

TRAFFIC SAFETY DEPENDENCE ON ROAD QUALITY

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1. Introduction

Good condition of country's roads is considered to be one of the factors determining favourable conditions for the development of country's economy, improvement of economic welfare of its citizens. There is no doubt that a reasonably developed road network, its proper maintenance as well as safe traffic is a mirror of economic and cultural development of every country.

The number of motor vehicles is increasing very rapidly in Lithuania. At present Lithuania has about 1 million cars, roughly 250 cars per 1000 inhabitants.

According to the official statistics almost 700 people are killed and more than 5000 are injured every year in traffic accidents in Lithuania.

Young people drive powerful second-hand cars bought from West European countries; this rises two major problems: lack of experience of young drivers and bad technical quality of cars. Among diverse reasons of a high rate of road traffic accidents one is road quality. It is estimated that about 22.3% of the total amount of accidents are related to the quality of roads.

2. Lithuanian road network

The network of roads in Lithuania (table 1; fig 1, 2) consists of about 55 thousand km; however, the main roads which are state roads make up almost 21 thousand kilometers. Out of them about 16 thousand km are regional roads; about 3.4 thousand km are national roads and 1455 km are main roads. All these roads have solid pavement and half of them (50.15%) are paved with asphalt concrete.

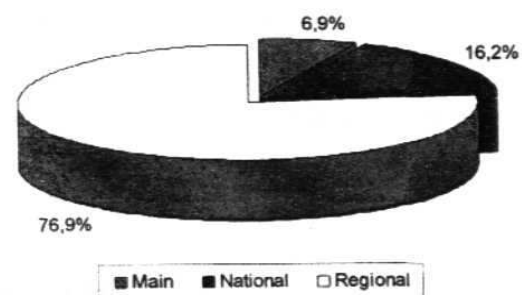
The density of state roads in Lithuania is 324.5 km per 1000 sq. km of the territory; 162.8 km out of this amount have asphalt concrete pavement; 5.69

km roads per 1000 inhabitants, 2.87 km of them have asphalt concrete pavement.

Table 1. State road network according to the type of pavement, km

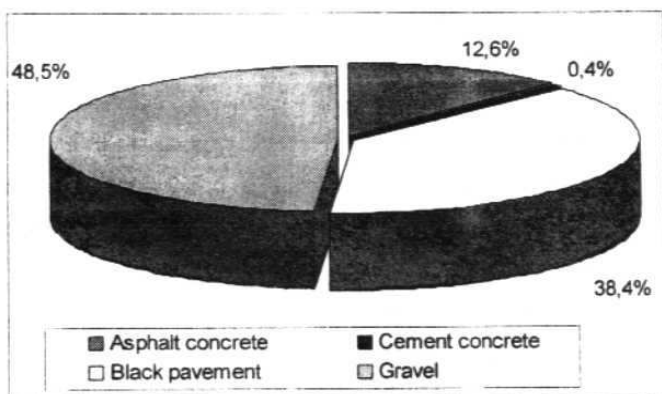
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Pavement	Main roads	National roads	Regional roads	Total, km
Cement concrete	12	72	6	90
Asphalt concrete	1028	978	657	2663
Black pavement	415	2280	5400	8095
Gravel	0	86	10187	10273
Total, km	1455	3416	16250	21121
Bridges and viaducts on state roads				01 01 1998
		Number	Metres	
Total number		1526	48006	
Of which Metal		71	4411	
Reinforced concrete		1449	43361	
Timber		6	294	



1998 01 01	State roads
Main	1455
National	3416
Regional	16250
Total	21121

Fig 1. Structure of road network



1998 01 01 Pavements	
Asphalt concrete	2663
Cement concrete	90
Black pavement	8095
Gravel	10273

Fig 2. Types of pavement

At present 12.6% of road network are roads with concrete and asphalt concrete pavement; 38.4% are roads with black pavement. Gravel roads are prevailing in the country, - they amount to 48.6%.

The existing condition of gravel roads cannot ensure efficient and safe road traffic. The loss of traffic on gravel road increases due to the lower speed which is 20% lower as compared with the driving speed on roads with asphalt concrete pavement and 15% lower in comparison with roads with asphalt pavement.

