on the road, means anything that could threaten the safety, the flow or economy of road traffic, such as a parked vehicle in a no-parking place or an unlit vehicle. The obstruction on the road must be removed without delay. The person who caused the obstacle must ensure this obligation without delay. If he does not do so, the road administrator must immediately remove the obstacle at his expense. The paper deals with the significance of the road traffic obstacle and its impact on the safety, flow and economy of road traffic on roads (motorways and expressways). First of all, an obstacle in road traffic is defined and the basic concepts related to it, the perception of the character of the obstacle from three points of view (aspects forming an obstacle, the causes of the obstacle, the consequences of the obstacle), as well as the basic distribution of obstacles in road traffic. Subsequently, the issue of removing road traffic obstacles is described. In the economic field, attention is paid to the problem of quantifying the adverse effects on the gross domestic product when a highway or expressway is closed due to an obstacle in road traffic. At the end, proposals are presented for initiating changes in the valid legal framework in the territory of the Slovak Republic.

Keywords: Road traffic. Highways. Expressways. Obstacle in road traffic. Legal framework of the Slovak Republic. Gross domestic product.

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I. Introduction

Road traffic can be characterized as the use of highways, individual types of roads, local and purpose-built roads by road traffic participants, especially vehicle drivers and pedestrians [1]. The transport process, it is made up of a number of sub-phenomena connected to each other, which in addition to positive aspects also bring various negative phenomena, including traffic accidents. Traffic accidents, in addition to primary material damage to property or consequences for the health and lives of road users, also cause secondary consequences in the form of obstacles in road traffic (especially crashed vehicles), which prevent the flow of road traffic until they are removed.

In road traffic, each event and the related obstacle to road communication is specific in its own way, and therefore it is necessary to focus mainly on its location, the number of vehicles involved, the number of injured, as well as information on the transported cargo (character, type, quantity), information about the pollution of the road and its components and, after a thorough evaluation of the event in question, apply specific procedures when removing the obstacle.

Legal framework of the Slovak Republic

Pursuant to Act No. 135/1961 Coll. on land roads (hereinafter referred to as the Road Act), as amended, land roads are mainly intended for the road vehicles traffic. They are divided according to the traffic significance and the purpose of the technical equipment into roads (motorways, expressways, I., II., III. class roads), into local and purpose-built roads (processed in more detail in Table 1).

Ground communication consists of the road body and its components, bounded by the outer edges of ditches, gutters, embankments and slope cuts, facing walls and the foot of retaining walls. It also includes all facilities, buildings, objects and works that are necessary to ensure safe, smooth and economical traffic on them. [2]

Table 1. Length of roads in km over the years 2011-2021 [10]

Years	Length of road communications [km]					Together
	Freeway	Express ways	Class I roads	Class II roads	Class III roads	
2011	430	242	3317	3639	10411	18040
2012	432	248	3312	3637	10415	18044
2013	423	260	3291	3617	10379	17970
2014	421	265	3293	3616	10369	17963
2015	464	277	3302	3616	10360	18019
2016	464	287	3306	3611	10363	18031
2017	483	295	3311	3610	10357	18057
2018	483	295	3312	3610	10358	18059
2019	496	271	3333	3631	10340	18072
2020	521	297	3337	3632	10343	18130
2021	545	304	3339	3624	10341	18152

Motorways, expressways and Class I roads, the public contracting authority of which is the Slovak Republic, are owned by the state on the basis of a concession contract. Their management according to the approved development plan is carried out by the National Highway Company (hereinafter referred to as NDS).



Fig. 1. The network of highways and expressways in the Slovak Republic [10]

A highway is a road communication intended for traffic connection between important centers of national and international importance. It is a multi-lane divided road with limited access and connections, and its intersections with other roads are off-level. It is reserved for motor vehicle traffic with a specified permitted speed according to the Road Traffic Act. From the point of view of construction engineering, the basic highway network is supplemented by a network of expressways, which differ from the highway in terms of construction and design elements. [2]

