POSSIBLE SOLUTIONS FOR DIMINISHING THE NOISE EMITTED BY ANTROPIC ACTIVITIES IN ROSIA DE JIU OPENCAST

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Abstract

The development of modern technology towards increasing power and speed of aggregates and machinery, the evolution of transporting means and upgrading work technologies led to new sources of noise and a considerable increase of industrial noise. Due to the high intensity and big duration of industrial noise, the negative effects on health and work capacity of persons performing or supervising operations with industrial machinery are major. This paper presents some solutions to reduce noise in the Rosia de Jiu opencast and its related areas.

1. Introduction

Romanian industrial activity is facing great difficulties (low technical lever, insufficient financial resources, limited autonomy), which limits the choice and implementation of noise reduction solutions. [1]

In all sectors (mechanical engineering, chemical, mining, metallurgy, of transportation, construction, etc), noise control solutions aimed at:

- mitigate the noise at source;
- mitigate noise propagation path;
- noise attenuation to the receiver.

Since the constructive – functional characteristics of aggregates and equipment limit the possibilities of noise canceling at source, applying these solutions is required by specific working conditions.

This requires knowledge of the causes of noise in each working body composition and mechanism/equipment of the unit (bearings, gears) to electric cars, internal combustion engines, machine tools etc. Knowledge of the operation mode, maintenance and safety instructions, provides choosing the means of reducing noise to acceptable limits.

2. Presentation of the Rosia de Jiu opencast

Technical-mining conditions are specific to each operating area and various, depending on reservoir conditions (depth career, configuration of the layers), location, year of commissioning, operating method applied, construction/development work stepts, geomorphology, etc.

The technical equipment being like all the open pits from the mining basin Rovinari (types of equipment) has little influence on the noise level, therefore it is not included in specific conditions. The Rosia de Jiu opencast, by its placement in the region, reservoir conditions, development of work steps, land morphology and wider scope, is a study support for analyzing the possibilities of noise reduction.

Location: Farcasesti

Adjacent places: Rovinari (<1km), Urdari (3km);

Year of commissioning: 1973, exploitable layers: V-X

Technical equipment: 9 bucket wheel excavators, type 1400, 1300, 2000; 4 dump machines, 2 deposit machines (KSS and ASG); >52 conveyor belts.

Mining method: method combined with the transportation of a part of the tailing at interior dumps and transhipping it into the internal dump. Transformer stations: 110/20 kV Rosia stations, 20/10 kV own stations.

The development of the quarry in unfavorable land ensuring conditions, determined the current position of the excavation and landfill stages:

- two upper steps of excavation (hilly area) are about 1 km distance from households located on the northern side of the career;
- last step is located near the landfill (approx. 1,5 km) of households near the Rosia de Jiu opencast. (fig. 1).

The coal deposit of the opencast is located at a distance of about 1,5 km from the town of Rovinari.

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Fig.1. *Rosia de Jiu opencast and noise measurement points*

3. Noise sources in Rosia de Jiu opencast and its related areas

The Rosia de Jiu opencast is considered to be representative in terms of noise by:
-big number of machines;
-human settlements located on two sides, at distances of 100-150 m;
-configuration and negative rates of three edges (limits) of the opencast (at households level).
Specific to the activity in the lignite open pits are the sources which produce noise by:

- mechanical action (rolling the rubber carpet on the support rollers), improperly installed devices (protection of moving organs, cleaning devices etc);
- friction: gears, bearings etc;
- interaction between electromagnetic forces of rotor-stator interspace of engines.

In addition to the sources of noise pollution, generated by the basic technology (excavation, transport and rock storage), a significant level of noise is produced by machines with discontinuous action (excavators with bucket and automobiles) which are used for auxiliary technological operations (road facilities, extension of strips, etc)

In terms of constructive and functional characteristics of equipment, career tools are generally the same: excavators type 1400, 1300 and 2000, conveyor belts in widths of 1400 ÷ 2000 mm, special landfill machines with a capacity of 6300 - 12 500 m3 / h, storage machines with a capacity of 4000 average t / h

For this reason the noise level in the pit is differentiated according to the geometry (depth, number of steps), the morphological configuration of the area, working time and the distances from located adjacent localities.