In view of the current economic situation in Lithuania the improvement of the condition of roads and maintenance of the existing network of roads and motorways is at a focus of the Lithuanian Road Administration.

Figures 3, 4, 5, 6 illustrate road sector funding situation and show the number of km of different

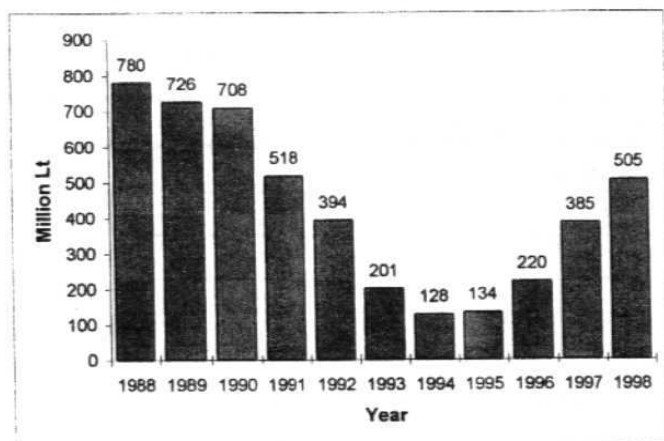


Fig 3. Fluctuations of funding of Lithuanian road sector during 1988-1998 (million Lt.)

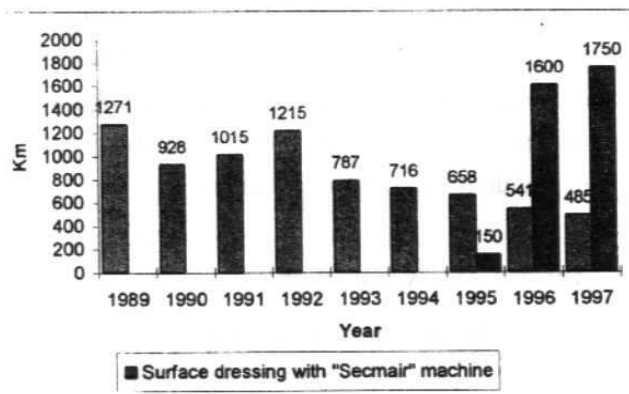


Fig 4. Fluctuations of the volume of black pavement surface dressing activities during 1989-1997

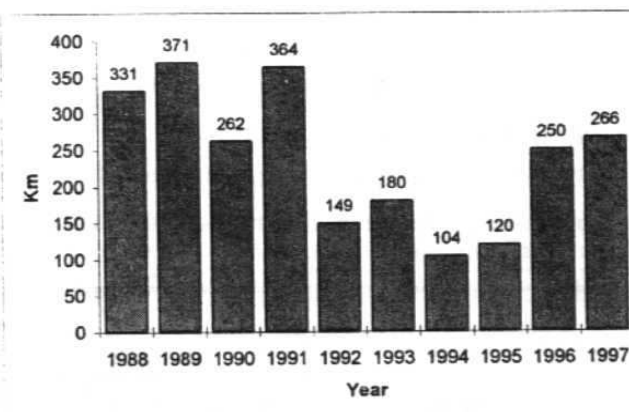


Fig 5. Fluctuations in the activities of construction and rehabilitation of black pavement surface dressing in the period of 1988-1997

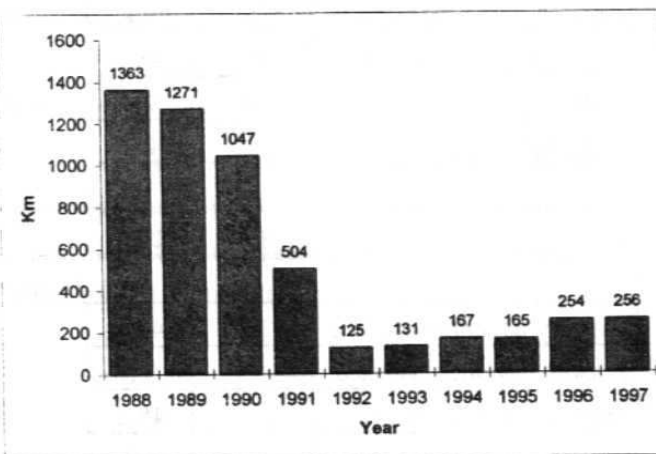


Fig 6. Fluctuations in gravel pavement rehabilitation activities in the period of 1988-1997

types of pavements constructed and repaired during the last ten years in Lithuania [1].