Act No. 8/2009 Coll. on road traffic as amended (hereinafter referred to as the Road Traffic Act) defines road traffic obstruction as anything that can endanger or limit the driving of vehicles and the movement of road users. The entity that caused an obstacle to road traffic is obliged to remove it immediately. In the event that this entity does not remove the obstacle, it must be removed immediately by the administrator of the relevant road at the expense of the vehicle operator. In addition to obstructing road traffic, the removal of objects and waste obstructing the pass ability of the relevant road must also be ensured. [1]

The obstacle on the road must be marked so that other road users can notice it in time. It is indicated mainly by a barrier to mark the shutter, an orange warning light, and in reduced visibility by a red light or a reflective red flag. The driver of a vehicle with a compulsorily equipped portable warning triangle must place this triangle on the edge of the highway or expressway at a distance of at least 100 m behind the vehicle. [1]

Distribution of obstacles in road traffic

The character of the obstacle can be perceived according to the aspects forming the obstacle, according to the causes of the obstacle and according to the consequences of the obstacle. At first glance, it is possible to divide the aspects into movable things (such as different categories of means of transport, transported loads and dangerous goods, damaged vehicles due to a traffic accident or damage event) and living animals (such as an object of transport, wild animals injured or dead due to a collision with a transport vehicle). As for the causes of

road traffic obstructions, the most common are various breakdowns of means of transport, vehicles standing in the parking lane, traffic accidents or damage incidents. From the point of view of the consequences of the obstacle, it can be the death or injury of road users, damage to road traffic or generally useful equipment, the extent of material damage to means of transport or transported items, leakage of dangerous goods. [4,7,9]

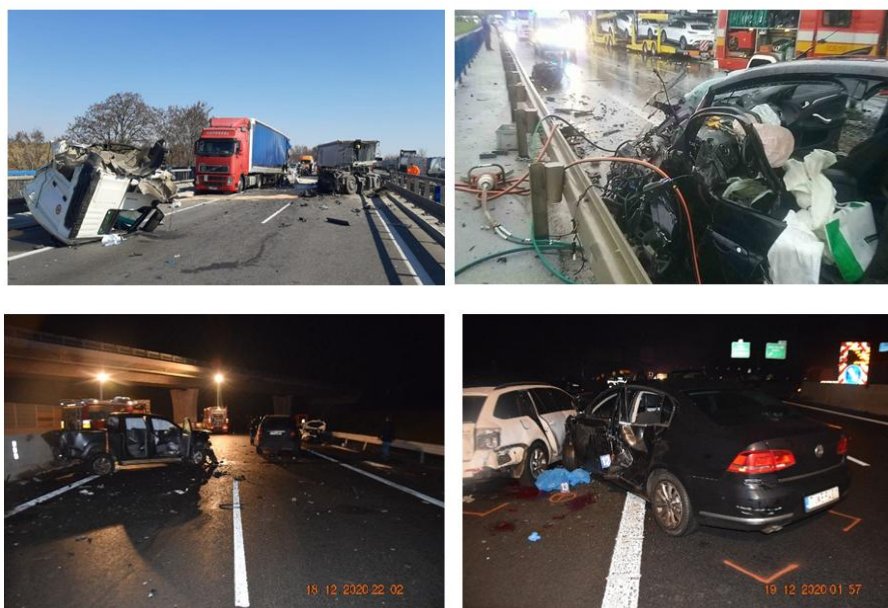


Fig. 2. Examples of obstacles in road traffic after traffic accidents [5]

Proposed distribution of accidents and created obstacles on the highway network created for the needs of operational procurement of towing service:

Obstacle type A - load capacity 2 t (motorcycles, passenger motor vehicles + trailers)

After the accident, the vehicles are immovable, damaged, or only the axles and wheels are damaged. The towing of these vehicles is possible using a simple technique (towing truck, towing vehicle with a folding platform, towing vehicle with extendable skids). Injuries of the participants do not occur, or they are minimal and do not require the intervention of the fire and rescue services. It can also be an obstacle due to the sudden immobility of the vehicle due to a technical fault, where the vehicle may require a battery recharge, refueling, repair of a defect, etc.

