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Reduction of Automotive Noise Pollution

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Abstract: Noise pollution is one of the most widespread types of negative physical environmental impact. It causes the increase of reaction time, fatigue and has a general negative impact on humans. Scientific researches show that noise with the level of 70-80 dB increases pulse rate, causes vessel constriction and leads to threefold increase of the risk of cardiovascular system diseases. Noise level as low as 35 dB affects normal sleep, noise with the level of 40 dB has negative influence on nervous system. World Health Organization, WHO has included noise pollution in a list of the most urgent environmental problems. It affects hundreds of millions people around the world. Many countries have appropriate legislation that regulates noise and requires undertaking protective measures. Spending on protection from noise pollution in overdeveloped countries is high and constantly grows. Environmental pollution arises from inadmissible exceeding of natural level of acoustic vibration. Automobile transport in residential areas is one of the main noisemakers and a search for methods and means of protection from this negative impact is an urgent task nowadays. Noise pollution in settlements is almost always local and protection from noise pollution became more and more urgent task.

Key words: Noise · Noise protection · Automotive noise · Automobile transport · Noise pollution · Environmental safety

INTRODUCTION

Noise is one of the most widespread sources of negative physical environmental impact in settlements. Automobile transport remains the main source of acoustic pollution in settlements and its negative impact constantly grows due to constant increase of a number of vehicles [1]. According to the World Health Organization in European countries 60-80% of population subject to automotive noise impact with daytime levels of 70-90 dB while accepted normal level is 55 dB. It means 15-35 dB excess or 3-4 times increase in subjective perception of noise volume. Automobile transport makes it easier for us to get to workplaces, universities, markets, entertainments areas and other creature comforts and plays the key role in economic developments. Nevertheless motorists themselves, other people and society as a whole pay great fine for using auto-roads due to noise environmental pollution and road accidents [2]. Studies showed that high noise level is the cause of almost 30% of all diseases in settlements. Spending on noise pollution protection in overdeveloped countries constantly grows. It equals about 1% of European Union’s aggregate profit. European Union spends annually more than 50 billion euro only for noise protection: glazing and protective screens construction [3].

The Main Part: At the beginning of XVIII Thomas Young discovered the phenomenon of interference of the sound. Two overlapping acoustic waves from different sources with the same frequency form fields of high and low sound volume. When waves propagate in one direction it is possible to obtain total blanking of propagating sound wave in a certain field by varying parameters of the wave. This effect was theoretically described in 1970s by Soviet physicist G.D. Maluzhinets. He suggested enclosing the noise source within a surface with sound receivers and emitters placed in a certain order on it. Incident sound wave inside the surface gets out having a form similar with the form of source sound field but in antiphase with the source wave. It results in blanking of sound field of random form in wide frequency range. More than 60% of all scientific articles in a world covering the problems of noise protection concern active blanking. Systems of

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active blanking are rather expensive-much more than analogous passive systems. Anyway in some cases methods of active blanking are the only possible way of noise reduction.

The problem of noise protection is significant scientific and technical problem and it is carried out a number of directions. The main directions are working out norms and legislation for noise protection, development of methods and means of noise protection.

Methods of automotive noise reduction may be divided into three groups:

- Construction of barriers for noise propagation (sound proofing);
- Reduction of sound waves by the way of their propagation (sound absorption);
- Using of personal protection equipment.

Using of a certain method or combination of those depends mainly on the degree and the character of necessary noise reduction taking into consideration both economic and operational restrictions.

Automotive noise level is defined by the following factors:

- Traffic density [4];
- Percentage of the most noisy trucks;
- The kind of road reserve;
- Road conditions that determine traffic conditions.

Estimated value of equivalent automotive traffic sound level of (automotive traffic noise characteristic-L_{atnc}) is normally defined at the distance of 7.5 m from the axis of the nearest lane at the height of 1.5 m from the level of road surfacing [5].

To reduce the noise impact on adjacent territory it should be applied all the complex of design decisions and traffic arranging measures. Choice of a certain measures is defined by a certain conditions taking into consideration technical and economic requirements.

Regardless of the extent the sound level exceeds the allowed level the first problem to consider in motor road design is the increase of the distance from the buildings to provide acoustic comfort. When sound level is on 15-20 dBA higher than allowed special sound protection constructions may be provided. When the excess in not more than 5 dBA it may be applied sound protective landscaping or some changes in road geometry.

Choice of sound protection measures should consider the subjective estimation of such measures. Sound protection construction reduces sound effectively when one cannot see the sound source (motor road) from the point where sound protection is provided. Sometimes even low acoustic effectiveness of constructions (about 5 dBA) is subjectively regarded as much higher. On the contrary even high degree of sound protection is perceived as lower when the sound source-auto-traffic is not removed from the view.

