Application of acoustic screens in solution of problem of highway territories protection

Mykola Khvorost, Karina Danova, Viktoriya Malysheva

Safety of Life Activity Department, Kharkov National University of Municipal Economy, 12, Revolutsii street, Kharkov, UKRAINE E-mail: bgd@kname.edu.ua

The increase of automobilization level causes the augment of the harmful influence of traffic flow on the environment such as gas contamination and noise. Acoustic Y-shaped screens allow protecting the residential area from these negative factors.

Key words – highway, noise, gas contamination, dwelling zone, screen.

I. Introduction

Currently there is a persistent tendency in the increase of quantity of the transport vehicles which move along the streets in Kharkov. It has been calculated that the main contribution to the city pollution compared to the stationary sources is made by the automobile transport (89 %). Every year the quantity of cars on average increases of 20 thousand units.

The increase of automobilization level causes an increase of the harmful influence of traffic flow on the environment. Besides the emissions of exhaust spent gases into the environment, transport flow emits the noise into the environment, which has a harmful effect on health of the people that work or live near highways.

The countries of the European Union consistently follow the way of severity increase for the noise emission of transport vehicles. This indicates that the problem of transport noise reduction is gaining the major urgency in economically developed countries.

II. Noise Influence on People

Investigations of the noise harmful influence on human organism have been started since the beginning of 60s of XX century by national and foreign researchers. The papers of Suvorov G. A., Caragodina I. L., Yudin, E. Y., Andreeva-Galanina E. C., Alekseeva S. V., Pokrovsky N. N., Shydlovskaya T., Middlebrooks G., Good M. and other native and foreign scientists are dedicated to the study of specific and non-specific effect of noise on human.

The studies of the researchers have shown that noise adversely influences practically every system of the human body inducing the short and long-term and stable functional changes that can cause emergence of cardiovascular diseases, nervous and other systems, as well as weakening the immune system. The excessive noise can be the cause of nervous exhaustion, mental depression, vegetative neurosis, peptic ulcer, disorders of endocrine and cardiovascular systems.

Negative noise impact causes its physical parameters (sound pressure level, frequency, intensity, exposure time, permanent or non-permanent noise etc), specificity of human organism (age, gender, state of health etc) and the influence of concomitant factors which may increase the noise harmful effects.

III. Protective Measures for the Dwelling Zone

The complex process of traffic noise spreading at work places and dwelling zone requires the development and implementation of integrated noise-reducing measures. According to [1] methods of collective protection are classified into the realization methods: acoustic; architectural planning; organizational-technical.

To protect the dwelling zone and workplaces located in the houses nearby to highways from the noise, it is reasonable to use such acoustic protections as: means of noise insulation; means of sound absorption, vibration isolation, damping and noise-reducing mufflers.

The use of architectural planning and organizational-technical methods to protect houses from traffic flows noise can perform protective and aesthetic functions. These methods include optimal acoustic solutions of the houses location planning; the creation and optimal acoustic planning zones and traffic condition of vehicles and transport flows; creation of noise protective zones in different places of person possible residence in the course of their life [1].

One of the most promising directions to protect the residential area located near the transport highway is to implement the acoustic screens [2]. The advantages of applying acoustic screens compared to, for example, with landscaping, should include constant efficiency, regardless of the season and the leaves density. Moreover, the efficiency of acoustic screens effect comes from the moment of their arrangement while achievement of a certain noise protection efficiency of landscaping needs a long time until the trees and bushes reach a certain height and other characteristics.

If we compare the acoustic screens with earth-deposits or excavations, it is obvious that these noise protection measures should be used in places where natural lay of land allows implementing this.

It should be noted that the above-mentioned noise protection measures, namely: earth-deposits or excavations have little application in the city conditions. The same can be said about the protection from traffic noise by distance. Creation of buffer zones in conditions of the density growth of city building will be economically unreasonable.

Thus, in conditions of large industrial cities with building which has been evolving for over the years, and considerable levels of traffic flows noise, the most reasonable thing is to use the acoustic screens.

Design of acoustic screens is very diverse and it differs in many respects.

Construction of acoustic screens may include the following elements:

1) the foundation;

2) bearing components of the frame (stanchions, calibration profiles and other);

3) mounting hardware;
4) noise-attenuating panels;
5) transparent sound-reflecting panels.

