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STUDY REGARDING INDUSTRIAL NOISE REDUCTION WITH SOUND ABSORBING SCREENS

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Abstract: *To establish a coherent, realistic and tangible effects strategy on the work place environment, it is necessary to know the industrial noise level and characteristics. The noise is the main risk in the case of occupational illnesses of the hearing loss type given that all workers must be protected. The realised determinations showed an acceptable value of the noise attenuation coefficient for screen less than 0.1 m thick. Also their utilization can decrease the acoustic pressure from 9% to 35%, the reduction depending by screen thickness. Reduced weight, the different geometries of realising and assembling (with the scope to extension the surface covered by them), suggest that, they be used to improve the work environment.*

Key words: *noise, sound absorbing screen, occupational health.*

1. Introduction

Noise can be an unwanted or harmful sound for the work environment. The important characteristics of it are the frequency measured in Hz and the intensity, measured in dB. The typical examples of the sound are [1], [7], [8]: normal conversation - 60 dB(A); children class of the primary school - 75 dB(A); heavy road traffic - 85 dB(A); compressed air hammer - 100 dB(A); jet plane take off 100 m distance - 130 dB(A).

Noise can be harmful depending on the sound intensity, frequency or tonality, periodicity and duration. For a 140 dB noise, a single exposure can cause a permanent damage of the ear. This level of the noise exposure at the work place is rare. The reality is that the damage due by the noise is produced over time.

The prolonged exposure to strong noise can lead to the hearing difficulties. For the workers protection, the 2003 EU noise directive, which is valid in the all EU member countries which begin in 2006, establishes a limit value of the 87 dB(A) noise daily exposure (8 hours) [9-11].

Studies show that throughout the world there are more of 500 millions citizen with hearing loss (different degrees), and for 2015 it is established that this number will be around 700 millions [12-14].

Workers protection against the noise effects can be a difficult task, because it must take in the considerations the work place noise, particular characteristics and other existing risks in them. Undesirable effects of the noise are: the increased risk of work accidents, stress and cardiovascular system illnesses [5].

The distribution of the new occupational

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illness (see Figure 1) shows that in the analysed period, shows that the greatest number are occupational illnesses caused by noise [6].

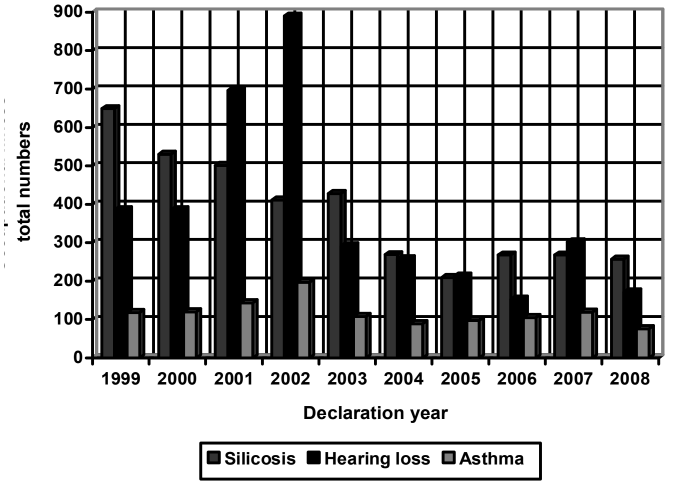

Fig. 1. *Evolution in Romania of new occupational illness cases*

In Braşov County, the most frequent illnesses in the 2005-2009 periods were (see Figure 2):

- occupational illnesses determined by silica and asbestos powders (BPAR);
- pulmonary illnesses (BPOC);
- intoxications and occupational illnesses determined by chemical agents exposure (I);
- bronchitis asthma (A);
- occupational illnesses caused by noise (BPDZ);
- occupational illnesses determined by the locomotor apparatus overtaxing (BPAL);
- cutaneous occupational illnesses (BC).

The Figure 2 shows the percentage distribution of the above mentioned occupational illnesses, those due to noise being in second place, both at the regionally and country level. Noise becomes the main factor in the hearing loss appearance, when ever it exceeds the limit value of daily professional exposure, that is of 87 dB(A).

