IMPACT OF ROAD TRANSPORT NOISE POLLUTION ON THE ENVIRONMENT OF URBANISED AREAS

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Introduction. It is known that road transport is a source of significant negative impact on the environment and human health. It is believed that the main damage to the environment from motor transport occurs as a result of exhaust gas emissions. Thus, according to the state report on the state and protection of the environment, road transport is in first place in terms of pollutant emissions in the country. Its share increases every year (Freitas et al., 2018).

However, such an environmental aspect of motor transport as noise is not given due attention and its impact on the human body has not been fully studied. Meanwhile, the largest area of noise pollution on the territory of cities (up to 80%) is caused by the impact of motor transport flows.

Noise is sound vibrations in the audible frequency range that can have a harmful effect on human safety and health. According to the World Health Organisation, noise is the second most significant environmental problem for human health after atmospheric air quality. When a person is exposed to noise levels of 40 dB or higher on average over the course of a year, adverse health effects such as sleep disturbance and wakefulness can occur. At long-term average exposure to noise levels above 55 dB, blood pressure rises, the central nervous system is depressed, respiration and pulse rate change, metabolism is disturbed, cardiovascular diseases, stomach ulcers, hypertensive diseases, mental disorders occur (Kou et al., 2021). The danger of noise exposure is aggravated by the property of the human body to accumulate acoustic irritations.

According to studies, noise from motor vehicle traffic poses the greatest risk to human health, as motor vehicle traffic is a source of constant linear noise in the immediate vicinity of residential areas. It was found that residential populations responded more acutely to lower levels of traffic noise compared to those on pavements and near-maintained areas. Significant shifts were found at noise levels of 40-50 dBA on the part of the hearing organ, central nervous system, visual analyser. It is noted that the share of night time, when people are most sensitive to noise, with increasing noise levels is growing especially intensively. In the European Union social losses of the negative impact of noise from motor transport on the human body are estimated at €40 billion (Freitas et al., 2018).

Also in places with high noise levels there is a high concentration of pollutants in the surface layers of atmospheric air. For example, a direct correlation between the values of the equivalent noise level from motor transport flows and concentrations of fine particles in the atmospheric air has been found.

Presentation of the main research. The Shevchenkovsky district of Poltava (Ukraine) was chosen for the study. The district occupies the south-western part of the city, on the right bank of the Vorskla River. This area is characterized by dense buildings, increased intensity of the traffic flow, active movement of municipal transport and the presence of stops for disembarking passengers. The district is the most densely populated area of the city, where, according to official statistics, 139 thousand people live. In order to measure the noise characteristics of the traffic flow, as well as to assess the impact of traffic flow parameters on noise levels, it is necessary to carry out field surveys of problematic sections of the street network, as they are the most effective method of analysing the situation on the roads.

Field surveys consist of recording specific conditions and indicators of traffic actually occurring during a given period of time. This group of methods is currently the most widespread and is characterised by great diversity. In-situ surveys are the only way to obtain reliable information on the condition of roads and allow for an accurate characterisation of existing traffic and pedestrian flows and also in places with high noise levels there is a high concentration of pollutants in the surface layers of atmospheric air.

Places for measurements were chosen on straight horizontal sections of a street or highway with a steady speed of vehicles. In addition to determining the noise level, the intensity of the traffic flow was determined, i.e. the number of vehicles moving during a set time interval. Time interval selected 15 min. The noise levels from traffic flows were measured in accordance with GOST 20444–2014, using the Testo 815 sound level meter, the technical data of which are as follows: measurement range – 32…130 dB; error – ±1 dB; working temperature – 0…+40 °C.

The sound level meter was pre-calibrated. Each measurement lasted 15 minutes. The microphone was directed towards the traffic flow and located at a height of 1.5 m ± 0.1 m from the level of the roadway coverage. The intervals between readings of sound levels were 5–7 s. The countdown is made during the entire measurement period, both in the presence of vehicles on the site, and in their absence. The survey results showed that the measured sound level significantly exceeds the maximum permissible sound level (55 dBA) for all measured values of flow intensity and distance from the road (see Table 1).