Obstacle type B - load capacity 3.5 t (motorcycles, personal motor vehicles + trailers)

After an accident, the vehicles are immovable, damaged, or only the axles and wheels are damaged. The towing of these vehicles is possible, by using a simple technique (towing truck, towing vehicle with a folding platform, towing vehicle with extendable skids). Injuries to participants are frequent and require the intervention of the fire and rescue services. In this case, it is also possible to pollute the road and the surrounding area with operating fluids and vehicle debris. There can also be an obstacle due to a dropped load, for example, from a trailer.

Obstacle type C - (vans, light trucks, their trailers and semi-trailers)

The vehicles are immobilized after the accident and the deployment of heavy equipment is required (such as rescue special, special tractor and undercarriage, rescue crane). It can also be an obstacle due to the sudden immobility of the vehicle due to a technical fault. Injuries to participants are frequent and require the intervention of the fire and rescue services. In this case, it is also possible to pollute ground communication and the surroundings with operating fluids and vehicle debris.

Obstacle type D - (trucks, buses, their trailers and semi-trailers)

The vehicles are immobilized after the accident and the deployment of heavy equipment is required (such as a special recovery vehicle, a special tractor and undercarriage, a recovery crane). It can also be an obstacle due to sudden immobility of the vehicle due to the technical lane. Injuries to participants are frequent and require the intervention of the fire and rescue services. In this case, it is also possible to pollute ground communication and the surroundings with operating fluids and vehicle debris. When reporting, it is necessary to specify the damaged cargo and its nature (number of injured, victims, spilled liquids, bulk material, dangerous cargo, ADR, live animals, frozen food), etc. At the same time, when reporting, it is necessary to state whether the accident occurred in a tunnel.

Type E obstacle (electric cars, plug-in hybrids)

Due to the serious issue of the special removal and storage of these vehicles, it is essential that detailed information about the vehicle in question be reported. When deciding on towing, the towing service must meet special

conditions for the removal of electric cars and plug-in hybrids (technical equipment, procedures, protective equipment, cooperation with members of the Fire and Rescue Service).

Obstacle type F (unspecified, e.g. forest animals, companion animals, dropped cargo, trees, landslides, loose traffic signs)

When reporting, it is necessary to specify the nature, type, size and quantity to be removed. In some cases, the cooperation of other services is also necessary, such as the local hunting association, the veterinary administration, as the relevant towing service is not authorized to remove such an obstacle. [4,7,8]

With the proposed breakdown of accidents, the operator will be able to provide the appropriate towing service with relatively accurate information about the equipment and human resources needed to remove the obstacle, to reload the material, etc. The operator should have information about towing the obstacle to the nearest parking area or about the possibility of storing the vehicle in guarded parking areas. The need to remove obstacles or accidents can be reported to the relevant towing service through the central operator workplace of the NDS, an authorized person from the Center for Administration and Maintenance of Highways or Expressways, as well as through the Slovak Police Force, i.e. PZ SR → NDS and NDS → towing service.

The problem of removing obstacles in road traffic

NDS, as the administrator of highways and expressways, is obliged to immediately remove the obstacle in road traffic, of course at the expense of the vehicle operator (if the vehicle operator has not removed it). The amendment to the Road Act allows NDS to remove obstacles with external towing services. [1] Currently, there are approximately 14 towing services designated for the removal of obstacles in the territory of the Slovak Republic, which meet the specialized, formal, technical, material, personnel and legal prerequisites for the proper performance of the activity in question. These towing services can tow vehicles professionally, provide care for the crew, or clean up accident sites, as well as perform other tasks. Due to the fact that the current legal framework does not solve (or solves marginally and non-comprehensively) the issue of towing vehicles, several problems arise in this area.