In the medium frequency range the sound protection extent is defined by mass low: the heavier construction is the more effectively it blocks the sound and the lower sound propagates further. It should be also kept in mind that even small crack wipes out the effect of all the spending on erection of sound protection constructions. Sound protective barriers do not reduce sound energy as sound acoustic backing do but simply redistribute it: the energy is accumulated before the barrier. So to provide maximum efficiency sound protection barriers are usually combined with acoustic backing. Sound level may be reduced by sound absorbing materials that reduce the sound wave energy. On such materials sound energy is converted into heat energy due to the frictions of air particles in micro voids of sound absorbing coating. Using sound absorbing coatings requires acoustic calculation because both insufficient and excess sound absorption causes discomfort.

It should be taken into consideration that sound propagates not only in the air but also in constructions: walls, pipes, ceilings. In these constructions acoustic energy propagates as elastic vibration (vibrations). In most cases noise originates due to elastic vibration energy transformation into acoustic energy. Vibrating surfaces of vehicles, machines, compartments etc. produce sound. To increase effectiveness of sound protection it is suggested to cover engine jacket with sound insulating material that allows obtaining required acoustic efficiency to protect the motor of the vehicle [6].

Research show that a certain success in noise reduction may be obtained by relevant configuration of tread pattern and tyre design. But considerations of sound protection in tyre design contradict with the pressure to safety; tread heating protection and vehicle efficiency. So development of perspective alternative road surfacing constructions provides great possibilities for noise reduction.

The structure of road surfacing itself is apparently important from the point of view of noise reduction; either it is bituminous pavement with random pattern or concrete with prevailing transversal structure. Measurements determine elementary correlation between skid resistance on a certain surface and total sound level generated by vehicles moving with high speed on that surfacing. It was defined that the correlation is statistically independent of road surfacing structure. Unfortunately although this result is important for development of the norms for road surfacing that account for safety and environmental protection it reveals the contradiction between definition of road surfacing with low noise level and satisfactory safety norms at high speeds. For example, smooth surface may provide rather low noise but it is absolutely unsafe when moisture level is high.

Research and development of low noise road surfacing show reduction of automotive noise for more that 3 dBA. Research covers different types of rigid nonporous surfacing with optimized structure, 3-4 millimeters particles of mineral filler and tar, epoxy resin, cement as binding agent. There was analyzed the design of porous road surfacing with more than 15% of air cavities capable of water drainage in vertical plane. Such parameters of porous surface as thickness, fluidity resistance and surface curvilinearity as well as the type of binding agent were evaluated for the impact on acoustic characteristics. There were defined 3 up-to-date directions in low noise road surfacing design: fine-grained mineral fillers, high level of porosity, two-layer surfacing [7].

CONCLUSION

Ambient noise level in the world constantly grows. It is caused mainly by increase of specific power of automotive transport because sound energy of production facilities is a certain part of all the energy produced by vehicles. Besides in many industries there is a tendency to lighten constructions of engines and machinery, reduce specific quantity of metal and as a result their sound protection also becomes lower. The list of noise protection means become longer and protection means are also being improved [8]. But now the only factor that significantly reduces wide application of noise protective means is extra spending.

Summary: The most obvious mean to reduce automotive noise is to reduce traffic intensity by displacement of transport streams [9]. Division of transport stream for example in two generally reduces the level of automotive noise for 3 dBA.

Theoretically lowing speed of auto-transport is one of the most effective measures to limit the level of automotive noise. Limiting the average speed of the vehicles in the highways to the half of the current speed may reduce the relevant noise level for 5-6 dBA.

Noise mapping may be used to map acoustic features of a certain space. It allows to display the information massive in more vivid graphic form than text and tables. It became a convenient mean for analysis, decision making and PR. Despite yet relatively high price of development of noise map they grow in popularity and become highly demanded mean for optimal regulating of the city noise space in particular because of putting into operation French now and then-European norms of noise regulation [10].

It should be mentioned the high importance of the measures for limitation of existing noise together with the main method of reduction of automotive noise-suppression of its source. These measures include improvement of road construction and their layout, using of screens and barriers.

Residential areas may be protected from automotive noise by their placement on a relatively long distance from the sound source. But designers consider such approach inefficient. Often it's true because in buildings near the auto-roads (less than 100 m) noise level is rarely reduced lower than 70 dBA. Still sometimes spacing the buildings and auto-roads should be considered the only positive way to solve noise problem.

The main objective of system regulating of auto-transport is to find rational correlation between provisioning of society needs and reduction of the level of environmental noise pollution. The strategies will depend on local situations and will vary for a certain countries, regions and cities.

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