Acoustic screens functionality can be divided into three types: noise-absorbing, noise-reflective and combined. The experience of leading screens manufacturers has showed that combined noise protection screens are the most efficient. These screens contain both the sound-insulating and absorbing properties which increase its efficiency.

Noise protection screens can be both non-transparent that only consists of continuous acoustic panels and translucent - with panels made of organic glass. In this case, the screen can fit very well in roadside landscape and it does not cause discomfort and fatigue for drivers, pedestrians, residents of roadside areas. The possibility to use the various designs of the screens depending on the environment needs of the main traffic artery defines the acoustic screens as the most optimal approach in struggle with the transport noise [3].

The acoustic waves spreading from the traffic in the environment the eventual sound level on the protected facility depends on a number of physical (wave) effects, in particular the acoustical interference, their absorption, diffraction effects and other. These aspects are necessary to be taken into account when the acoustic screens efficiency is determined.

At the same time, the efficiency of the noise protection screens depends on the several factors of non-wave character, among which the main are:

1) geometric parameters, form and material of the screen;
2) the sound-proof treatment of the functional surface of acoustic screen;
3) availability of screening devices on the opposite side of the main traffic arteries;
4) size of the perforations and leakiness in the construction;
5) location and size of the protected object, and other.

Geometrical parameters and form influences the noise attenuation degree most of all since they stipulate the size of the zone of the acoustic shadow, which is formed behind the screen. The availability of diffraction effects causes the reduce of effectiveness of shielding constructions and reduce of the screen construction and reduction of the acoustic shadow zone, therefore now when projecting noise protection screens are designed they are made in the compound geometrical form with canopies and folded edges. On the one hand this allows preventing the ingress of acoustic waves beyond the screen; on the other hand, it gives the opportunity to improve the efficiency of relatively small length of structures [2].

The availability of sound-absorbing material on the effective area of acoustic screen allows reducing the sound waves reflection from it, thus preventing an increase of noise levels from the opposite side in the case of a single-sided noise construction.

In case of placing the acoustic screens on both sides of the highway it is possible to intensify the noise levels due to multireflection of sound waves from the screen surface, so this should be considered when designing a double-ended noise protection of the environment from the traffic noise.

The availability of leakages in the construction of acoustic screens considerably reduces their effectiveness since it allows sound waves to penetrate into the protected zone. It is considered that the size of hole of 20 cm reduces the effectiveness of the screen of 1 dBA [2].

In case the length or height of the screen under the conditions of the placement are not sufficient to create the effective protection of the adjacent territory and objects on it, it is reasonable to arrangement screen in Y-shaped form that allows achieving noise abatement, similar to a flat screen with the smaller sizes.

The selection of form of acoustic screen is stipulated by:

1) the possibility of diffraction reduce on its border;
2) preventing the formation front of reflected sound waves which allows not to install acoustic screen on the opposite side of the roadway;
3) the possibility of the selection of screen modules to the preselected transport noise spectrum;
4) simplicity of assembling and operation.

Conclusion

The method of protection the residential area from harmful influence of highway has been offered by means of the application the acoustic Y-shaped screens.

References

[1] GOST 12.1.029-80. SSBT. Sredstva i metody zashhity ot shuma. Klassifikacija. – Occupational safety standards system. Means and methods of defence from noise. Classification.

[2] Primenenie shumozashhitnyh jekranov na avtomobil'nyh dorogah SShA // Avtomobil'nye dorogi i mosty: Obzornaja informacija // Pod red. Evgen'eva G.I. – Vyp. 5. – M.: Federal'noe gosudarstvennoe unitarnoe predprijatie «Informacionnyj centr po avtomobil'nym dorogam», 2005. [Jelektronnyj resurs]. Rezhim dostupa: http://www.norm-load.ru/SNiP/Data1/56/56231/index.htm#i45589 - G. Evgen'ev, "The use of noise protection screens on the United States roads", Free documents library, May, 2005. [Online] Available: http://www.norm-load.ru/SNiP/Data1/56/56231/index.htm#i45589 [Accessed: June, 15, 2005]

[3] K.V. Danova and V.V. Danova, "Vplyv transportnoho shumu na liudynu ta shliakhy yoho znyzhennia" [The transport noise influence on the human and the means of its reduction], Naukovyi visnyk budivnytstva – Building scientific reporter, Vol. 55, pp. 270-273, Sept. 2009.