Noise impact analysis in lignite mining activities in open pits with continuous flux technologies, are realized like in the following steps:

- identification of noise sources;
- estimating the harmful effects of noise;
- studying and implementing solutions to reduce the noise level to admitted limits.

Noise level measurement results in the southern part of the Rosia de Jiu opencast in February 2012 are summarized in table 1.

Table 1 *Noise level in the southern part of the Rosia de Jiu opencast*

Site measure ments of noise/ sound lever measured dB (a)	Sound lever measured dB (A)	Permissibe limit dB (A)	Exceedancs limit admissible dB (A)	Comments
2.	**3.**	**4.**	**5.**	**6.**
- to 40 m - measuring point 1	51,2	**50**	**1,2**	T = -3,2^{0}C W = 97% Cloudy sky
- to 30 m - measuring point 2	57		**7**	
- to 30 m - measuring point 3	51,1		**1,1**	
- to 30 - measuring point 4	54,2		**4,2**	
- to 30 m - measuring point 5	66,6		**16,6**	
- to 40 m - measuring point 6	64,6		**14,6**	

From the presented data results that there were exceedances of the noise at all measurement points, respectively 7dB in point of measurement 2, 16,6 dB in point of measurement 5 and 14,6 dB in point of measurement 6.[9]

4. Possible solutions to mitigate noise made by sound sources in Rosia de Jiu quarry and surrounding areas

To establish possible solutions to mitigate noise generated by existing sources in Rosia de Jiu opencast, it is necessary to analyze the possibilities of reducing noise at source, at the receiver and on the path of propagation (transmission) in the specific existing conditions.

4.1. Reducing the noise at source

The problem of reducing noise at source addresses on the causes that produce it, malfunctioning components operated groups (engine, gearbox, coupling), the mechanisms of machinery (continuous and discontinuous sewage facilities –pumps- and machine tools).

About the causes of noise in these components (bearings, gears, parts of electrical machines and internal combustion engines etc) we can make the following comments:

- construction deficiencies are eliminated by redesign;
- deficiencies caused by additional efforts are eliminated by the optimization of the maintenance activity;
- disorders, excessive usage or deformations require replacing the respective component.

Regarding the solutions of mitigating noise coming from utilities with continuous action, by enclosing the sources in soundproof enclosures, it should be noted that the possibilities are limited, due to restrictions:"

- making opening in the walls of the case;
- removing the case during interventions;
- authorizing of the construction.

Since these restrictions diminish the leakage of the case, its efficiency is greatly reduced, and the solution is unreasonable.

Big dimensions of the groups driving the mechanisms make very difficult the creation of the case, making great safety problem to control and surveillance staff.

The difficulties of construction and installing the case, also the necessary costs are some reasons why this solution is not efficient, both financially and mitigation noise.

4.2. Reduce noise level at the receiver

Protecting the personnel against noise level which exceed acceptable limits can be achieved by:

- providing means of individual protection (earplugs) authorized by specialized institutions;
- specialized periodical medical examinations;
- reducing work schedule in noisy areas;
- sealing shelter cabins (for supervising staff) and control cabins;
- sealing material delivery-receiving bunkers.

Under legislative rules for health safety at work (law 319/2000) and social security (public pension system, law no. 19/2000), replaced by law no. 216/2011 was established the methodology for classification of jobs in mining at surface, in the special conditions group. [10]

This classification was based on the evolution of risk factors specific to lignite open pits (harmful gas level, unfavorable microclimate conditions, physical and nervous strain). Programs of technical measurements compiled from summary files of the unconformities between the production process and the working environment can not eliminate/mitigate the effects of activity specific risk factors from open pits, so that regulations can not be deemed to have personnel protection character, but one of compensation.