The figures above indicate that the volume of surface dressing activities in 1994 dropped by 44 % as compared with the volume of activities carried out in 1989. The volume of asphalt pavement construction and repairs decreased by 72%; and the volume of gravel pavement repairs decreased most considerably (87% compared with 1989). It was mostly caused by a significant decrease in the fund-

ing of construction, maintenance and reconstruction of road and street pavements. As a result a significant determination of the condition of road and street pavements as well as an increase in the number of road accidents has been observed.

3. Traffic safety problems

According to statistics roughly 70% of the total number of registered accidents occur due to the carelessness of drivers and pedestrians cause about 20%.

Traffic accidents related to drivers' fault are mainly caused by the following reasons:

- 1) Speeding - 31%;
- 2) negligence of driving priority rules - 19%;
- 3) drunk driving - 19%;
- 4) lack of experience - 17%;
- 5) left-side driving - 13%;
- 6) distance between the cars - 5%;

- 7) negligence of road sign requirements - 4%;
- 8) negligence of overtaking rules - 4%;
- 9) use of vehicles with technical defects - 3%;
- 10) overstrain, drowsiness of drivers - 1%.

Roughly 22.3% of accidents are related to bad condition of roads and structures. The main reasons of this accident category are as follows:

- slippery road pavement surface;
- uneven pavement surface;
- soft road shoulders;
- inadequate width of bridges in relation to the carriageway width;
- unsatisfactory condition of railway crossings;
- trees and lighting poles in the road zone;
- lack of sidewalks and pedestrian paths;
- lack of fencing of hazardous areas;
- insufficient lighting of road carriageway;
- unmarked road job sites and lack of fencing around them;

Causes	Total number of accidents in Lithuania								
	1995			1996			1997		
	Number of accidents	% of total number	Total number of accidents	Number of accidents	% of total number	Total number of accidents	Number of accidents	% of total number	Total number of accidents
Slippery pavement surface	378	44.3	4144	590	55.4	4576	491	40.3	5319
Uneven pavement surface	24	2.8		34	3.2		52	4.3	
Trees, supporting poles	414	48.5		394	36.9		472	38.7	
Lighting	23	2.8		32	3		145	11.9	
Road signs	1	0.1		3	0.3		5	0.5	
Other	13	1.5		13	1.2		52	4.3	
Total	853	20.6		1066	23.3		1217	22.9	
Accidents on the roads									
Slippery pavement surface	268	45.7	1724	275	45.8	1765	302	39.4	2257
Uneven pavement surface	21	3.5		31	5.2		45	6.0	
Trees, supporting poles	283	48.2		273	45.5		335	45.5	
Lighting	8	1.4		8	1.3		17	2.3	
Road signs	0	0		3	0.5		3	0.5	
Other	7	1.2		10	1.7		33	4.5	
Total	587	34		600	34		735	32.6	
Accidents on the streets									
Slippery pavement surface	110	41.4	2420	315	67.6	2811	189	39.4	3062
Uneven pavement surface	3	1.1		3	0.6		7	1.4	
Trees, supporting poles	131	49.2		121	25.9		137	28.5	
Lighting	15	5.6		24	5.2		128	26.7	
Road signs	1	0.4		0	0		8	0.3	
Other	6	2.3		3	0.6		18	3.7	
Total	266	11		466	16.6		482	15.7	

- absence of road signs or their wrong positioning;
- lack of horizontal marking of pavement or poor visibility ;
- bad technical condition of traffic lights or their insufficient visibility.

Accident frequency on city streets and roads is presented in Table 2. The data show that the frequency of accidents on the country roads is lower than that on city streets. More than 50% of all the accidents occur on city streets whereas five years ago and earlier the number of accidents on roads and city streets was approximately the same. It should be also noted that formerly this statistics excluded a big number of accidents caused by unsatisfactory condition of roads i.e., the statistics was not accurate.