Liquidation of the consequences of traffic accidents of passenger motor vehicles that have created an obstacle to road traffic (including vehicles off the road) is almost problem-free due to the weight of the vehicles and the wide availability of extrication and towing services. In most cases (if they are not serious traffic accidents), road traffic is partially or completely restored in a relatively short time and the delay is minimal. Of course, the waiting time depends on the traffic density and the type of road. The situation is much worse, for example, in the liquidation of the consequences of traffic accidents involving heavy-duty motor vehicles and their parts intended for the transport of goods, where the removal of the obstacle requires the deployment of heavy equipment and the cooperation of other components, as well as the closure of road traffic, often for several hours. The most complicated situation is with crashed vehicles designed to transport goods with a weight from 3.5t to 12t and with a weight greater than 12t often found even off the road. Rescue work associated with the complete closure of the road can begin at an acceptable time, but with improperly used equipment and unqualified personnel, it will not end even after long hours. In addition, the time required for the reloading of the transported goods must also be taken into account. Damages caused by drivers waiting in endless queues and their costs for detours are sometimes much higher than the sums for towing, for example, a crashed truck. [4,5,7, 8]

Attention should also be paid to road vehicles with a fully electric or hybrid drive. Problems arise not only during rescue operations (such as freeing the injured and victims, firefighting, handling the vehicle in the event of an overturn), but also during the actual removal of the obstacle. The towing service must have not only the necessary equipment, but also protective clothing, trained workers, or special parking areas. Electric cars often catch fire several hours after the crash, and it is not safe to park them next to other vehicles. [3]

It is obvious that the beginning of the removal of the obstacle (response) in the case of traffic accidents can only begin after the approval of the authorized member of the SR Police Department. On the other hand, it is possible and necessary (currently even common) that the towing service is contacted in order to speed up the process of removing the obstacle. In most cases, the towing allows service waits at the scene of the accident until PZ SR vehicles to be towed. Often, towed vehicles are detained for expert examination, where traffic accident analysts are present at the scene of the accident. When interventions in tunnels, it is necessary to take into account the distances from the nearest towing service, as well as the more complicated handling of equipment during intervention and removal of vehicles compared to intervention on a free highway due to the limited space. [7,9]

The use of highways and expressways as roads of the highest transport importance has an impact on the output of the state's economy (it affects the public interest), and this impact can also be derived from the perspective of the macroeconomic indicator, which is the gross domestic product (hereinafter referred to as GDP). GDP is determined by the production (manufacturing) method and includes factors not only from the point of view of added value created in the economy, but also from the point of view of revenues to the state budget. The

production process needs to be ensured directly with the needs of the market in real time. [6] In the case of an obstacle on the road, this has to do with removing it as quickly as possible, so that there are no unnecessary downtimes for business entities.

For the calculations of the consequences related to the violation of the legal obligation consisting in the removal of an obstacle on the highway or expressway, GDP by industry in current prices for the year 2019 was determined as the basic input data (the said year was not affected by an unfavorable epidemiological situation).

Table 2. Selected sectors from GDP in current prices (million €) for 2019 [11]

Classification of economic activities	Year 2019				Overall
	1.Q.	2.Q.	3.Q.	4.Q.	
Agriculture, forestry and fishing	401,2	510,6	861,2	396,7	2169,7
Industry + production	10189,4	8352,7	8992,9	11343,2	38878,2
Construction industry	820,9	1437,1	2307,3	2134,2	6699,5
Wholesale + retail, vehicle repair, transport and storage, accommodation and catering services	3765,3	4488,6	4449,2	3317	16020,1
Overall	15176,8	14789,0	16610,6	17191,1	63767,5

Items that are directly related to the provision of transport of production factors for the agriculture, industry, construction, wholesale and retail trade, motor vehicle and motorcycle repair, transport and storage, accommodation and catering sectors were selected from the individual GDP sectors listed in current prices. of services via highways and expressways in the Slovak Republic. This proportional part of the GDP for 2019 was calculated and represents a value of 63,767,500.00 € = 63,767.5 €. The stated proportional part of GDP was then divided by the number of days in a year (365 days) and the number of hours per day (24 hours), which gave us the value of hourly GDP. Its resulting value for the purpose of calculating the consequence of violating the obligation to remove an obstacle on the highway is:

Hourly GDP = $63,767,500.00 / 365 / 24 = 7,279,394.5$ €/hour. Subsequently, the hourly GDP per 1 km of road was determined. This calculation was based on the total length of roads listed in km. In 2019, the total length of roads was 18,072 km. Hourly GDP = $7,279,394.5 / 18,072 = 303.92$ €/hour/km.