4.3 Reducing noise level on the propagation path

The problem of reducing noise on the propagation path considers exposed population from both sides of the opencast:

- the northern side, where flats belonging to the household area of Rovinari and households belonging to Rosia de Jiu village are built, located at distances of 120-200m;
- the southern side, where are located households belonging to Rosia de Jiu village, located at distances of 150-200m;

To protect people from these areas, the solutions for reducing the noise made by machines from the opencast are:

- moving the coal storage outside the area;
- installing soundproof screens.

4.3.1. Moving the coal storage

Moving the coal storage from the actual location was imposed as a solution to protect the area, after the emissions measurement results, in the level II environmental audit.

The emissions values were:

- air concentrations of fine sediments and PM 10 exceed the amount allowed with 5,04 mg/kg and the total concentration of heavy metals in soil is at the limit of intervention;
- equivalent noise level exceeds the limit, with 12-14%.

Whereas by reducing the concentration of emissions from the coal storage are there were no conditions for applying technical solutions, unfavorable ground for mounting soundproof screens, with their dimensions incorrelating with the height of the flats, the measurement of assembling it was adopted, conditioning obtaining the environmental authorization by including the measure in the career compliance program.

The program of moving the deposit from its actual position will be realized after a stuffy prepared by a designer, with the analysis of two variants, depending on the possibilities of correlation with Pinoasa quarry coal deposit.

The solution of moving the coal deposit requires very high costs, in order to acquire the material required for assembling in advance the transporters, moving the depository utilities etc.

The application of these solutions has the following advantages:

- the new location is far away from households;
- the geomorphologic conditions of the new area provide opportunities to mitigate noise and other emissions;
- the chain of fines given to the quarry and CET Rovinari, but not after inspections, but after complaints from locals, will be broken.

4.3.2. Installing soundproof screens

Protecting the owners of the households near the southern limit of Rosia de Jiu opencast can be achieved using a soundproof screen. Proper alignment and distance for the level of the desired mitigation are determined considering the morphologic conditions of the land and evaluating the noise, considering the allowed levels.

- **Establishing the location of the screen**

The configuration of the land in the noise exposed area is the result of local morphology and mining done on this side of the career:

- height difference (about 4 m) from the center of the village;
- the portion of slope situated outside the border of the opencast;
- the safety pillar on which are mounted two fixed conveyors;

To assure proper conditions for installing the screen (the foundation), its alignment follows the land with little level differences, having a shape corresponding to the contour of the opencast and a length of about 640 m. (fig 2).