More than one half of traffic accidents is registered when road condition is satisfactory i.e., when the surface of road pavement is dry. This can be observed when we look at the data given in Table 2 and Fig 7.

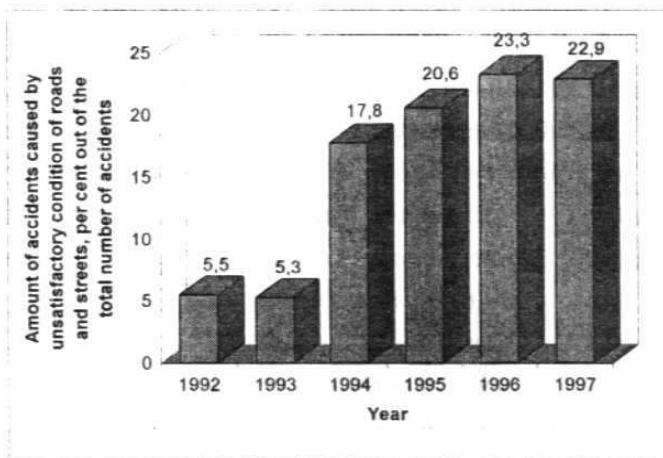


Fig 7. Fluctuations of the number of accidents caused by unsatisfactory condition of roads and city streets during 1992-1997

A great number of accidents is caused by a slippery road pavement surface. The temperature of the weather frequently changes in Lithuania and precipitation is quite common as well. Snow, sleet, freezing rain as well as changes of the temperature from plus to minus cause additional troubles to the road maintenance companies seeking to ensure safe and convenient traffic.

Slippery road pavement surfaces in winter substantially reduce the driving speed of vehicles; consequently work efficiency of vehicles is reduced by

30-40% and the cost price of road haulages thereof is increased by 25-30%. The number of road accidents grows by 40-50%.

One of the main technical factors ensuring safe driving on roads is proper adhesion between the wheel and the road pavement. The minimal allowed adhesion value for safe driving is 0.40. The type of pavement as well as climatic conditions can influence this variable: dry, wet, covered with wet snow, snow-ice layer and icing [2].

Wheels easily turn from rolling to slipping on icing road pavement surface. This is quite often observed on road horizontal curves where transversal force acts and on slopes. Influence of road pavement on the braking distance is indicated in Table 3.

Table 3. Influence of pavement on vehicle braking distance

Car driving speed, km/h	Average braking distance, m	
	Dry pavement surface	Icing pavement surface
20	3.1	10.5
30	7.1	23.6
40	12.6	42.0
50	19.7	65.6
60	28.3	94.4
80	50.4	167.9
100	78.7	262.3

The diagram of adhesion factor distribution on the main roads in the Republic of Lithuania is given in Fig 8. The diagram indicates that adhesion factor value ranges between 0.4-0.5 only on 1000 km of main roads.

Evenness of road pavement surface is to be considered as another important factor in view of traf-

