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ENVIRONMENTAL ASSESSMENT OF THE STATE OF THE ROADSIDE AREA OF HIGHWAY SECTIONS IN KHARKIV REGION WITH REGARD TO SOILS POLLUTION BY OIL PRODUCTS AND NOISE POLLUTION

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Abstract. The article deals with the methods of experimental studies to determine the oil content in the soils of the roadside area and acoustic contamination generated by the operation of highways.

Keywords: highway, surface runoff, oil products, gravimetric method, acoustic pollution, traffic noise, acoustics, roadside area.

Introduction

The highway is a source of pollution of the roadside area by petroleum products that are transported by surface runoff, as well as by the source of noise pollution. Further ignoring of the existing situation with regard to water bodies contamination by highway surface runoff can only lead to a deterioration of the overall environmental situation. Traffic noise as one of the factors of the negative impact of highways on the environment has been paid the biggest attention to in recent years. Lately, the average noise level produced by the automobile transport has increased by 15–20 dB, so the problem of dealing with traffic noise becomes rather pressing.

Analysis of sources

Regulation of surface runoff today has become an important task in such countries as USA, Canada, Germany, the United Kingdom, Australia, etc. Studies conducted in this area have been paid much attention to at many organizations of the CIS countries, namely: Moscow Engineering Design Institute, Moscow Automobile and Highway Institute, "Standartpark" company (Moscow), Kiev Automobile and Highway Institute, Ukrainian State Research Institute «UkrVODGEO» (Kharkiv), Ukrainian Design Research Institute «UkrkomunNIIproekt» (Kharkiv), Ukrainian Research Institute of Ecological Problems «UkrNIIEP» (Kharkiv).

Numerous studies of the scientists of the national school of urban planning and architecture acoustics contributed to the provision of noise abatement. Representatives of this school solved such important issues as forecasting of noise on highways and the roadside area of communities, establishing of urban policy towards the implementation of noise reduction methods through urban planning means, introduction of methods directed to protection from noise. Among the founders of the school of urban acoustics it is essential to note the following scientists: G. Osipov, V. Lukanina, N. Ivanov, I. Karagodin, B. Prutkov, E. Sa moylyuka, I. Shishkin, E. Yudina, P. Pospelov. Introduction of methods of noise protection , as part of environmental sustainability of motor roads have contributed The works of V. Babkova, M. Nemchinova, I. Evgenyeva and many others contributed much to the introduction of methods of noise protection as part of environmental sustainability of highways.

The purpose of the study

Analysis of the results of experimental studies to determine the oil content in the soils of the roadside area and noise pollution of the roadside area of highway sections in Kharkiv region.

Results of experimental studies to determine the oil content in the soils of the roadside area

To determine the feature of oil products distribution in the soil of the roadside area of highways as you move away from the edge of the road, they defined the concentration of oil in the roadside area of highways M18 Kharkiv–Simferopol–Alushta–Yalta km 14 and km 33,

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M03 Kyiv–Kharkiv–Dovzhanskyi km 474, P46 Kharkiv–8 km Akhtyrka within the Kharkiv region.

There was conducted the analysis of traffic density and existing performance indicators (evenness of the pavement, friction coefficient) on the given road sections. The data was provided by the Highway Service in Kharkiv region.

At experimental highway sections they conducted soil sample taking by means of the "envelope" method at a distance of 1, 5, 8 m from the roadway. In these samples there was determined the concentrations of oil-products by gravimetric method. The gravimetric method is one of the few "absolute" methods of analytical chemistry, excluding the need to use standard samples of the same qualitative and quantitative composition, as well as the test sample, thereby this method is adopted as an arbitration one according to the recommended procedure (Методика… 2011).

The method is based on the extraction of organic substances from the soil sample by chloroform, evaporation and removal of the solvent, the residue dissolving in hexane, separation of polar compounds on the aluminum oxide column, removing of the solvent and gravimetric measurement of the balance weight. While conducting the analysis the oil-products extraction was carried out using chloroform and subsequent use of hexane as a solvent and with the use of only hexane to compare the efficiency of oil-products extraction. The content of petroleum products in the analysis sample volume was determined as the difference between the mass of the cup with the residue after removal of the solvent and the mass of the empty cup. The experimental data obtained are presented in Table 1.

The comparative analysis carried out of the obtained data with the classification of indicators of pollution level according to oil-products concentration in soils leads to the following conclusions:

1. The road section R 46 Kharkiv–Akhtyrka – has a valid (up to 1000 mg/kg) and a low level of contamination (1000–2000);

2. The road section M 18 Kharkiv–Simferopol–Alushta–Yalta km 14 and km 33 – have an average (2000–3000 mg/kg) and a high level of contamination (3000–5000 mg/kg);

3. The road section M 03 Kyiv–Kharkiv–Dovzhanskyi – has a very high level of contamination (more than 5000).

Results of experimental studies to determine the noise pollution

The noise performance of the traffic flow is to be measured in accordance with GOST 20444-95 "Transport Flows in Communities" and GOST 20444-85 "Noise. Transport Flows. Methods for measuring the noise characteristics".