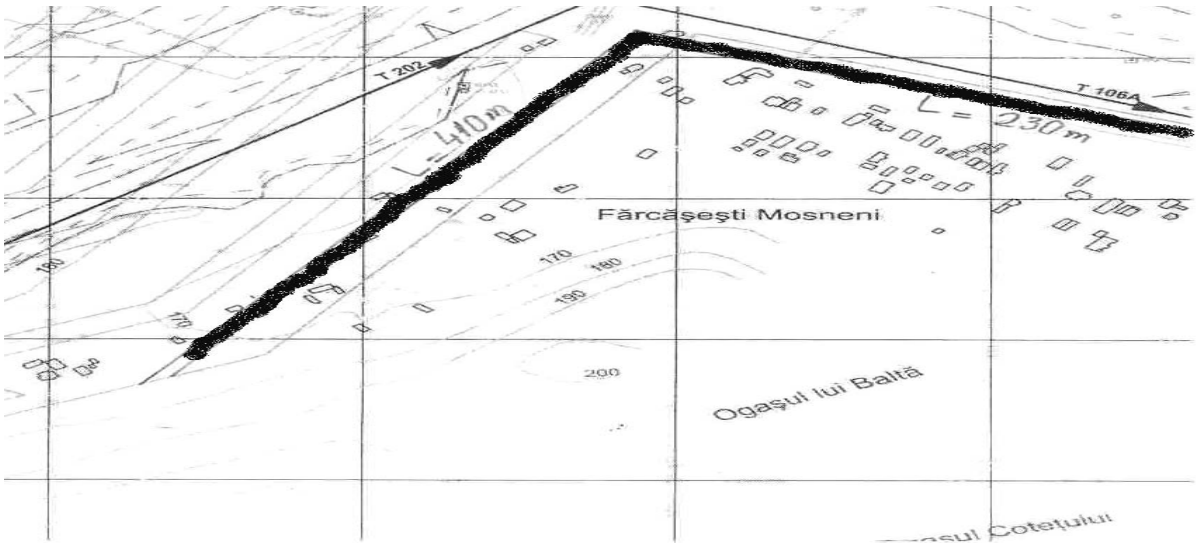

Fig. 2. *Soundproofing screen location*

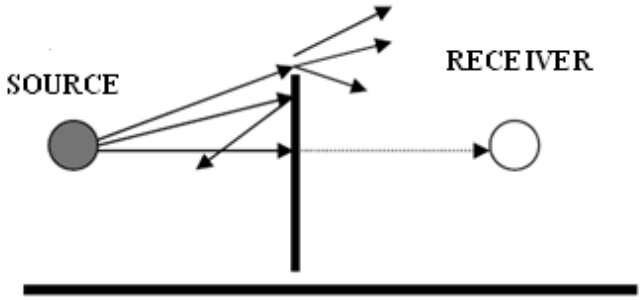

Fig. 3. *Reflections and diffraction occurring when an acoustic screen*

- **Establishing the distance from the source and from the receiver**

Distances screen – source and screen – receiver resulted from choosing the alignment, corresponding to the efficiency of the screen, as:

- distance between screen and source (Excavator 1400) is 60/90 m, the contact between it and the slope being sealed;
- all households (receiver) are situated in the area protected by the screen – the one in which direct sound waves do not interfere with the diffractions. (fig 3) .[1]

Configuration of the land, limit of the exploitation perimeter and the grouped households require:

- distance between screen and source: 90 m;
- distance between screen and households: 120m;
- screen length: 2 areas of about 410m, respectively 230 m;

The height of the panels that make up the screen shall be determined by calculation, according to:

- required level of mitigation;
- distance between screen and source (l1), respectively receiver (l2);
- spectrum of noise source (f);
- dimensional elements, surface of the screen (Sc);
- equivalent radius of the surface (r0);

In literature, [3], it has been established the scheme of geometry of screen sizes and the relation of calculus (1) for the level of mitigation of frequency 500-1000 dB.

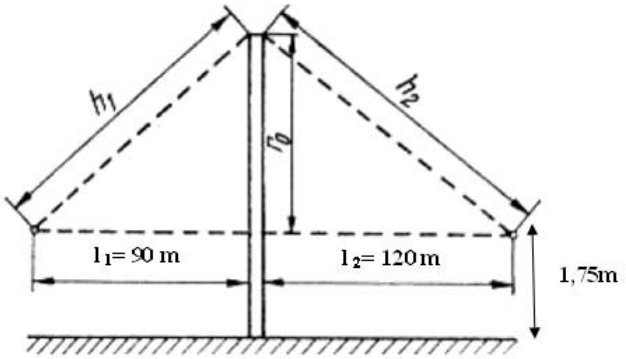

Fig. 4. *Soundproof screen*

$$\Delta L = 20\lg\cdot\frac{l_1\cdot l_2}{h_1\cdot h_2} + 2{,}5\left[\frac{f}{500} - 1\right](\text{dB}) \qquad (1)$$

where:

l_1, l_2 – screen – source distance, respectively screen – receiver distance;

f – frequency noise;

r_0 – height measured from the receiver's level;

Sc – screen surface;

$$h_1 = \sqrt{l_1^2 + r_0^2}\ ;\ h_2 = \sqrt{l_2^2 + r_0^2}\ ;\ r_0 = \sqrt{\frac{S_c}{\pi}}$$

Screen size is calculated in the following assumptions: the source and the receiver are on the same level; the influence of natural conditions is negligible, the frequency of sound is 500 Hz, the maximum height of the panel shall not exceed 6 m (height corresponding with wind resistance).