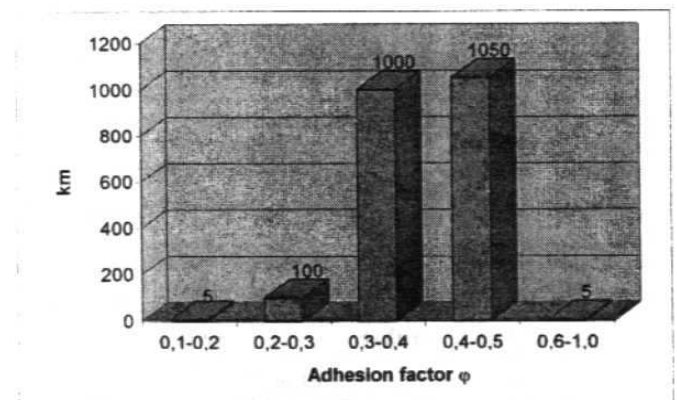


Fig 8. Diagram of adhesion factor distribution on the pavement of main roads

fic safety. Fig 9 contains a diagram of distribution

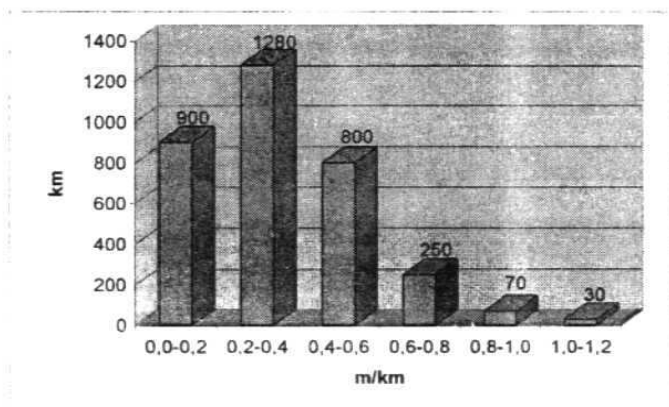


Fig 9. Distribution of pavement surface evenness on main roads

of evenness of pavement surface on main roads.

According to statistics as much as 37-43% of all registered road accidents occur at dark. A great number of accidents occurs in the darkness when the lighting of a road or a street is not turned on though available. Table 4 presents data of the interdependence of the number of accidents and visibility conditions on the road.

Figure 7 illustrates a significant increase in the rate of road accidents which occurred due to bad condition of roads and streets in the period of 1992-1997. An insufficient concern of the state authorities on construction, maintenance and rehabilitation of roads and streets in Lithuania mainly determined it. In the period of 1995-1997 the largest number of accidents occurred due to the slippery pavements (see Table 2). The analysis of road accidents caused by slippery pavements in the period of 1995-1997 has shown that most accidents occurred during winter months which is an indication that roads and streets in Lithuania are not properly maintained

during winter. An advanced 'wet salt' technology was currently introduced for the winter maintenance of Lithuanian roads and streets; more salt spreaders are acquired from Western countries. It is expected to have a positive effect on traffic safety situation in Lithuania.

4. Improvement of roads for traffic safety

During the last few years Lithuanian road builders started using bitumen emulsions for road construction and rehabilitation activities, new technologic equipment was acquired (bitumen emulsion-producing factories, bitumen sprayers, crushed stone sprayers, cold pavement regeneration machine Recycles 2100 DCR, asphalt pavement regeneration machine "Remixer-plus", etc.). It is expected to have a positive effect on the improvement of road pavements and traffic safety situation on Lithuanian roads.

One of the important factors to improve traffic safety is the installation of guardrails and marking of road carriageway.

Guardrails. Volumes of guardrail installation sufficiently increased in the last few years due to better funding of traffic safety program. Fig 10 indicates the volume of activities in this field.

Signal poles serve to improve visibility of the outer boundary of road shoulders in the dark when weather conditions are bad as well as for marking of culverts, intersections, tapered lanes and the points where the width of acceleration lane changes [3].

Fig 11 illustrates the volume of signal pole installation activities during 1994-1997.

Recently marking of the outer boundary of the road was completed on the entire main and national road network in Lithuania. It is recommended to put up reinforced concrete poles on regional roads

Table 4. Accident number dependence on road visibility conditions

Road visibility and lighting	Number of accidents									
	1992	%	1993	%	1994	%	1995	%	1996	%
By day	2316	57.2	2619	60.6	2391	61.3	2558	61.7	2888	63.1
At dark without lighting	929	22.9	921	21.3	787	20.2	799	19.3	862	18.8
At dark with the lighting	641	15.8	566	13.1	534	13.7	612	14.8	667	14.6
At dark without turned on lights	163	4.0	213	4.9	189	4.8	175	4.2	162	3.5
Total	4049	100	4319	100	3901	100	4144	100	4576	100