Table 1

Results of measurements of noise characteristics at different intensity of motor traffic flow

Hourly traffic intensity by vehicleson types on road section, pcs/15min					Equiv. sound level, dBA	Measurement conditions
Total	including					
	cars	trucks	Bus	Minibuses		
75	69	3	1	2	73,00	t_{air} = -1 0C V_{wind} = 1 m/s Duration of measurements = 2 min Flow velocity = 60 km/h Distance from road = 7,5 m
80	85	1	1	3	75,00	
93	87	2	2	2	77,50	
98	92	1	2	3	77,70	
116	106	1	1	8	78,40	
126	112	0	1	13	78,70	
131	116	3	3	8	78,80	
135	122	7	2	4	79,20	
138	129	3	2	4	79,40	
151	138	0	2	11	79,70	
151	140	1	4	6	79,70	
156	142	2	1	11	79,80	
164	157	1	1	6	79,90	
173	162	3	4	4	80,00	
181	170	3	5	3	80,10	
189	185	1	1	2	80,20	
200	190	3	2	5	80,30	

As a result of the correlation analysis it was concluded that under the current traffic flow parameters (high traffic intensity with a significant predominance of passenger cars in the traffic flow structure) the equivalent sound level is influenced by the total number of cars, while the influence of individual groups of cars (trucks, buses and minibuses and other types) is insignificant (Table 3).

Table 2

Results of noise measurements at different distances from the road

Distance from the road	Equivalent sound level dBA	Maximum sound level dBA	Minimum sound level dBA	Measurement conditions
0	79,9	83,1	78,4	t air = -1 0C V wind = 1 m/s Duration of measurements = 2 min Flow velocity = 60 km/h
2	78,5	78,8	73,1	
5	77,2	78,3	73,0	
8	74,2	74,4	71,7	
10	72,0	74,2	71,6	
15	68,8	70,6	68,3	
20	67,8	68,2	67,5	
25	66,1	66,6	65,3	

Table 3

Dependence of the equivalent sound level on the amount and composition of traffic flow

Factors	Dependence of equivalent sound level on factors (correlation coefficient value)
Amount of vehicles	0,869
Amount of passenger cars	0,834
Amount of trucks	0,023
Amount of buses	0,375
Amount of minibuses	0,317

The following main methods can be used to protect against noise (Ivanisova et al., 2021): 1) technical – eliminating the causes of noise generation or attenuating it at its source; 2) planning – reducing noise levels along its path of propagation; 3) organisational or administrative. The most radical and costly are technical measures that target noise sources. However, the effectiveness of measures to reduce the noise of vehicles in operation is rather low. Reduction or elimination of noise at the source should be achieved, first of all, in the design process.

Noise reduction in the city should be facilitated by the development of low-noise means of transport, such as electric cars, cars with hybrid engines, highly efficient silencers and afterburners. However, the automotive industry cannot be restructured in a short time to produce new modes of transport. Low-noise cars or electric vehicles will not be able to replace the entire fleet of modern cars. Therefore, the first and foremost means of combating urban traffic noise should be architectural, planning, construction and organisational. Reduction of noise levels penetrating into the premises from external sources should be ensured by rational room layout, compliance with measures for sound insulation of enclosing structures (walls, ceiling and floor), sanitary-technical and engineering equipment of buildings. Protection of the residential area from transport noise should be provided by rational urban planning means. In this case, the means of protection from urban noise are distance, application of artificial shielding means and plants.

In order to reduce the negative noise impact from traffic, acoustic screens are used along with other noise protection structures and technical and organisational measures. Noise shields reduce traffic noise through absorption, wavelength change, reflection, or diffraction. Noise shields are installed along roads, usually in the form of a wall, embankment or a combination of both. The type of screen is selected based on accessibility of the area, type of material, cost, aesthetics, and public convenience. Buildings and structures with reduced requirements to noise regime (consumer services, trade, catering, communal, public, cultural and educational, administrative and economic institutions) can also be used as screens.

In this case, they should be placed along the noise sources in the form of frontal, if possible continuous, development. Plants are also good sound absorbers. Even coniferous plants can reduce the level of noise emitted by cars by 6-9 dB. Positive results in the fight against noise can be achieved by using special planting methods - in several rows. The best results are demonstrated by a combination of trees and shrubs. However, according to studies, plants are ineffective in combating low frequency noise.

Therefore, to protect against noise from lorries and large buses, given the prevalence of low-frequency engine noise, it is necessary to use other measures (Banerjee, 2008). Organisational and administrative measures are aimed at preventing or regulating the operation of certain noise sources over time. These include redistribution of traffic flows along city thoroughfares; restriction of traffic at different times of the day in certain directions; changes in the composition of vehicles (e.g., banning the use of lorries and buses with diesel engines on some city streets), etc.

Conclusions Noise pollution has unique properties, namely: its level can change in short time intervals and does not accumulate in the body. However, persistent noise has a significant impact on health. Among the factors that also contribute to an increased noise load in the study areas are the movement of passenger and light freight vehicles, the lack of free traffic combined with a large number of intersections, stops and illegal parking along the roads, as well as the lack of acoustic protection, including roadside landscaping. . Ensuring landscaping of roadside areas in residential areas of the city adjacent to highways is necessary, because due to dense development along the roads a large number of residential buildings, public premises, office buildings are concentrated.

References

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