In addition to the determined value of the hourly GDP, it is also possible to calculate the hourly GDP for individual centers and sections with regard to the length of a specific section. For example, on the D1 stretch in the Senec - Horná Streda section of 64 km, the hourly GDP would represent a value of 19,450.88 €/hour/km. This value was calculated by multiplying the value of the hourly GDP with the length of the section in km. The value can be reduced by pointing out that the raw materials that enter the production process (or finished products) are also transported by rail, as well as by pointing out the intensity and traffic importance of a specific road section.

In order to ensure the obligation to remove obstacles in road traffic without delay, it is necessary to build a system that will ensure the removal of obstacles created on highways and expressways quickly, qualitatively, safely, at a fair price and in accordance with legal regulations. At the same time, it is necessary to ensure the possibility of longer-term parking of vehicles whose drivers (or owners) cannot ensure towing to the designated place. This also applies to transported goods that have been removed from road traffic.

Proposals for changes in the current legal framework

The Road Act and the Road Traffic Act represent legal regulations of public law, where a state administration body is authorized to impose a sanction in the manner and to the extent of offenses for violation of a legal obligation. Rather, the claim for damages relates to the level of private law, which creates a problem in relation to the sanction, the contractual penalty, which serves to secure the obligation, as well as the claim for damages.

A possible claim for the application of such costs would have to be regulated by a private-legal relationship between the road administrator and the executor of the removal of the obstacle in the form of another legal act consisting in the assignment of a claim consisting of the costs of removing the obstacle on the road. In this area, it would be appropriate to consider changing the current legislation, where the legal framework valid in Slovenia could serve as a model for how to solve the problem of removing obstacles in relation to the authority and obligations of the road manager (contractual relations and sanctions). There, the national regulation di-

rectly imposes the obligation to choose a contractor to remove obstacles through a public tender. A body in the position of public administration is authorized to enter into contractual relations and transfer the exercise of public authority to third parties.

Furthermore, it is necessary to break down the costs related to the removal of the obstacle depending on the possibility of implementation while observing the response time. If the assistance service would not be able to remove the obstacle in the specified time according to the accident category (for example, in the case of an accident of type A, B, the beginning of the removal of the obstacle within a maximum of 60 minutes and in the case of an accident of type C, D within a maximum of 90 minutes), then the obstacle was removed by a service provider chosen by the road administrator at the expense of the entity that caused the obstacle, in order to preserve the protection of the public interest.

In terms of efficiency, objectivity, speeding up, determination of responsibility and addressability of the service in removing obstacles, it would be most appropriate if this process were managed through the central NDS operator workplace. The central management in question has several advantages, such as a guaranteed permanent service, efficiency in planning, organizing, managing and controlling activities, direct transfer of responsibility for the activity, the assumption of effective communication with members of the Police Force, rescue units and towing services, etc.

In the case of defining the response time for individual categories of traffic accidents, the currently legally unclear term "immediately" would also be legally removed. The mentioned term can be defined "as soon as possible, taking into account the given situation and its development (in the shortest possible time) for the purpose of ensuring safe, smooth and economical traffic."

II. Conclusion

In addition to the basic theoretical principles in the field of road traffic obstacles and their impact on the safety, smoothness and economy of road traffic on roads, the paper also described the most common problems in connection with the removal of obstacles on highways and expressways. The legal area is complex, where it is necessary to resolve the legal issues of the collision of public and private law and the absence of other implementing regulations (inconsistency between public and private law in the process of removing the obstacle and reimbursement of costs). It is necessary to realize that an obstacle on a highway or an expressway, taking into account their transport importance and the nature of priority infrastructure, affects the public interest, while the damage caused in the causal connection with the obstacle has an impact on the output of the economy, which is interpreted in gross home product. In the economic part, the adverse effects on GDP due to the closure of the highway or expressway.

The National Highway Company, as the administrator of highways and expressways, is obliged, in accordance with the Road Traffic Act, to immediately remove an obstacle to road traffic if the entity caused an obstacle to road traffic and did not remove it immediately. Due to the fact that this company does not have sufficient technical and material equipment for the immediate removal of obstacles, one of the possible proposals is to conclude contracts with selected companies (towing services). Contracts would be concluded for the purpose of removing means of transport and other objects forming an obstacle in road traffic.

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