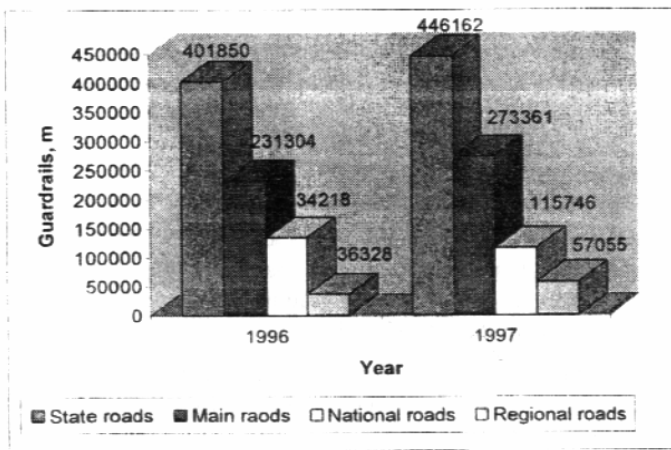


Fig 10. Fluctuations in guardrail installation activities during 1996-1997

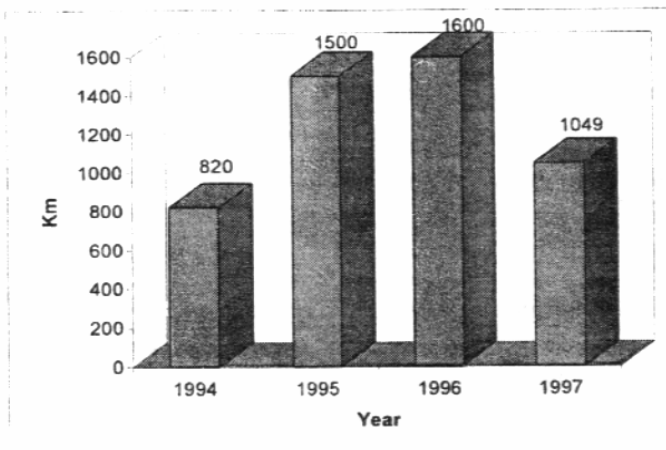


Fig 11. Signal poles installation activities in 1994-1997.

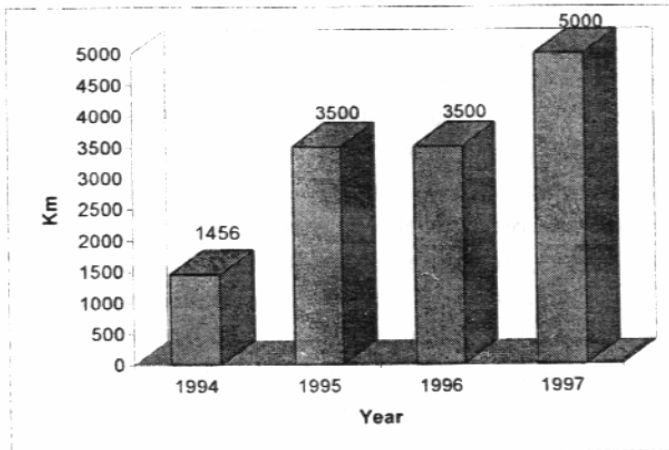


Fig 12. Road marking with light-reflecting paint in 1994-1997.

and elastic poles made of plastic on other roads.

Marking of road carriageway with light reflecting paint is recommended on all roads and streets having asphalt concrete, cement concrete and stone pavements; according to the latest regulations all the roads and city streets where traffic intensity in both directions exceeds 1000 vehicles per day must be adequately marked.

Fig 12 shows fluctuations of the volume of road marking with light-reflecting paint.

Conclusions

1. In recent years road accident data in Lithuania are a great deal more distressing than in other European countries. The main cause of most accidents is violation of traffic rules and poor discipline of drivers. In 1997 the number of road accidents related to the unsatisfactory condition of roads made as much as 22.3% out of the total number of accidents.

2. The biggest number of accidents (related to the condition of the road) occurs due to the slippery pavement surface of a road or city street. Accidents of this kind are mostly encountered during winter period. It is a signal of inadequate winter maintenance of roads and streets in Lithuania. The application of "wet salt" technology was successfully started and the current increase of the number of modern salt spraying machines is expected to have a positive effect on traffic safety situation in the country.

3. A big number of accidents occur due to the uneven pavement of roads and city streets. In the meantime Lithuanian road construction and maintenance companies own a sufficient amount of modern equipment; they mastered advanced road construction, rehabilitation and maintenance techniques. However, the inadequate funding of their activities is a hinder which does not allow utilizing all the possibilities. According to the forecasts evenness of pavements on the main roads in the Republic of Lithuania will deteriorate from 4.7 m/km to 8 m/km. This will undoubtedly lead to the growth of the number of traffic accidents. In order to keep the level of evenness of the road pavement of 1995, three times more funding is required.

