

About Forecasting Air Pollution in the Construction of Highways

N. Barikayeva¹, D. Nikolenko², J. Ivanova¹

¹ Volgograd State Technical University, Volgograd, Russia

² Don State Technical University, Rostov-on-Don, Russia

E-mail: nelli.barikaeva@yandex.ru

Abstract. The article considers the main types of environmental pollution in the construction of highways. First of all, they are the formation of dust (during the movement of transport, during the transportation of building materials, as well as in a number of technological operations) and the noise effect created by operating machinery. All the factors affecting the ecological situation in the residential area of road construction have been analyzed. The harmful content and elemental composition of fine dust (PM10 and PM2.5) during the construction period was investigated. The main sources of the release of pollutants into the atmosphere during the construction and repair of the motor road were considered namely: construction machinery; dust particles from the surface of the roadbed, sections of the pavement device, storage areas for loose building materials, etc. It is shown that the PM10 and PM2.5 dust concentrations can be considered as random quantities, and approaches to their prediction are also proposed.

1. Introduction

In the current conditions of rapid development of all types of human activities, the environment protection and natural resources saving issues becomes more important. The negative impact on the environment is provided by process of motorization and construction of roads and highways. Therefore, the issues of environmental protection and rational use of natural resources should be given more attention.

The construction of roads is accompanied by a number of processes that directly or indirectly affect the environment. The development of measures for the conservation and rational use of environmental systems depends from the extent to which the nature of these changes and their consequences are known.

Technological processes of construction and repair of roads are accompanied by a significant impact on the atmospheric air, namely, additional air pollution emissions of exhaust gases from vehicles, additional acoustic pollution by the noise of vehicles, dust emission during transportation and unloading of bulk materials.

It should be noted that road construction works, although it's temporary format, which is caused by the duration of construction, are often produced near a residential area in an urban environment. Thus, the construction of roads and highways is a source of impact on public health [1,2].

One of the negative factors affecting the health of the population during the construction period is noise, the source of which, as a rule, is construction equipment. The sound levels, measured at a



distance of 7.5 meters from construction vehicles and equipment during road construction works, reach 75-100 dBA, while the health standards of acceptable noise in residential buildings in the daytime are 55 dBA. Accordingly, during construction and repair work, noise is exerted on citizens living hundreds of meters from construction sites.

Technological processes at all stages of road construction are accompanied by intense dust release. Dusty air in the territories where these works are taking place is a significant threat to the health of workers and people living in close proximity, as in current practice, aspirating air systems for dust removal are not used enough. [3].

When carrying out work related to loading, unloading, leveling, transporting soil, inorganic dust with an SiO_2 content of 20 ... 70% is released into the atmospheric air. Crushed stone is transported to the territory of the site by road. When unloading, storing and transporting crushed stone inorganic dust, which is containing SiO_2 up to 20%, is released into the atmospheric air (table 1)[4].

Table 1. Emission of substance during construction

Name of substance	Code of substance	Hazard Class	Emission during construction, t
suspended particles	2902	3	0.00197
Inorganic dust, containing SiO_2 (20 ... 70%).	2908	3	3,07733
Inorganic dust, containing SiO_2 (up to 20%).	2909	3	0.51693
TOTAL			3,59623

Dust, formed during transportation and loading and unloading operations, is characterized by a wide range of particle sizes – from 1...2 mm to micron fractions. The atmosphere usually receives dust, the particle size of which is less than 10 microns. Large particles either immediately fall on the ground, or settle after a short time. The release into the atmosphere of minute mineral dust particles in a free state in the form of aerosols pollutes the air space mainly near the source of dust release and for a short time, but causes damage to the environment. Dust, settling on the ground, acts in its main role – a source of soil and water pollution, which predetermines the accumulation of hazardous substances up to and above the limiting concentrations [5,6,7,8,9].

In this case, fine dust with particle sizes of less than 10 μm (PM10) and less than 2.5 μm (PM2,5) is particularly dangerous. Thus, the study of the dispersion of dust formed during repair and road construction works is an urgent task. Fig. 1, 2 represents the results of a study of the dispersion of dust at various stages of road construction, which showed that up to 90% of dust is present in the air [10,11,12,13,14].

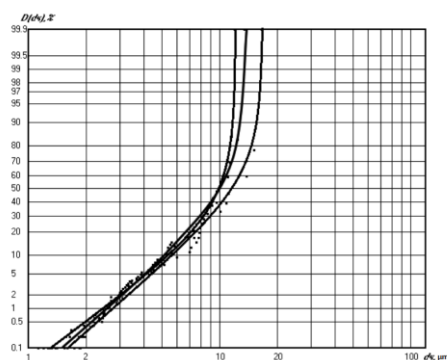


Figure 1. The distribution of particles by diameters for the dust taken during the construction of the subgrade (heavy dusty loam)

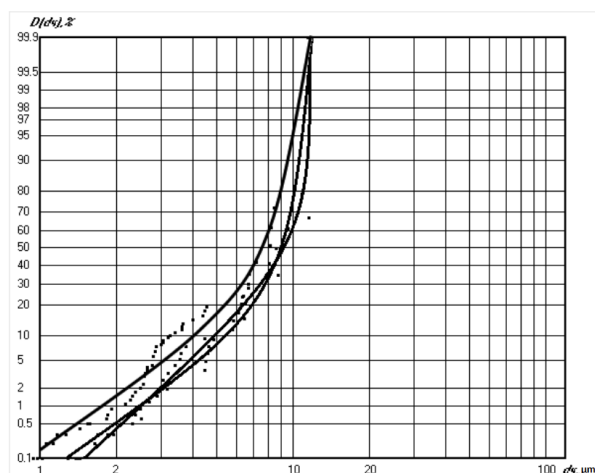


Figure 2. The distribution of particles by diameters for dust taken directly at the site during the laying of the base layer of the roadbed

Studies conducted in the air environment near urban roads under construction showed that in some cases the fluctuations of the dust dispersion composition will be significantly higher than the error of the measurement methods. In this case, the range of function values, should be related not to errors category, but to the characteristics of the random process, which, because of the influence of various factors (the scale of construction, the materials used) and varying within a certain range parameters of air environment (humidity and wind velocity etc.), determines the fractional composition of the dust. Therefore, it seems expedient to consider functions describing the disperse composition of suspended particles in the air of cities not as deterministic, but as random [15, 16, 17].

However, one must bear in mind that for practical calculations, it is necessary to check the independence, stationarity of the random process, and whether there is a normal distribution for it. As studies show, the distribution of the concentration of fine dust formed during road construction works is consistent with the normal or log-normal law, which is the rationale for using the Rice distribution to predict air pollution [18,19,20]:

$$\bar{v}_{C_{\text{норм}}} = \frac{\sigma_v}{2\pi\sigma_C} \cdot e^{-\frac{C_{\text{норм}} - M_C}{2\sigma_C^2}} \quad (1)$$

where M_C - mathematical expectation;

σ_v - variance of the rate of change in the ordinate of a random function

σ_C - mean square deviation

$C_{\text{норм}}$ - normative value of the concentration of pollutants in the air mg/m^3

C - concentration of dust in atmospheric air, mg/m^3 .

Proposed the formula allows to determine the average number of excess hygienic standards for the concentration of fine dust. The use of this probability characteristic is necessary for forecasting the environmental situation in the construction area and applying the necessary measures in case of non-compliance with regulatory requirements.

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