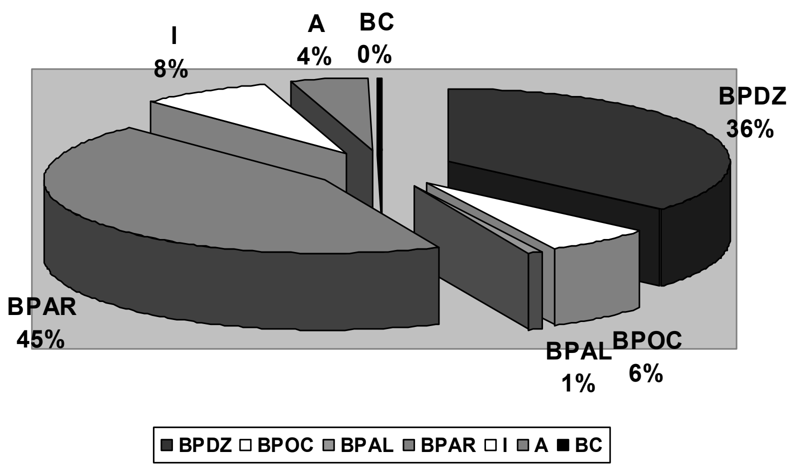

Fig. 2. *Most frequent occupational illnesses in analysed period*

2. Theoretical Considerations

In order to eliminate the negative effects of the noise action on workers health the following measures should be undertaken:

- reduce the noise at the source;
- reduce the acoustic wave propagation.

The noise that is produced in work spaces can be absorbed through: sound absorbing techniques, absorbing treatments within the dividing walls and individual protection equipments. The general methods to reduce the noise are [3-4]:

- source noise fighting methods;
- noise fighting methods to prevent propagation;
- noise fighting methods to the receiver.

Source noise fighting is the most effective method but non applicable in all the cases (e. g. the equipment case with large dimensions).

The noise fighting to the receiver is efficient only for the referred operator, other operators being insufficiently protected.

Noise reduction via propagation has the required efficiency and sound absorbing screen can realise this. These are acoustic obstacles between the noise source and receiver, their efficiency depends upon their dimensions and acoustic frequency.

The design and tested screen presented in this paper was named "spongi-flu" (see Figure 3), its composition being:

- A the material should be light sound absorbing and used within housing;
- B the material main sound absorbing;
- C the material should be thermo-insulating.

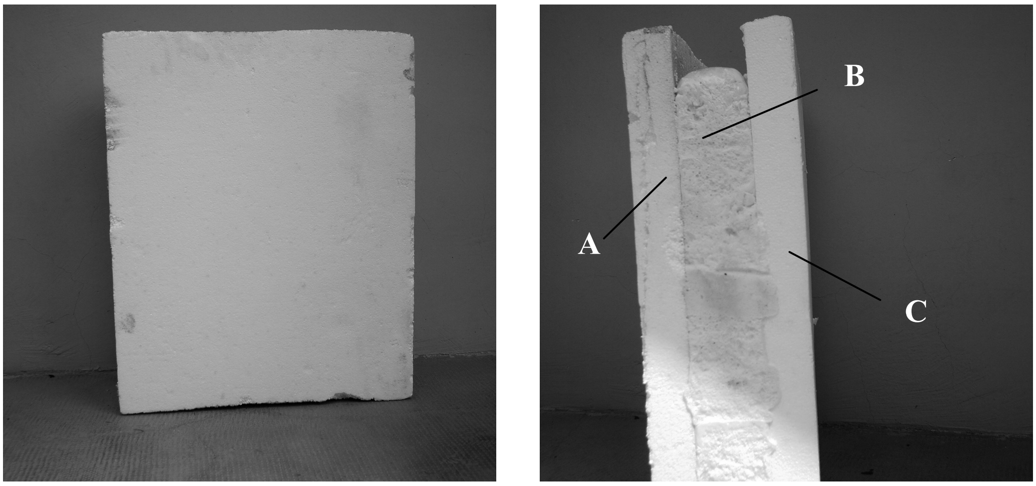

Fig. 3. *Spongi-flu sound absorbing screen*

The physical characteristics of the screen are: density up 31.85 to 41 kg/m^2, depending on the desired noise attenuation level and weight up to 3.75 to 4.20 kg/m^2, depending on the noise attenuation level. The noise attenuation level depends on the *B* material composition and volume. The noise attenuation coefficient determination, realised by the sound absorbing screen is shown on Figure 4 [2].

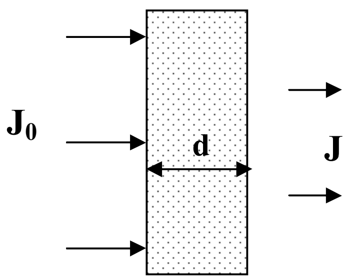

Fig. 4. *Acoustic intensity attenuation draft*

The noise attenuation law is an exponential law of the form:

$$J = J_0 \cdot e^{-\mu \cdot d} \text{ [W/m}^2\text{]}, \quad (1)$$

where: J_0 - incident sound acoustic intensity; J - emergent sound acoustic intensity; μ - attenuation coefficient of the sound absorbing screen; d - thickness of sound absorbing screen.