4. Accident rate calculations disclosed a big amount of road sections with an extremely high accident rate ("black spots") – 154. A ranking list of the black spots on the roads of the Republic of Lithuania has been made. The increasing number of vehicles and the parallel deterioration of the condition of roads will have a direct influence upon the number and length of these sections in future.

5. In order to upgrade the technical condition of roads and city streets in the Republic of Lithuania

and to reduce the number of road accidents it is necessary:

- To increase funding of road sector 2–3 times compared with 1997;
- To ensure timely and qualified execution of road and street rehabilitation and maintenance activities;
- To ensure proper marking of the road carriageway with light-reflecting paint and road boundaries with signal poles;
- To intensify manufacture and installation of high-quality road signs; it is suggested to use high intensity sheeting for road signs;
- To notify drivers about road pavement rehabilitation activities carried out on roads and city streets;
- To concentrate on modernization of roads and streets adapting them to serve heavy vehicle traffic. Pedestrians should be also given more consideration.

6. In most countries world-wide a great variety of measures for upgrading the condition of roads and improvement of traffic safety are applied (organization of traffic in roundabouts, different level intersections, improvement of visibility conditions, upgrading road shoulders, pedestrian zones, etc.). All specific conditions taken into account the most acceptable measures to upgrade the condition of roads and the improvement of traffic safety in the Republic of Lithuania should be as follows:

- Reconstruction of road sections and intersections with high accident rates;
- Extended surface treatment activities using modern technologies (bitumen emulsions, slurry seal, etc.), assuring a higher value of adhesion between wheels and road pavement surface;
- Increasing the number of bypasses which would serve to reduce the flow of transit traffic in the cities;
- Installation of safety guardrails on roads and sound insulating walls on the roads crossing towns and settlements and blinding-protection screens on safety fencing along the central reserve;
- Improvement of winter maintenance of roads and city streets, application of new technologies, materials, mastering and introduction of winter maintenance information system.

7. Improvement of road traffic safety is a long process that should be coordinated by the highest management institutions of the Republic of Lithuania

in the light of the State traffic safety program for 1996-2000.

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EISMO SAUGUMO PRIKLAUSOMYBĖ NUO KELIO KOKYBĖS

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S a n t r a u k a

Gerai automobilių keliai yra krašto ekonomikos ir kultūros lygio rodiklis. Lietuvos automobilių kelių tinklas yra pakankamai išplėtotas. Svarbiausias kelininkų uždavinys yra tinkamai prižiūrėti, remontuoti kelius ir automagistrales, kad būtų užtikrintas saugus eismas. Sparčiai didėja automobilių skaičius (šiuo metu yra iki 250 automobilių 1000 gyventojų), avarijų ir žuvusiųjų keliuose skaičius nemažėja. Statistiniai duomenys rodo, kad 70% visų avarijų kaltininkai yra vairuotojai, apie 20% – pės tieji. Avarijų, įvykusių dėl vairuotojų kaltės, pagrindinės priežastys yra greičio viršijimas (31%), eiliškumo taisyklių nesilaikymas (19%), vairavimas išgėrus alkoholio (19%), važiavimo patirties stoka (17%). Dalis avarijų įvyksta dėl prastos kelio ir statinių kokybės; tai slidi kelio danga, nelygi danga, minkštas kelkraštis, medžiai ir apšvietimo stulpai, stovintys arti važiuojamosios dalies, kai nėra pėsčiųjų takų ir kt. Straipsnyje pateikti išsamūs duomenys apie įvairių faktorių įtakos eismo saugumui dydį per paskutiniuosius 5 metus Lietuvoje. Išanalizavus esamą kelių tinklą ir jo būklę bei eismo saugumo padėtį, siūlomos eismo saugumo gerinimo priemonės: saugos barjerai, signaliniai stulpeliai, kelio dangos ženklavimas šviesą atspindinčiais dažais, nustatytos avaringosios kelių vietos – „juodosios dėmės“. Šioms ir kitoms eismo saugumą gerinančioms priemonėms įgyvendinti reikia papildomų lėšų visam Lietuvos kelių tinklui.

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