Substituting these values into (1) (for ΔL we will take into account the largest difference – 16,6 – between the measured noise level and the permissible value) resulting r_0 = 4,8m.

At the calculated r_0 value is added the average height of the receiver – 1,75 m – and it will result the height of the screen – 5,5 m (fig. 5). The mounting location of the screen is about 90 m from the sound sources and about 120 m from the households.

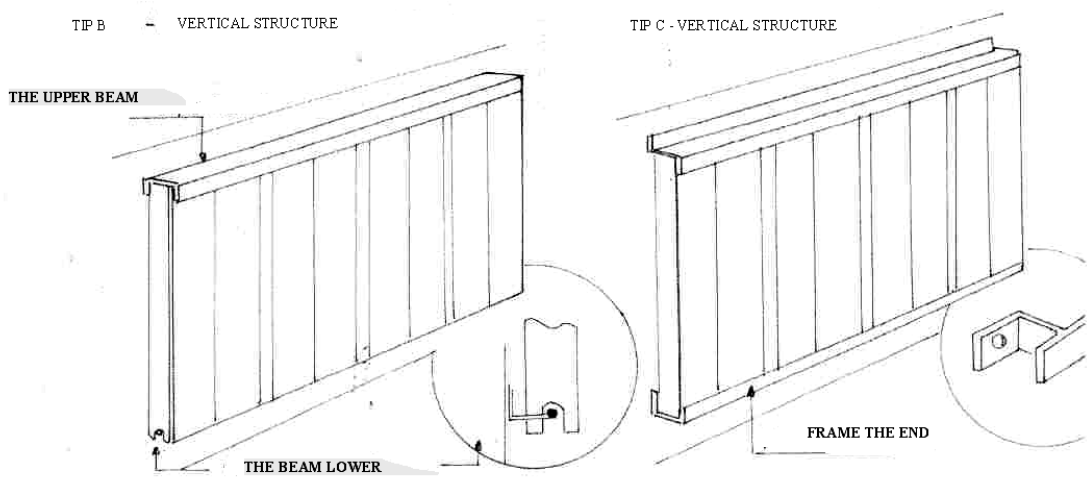

Fig. 5. *Execution panel fonoabsorbant*

5. Conclusions

The need of reducing the noise level is necessary for social and economical reasons, its harmful effects having serious consequences on health and human activity. Choosing and implementing solutions to combat noise are realized considering the analysis performed on the acoustic source – propagation path – receiver system.

The means of protection against noise presented in literature, were consisting of silencers, soundproof cases and soundproof screens. The effectiveness of these means is the way of execution and the existing installation conditions (distances from the source location and receiver, the restrictions imposed by safety standards, etc). Considering the specific conditions of lignite quarries with continuous flux technologies (equipment with constructive features – complex functional), mounting solutions for noise attenuators and soundproof cases are not efficient.

To reduce the level of the noise made by the sources in the Rosia de Jiu opencast (case study), there are two possible solutions:

a) moving the coal deposit from the actual location (located at distances of 90-120 m from the flats in Rovinari);
b) installing a soundproof screen, in length of 600 m, to protect households located on the southern side of the career.

To determine the size of the soundproof screen, we used a method of calculation recommended by literature [3], depending on the distances required by mounting conditions. In the mining units, noise reduction measures are applying (the cases of delivery bunkers, on tape circuits, reorienting the utilities in areas situated at big distances from settlements, planting vegetation belts, etc). Noise levels above allowable standards, resulted from measurements, prove the insufficiency of these measures. For own personnel, the mining units are required to provide individual noise protecting equipment and isolated control booths, whose effectiveness do not ensure acoustical comfort.

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