Based on the requirements set out in normative documents (ГОСТ 20444-85), for research there were selected highways M 18 Kharkiv–Simferopol–Alushta–Yalta km 14 – km 20 and km 30 – km 35, M 03 Kyiv–Kharkiv – Dovzhanskyi km 468 + 500 – km 474, P 46 Kharkiv–Akhtyrka 8 + km 623 – km 17 + 800. The assessment of the level of noise pollution is necessary to conduct by calculation method as well as by the method of field measurements, taking into account the data on traffic density and the existing performance indicators at experimental road sections, which were provided by the Road Service of Kharkiv region.

The field measurements of sound levels of the traffic flow were performed according to the method presented in regulatory requirements (GOST 20444-85). The measurements were carried out by means of precise pulse «Robotron» environmental noise monitor of German production. The measurements were made at the points at a distance of 7.5 m from the axis of the nearest road lane, which corresponds to the normative distance of noise measurement. For each point there were made 600 measurements of sound levels within 20 min. in accordance with the regulatory requirements. Determination of equivalent sound level was carried out according to the formula:

$$L_{Aэкв} = \Delta L_A + 10, \quad (1)$$

where ΔL_A – the average noise level, dBA.

Table 1. The average concentration of oil-products in soils of the roadside area of experimental highway road sections

Road	Research site	Side of the road	Distance from the road, m	Concentration of oil-products, mg/kg
M 18 Kharkiv–Simferopol–Alushta–Yalta	14 km	A	1	2750
			5	2963
			8	2263
		B	1	3280
			5	2365
	33 km	A	1	4035
			5	2660
			8	1960
		B	1	4815
			5	568
M 03 Kyiv–Kharkiv–Dovzhanskyi	474 km	A	1	6470
		B	1	7350
P 46 Kharkiv–Akhtyrka	8 km	A	1	1095
			8	692
		B	1	813

Table 2. The results of studies of acoustic pollution at experimental highway road sections

Highway	Research road section	ΔL_A, dBA	$L_{Aэкв}$, dBA
M18 Kharkiv–Simferopol–Alushta–Yalta	km 14–20	62	72
	km 30–35	68	78
M 03 Kyiv–Kharkiv–Dovzhanskyi	km (468 + 500) – 474	75	85
P 46 Kharkiv–Akhtyrka	km (8 +623) – (17 + 800)	72	82

The level of noise pollution can be calculated with the help of special techniques: "The method of estimating the projected noise level within the areas of highway impact" and "The method of identification, evaluation and ranking of potential environmentally hazardous road sections." The calculated level of the equivalent sound at highways, according to the requirements, is determined by the formula:

$$L_p = L_{mn} + \Delta L_m + \Delta L_d + \Delta L_c + \Delta L_y + \Delta L_n + \Delta L_{pn} + \\ + \Delta L_k + \Delta L_з + \Delta L_{per}, \quad (2)$$

where L_{mn} – the design level of sound produced by traffic, dBA; ΔL_m – correction due to the amount of vehicles in the traffic stream with carburetor engines Lemma, dBA; ΔL_d – correction due to the number of vehicles in the traffic stream with diesel engines, dBA; ΔL_c – correction which takes into account the deviation of the average speed at a road section compared with the velocity at a horizontal one, dBA; ΔL_y – correction that takes into account the magnitude of the longitudinal slope of the road, dBA; ΔL_n – correction due to the type of coating of the roadway; ΔL_{pn} – correction which takes into account the presence of the median, dBA; ΔL_k – correction that takes into account the surface layer of the road side; $\Delta L_з$ – correction due to construction on highway, dBA; ΔL_{per} – correction that takes into account the type of the road junction, dBA (M 218-02071168-416-2005).

The results of studies of acoustic pollution at experimental road sections are presented in Table 2.

Substituting the values into the calculation formula for the studied sections of roads, we'll obtain the results of equivalent noise 72–85 dB. These values correspond to good qualitative environmental assessment, so the modal assessment of the environmental safety of roads is environmentally rather unsafe. The obtained values exceed the limit values as for health standards.

However, the obtained values refers to a range of 40–85 dB, which corresponds to the modal evaluation of the highway "Environmentally rather unsafe", but with the noise of 68–90 dB there arise discomfort and fatigue. The population living within these areas is constantly under acoustic discomfort (M 218-02071168-416-2005).

Conclusions

On the basis of data on the pollution extent of runoff from the studied road sections in Kharkiv Region by oil-products there arises the necessity to assign the optimal treatment measures and establish the most appropriate treatment facilities that will allow avoiding of unreasonable costs to reduce runoff pollution from the surface of roads.

The test sections of highways in Kharkiv region have a significant noise impact on residents of different communities and the environment in general. For this reason it is necessary to take measures to reduce noise levels, namely planting of three lane tree and shrub belt areas.

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