Because the measurement determines the sound level values, it is necessary to use the relation (1) to change from acoustic intensity to sound level. The connection between sound intensity and sound level is given by:

$$N_x = 10 \cdot \lg \frac{J_x}{J_r}, \quad (2)$$

where: N_x - incident or emerging sound level; J_x - incident or emerging acoustic intensity; J_r - relative acoustic intensity and has the value of 10^{-12} W/m^2.

By the mathematical operations (division to J_r and application of logarithm), the relations (1) and (2) become:

$$\frac{J}{J_r} = \frac{J_0}{J_r} \cdot \mathrm{e}^{-\mu \cdot d}. \quad (3)$$

By passing from acoustic intensity to the sound level, relation (3) becomes:

$$N = N_0 - 10 \cdot 0.434 \cdot \mu \cdot d. \quad (4)$$

The relation (4) permits the attenuation coefficient value calculation for the sound absorbing material with:

$$\mu = \frac{N_0 - N}{4.34 \cdot d}. \quad (5)$$

3. Test and Results

The realised screen has been tested to establish its efficiency to noise reduction. To determine the screen attenuation capacity, the Volt Craft MS4 IN DT 8820 sound level meter was used as the receiver. A sound level noise of 79.90 dB was generating during the test.

After the putting sound absorbing screen between the noise source (*N*) and receiver (*R*), the sound level meter showed a sound level of 77.10 dB. The test values were: surface screen of 0.25 m^2, l_1 of 1.7 m and l_2 of 0.3 m. In the case of proposed sound absorbing screen, the relation (5) necessary values are: N_0 - incident sound level 79.90 dB; N - emergent sound level 77.10 dB; d - screen thickness (d_1 = 0.075 m).

The tested screen μ attenuation coefficient value is 8.50 *1*/m. If the screen thickness is double (d_2 = 0.15 m), the difference between the incident and emergent sound is reduced by 5.60 dB and for the thickness of d_3 = 0.20 m the noise level reduction would be of 8.40 dB.

The test layout is presented in Figure 5. The noise level attenuation realised by the sound absorbing screens is calculated with the relation:

$$\Delta N = -20 \cdot \lg \frac{l_1 \cdot l_2}{h_1 \cdot h_2} + 2.5 \cdot \left(\frac{f}{500} - 1 \right), \quad (6)$$

where: ΔN - difference between the incident and emergent sound level; $h_{1,2} = \sqrt{l_{1,2}^2 + r_0^2}$; $r_0 = \sqrt{\frac{S_s}{\pi}}$; S_s - screen surface; f - noise frequency.

In the case of the tests the noise frequency was of 560 Hz. It is recommended that the screen length to be at least 1.5-2 times larger than the height. For the different screen dimension (surface, thickness), the relation (6) permits calculation of the attenuation. This simulation showed that the maximum attenuation can be of 19.10 dB and this is obtained for a screen with the height of 3 meters and the length of 6 meters, mounted at 1 meter from noise source and 1.5 meters away from the receiver.

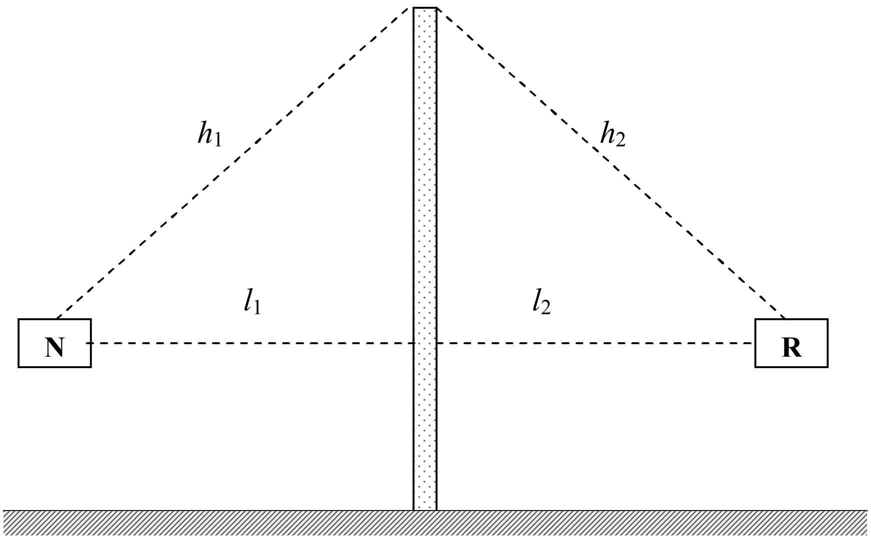

Fig. 5. *Sound absorbing screen placing draft (N - noise, R - receiver)*

4. Conclusions

By using the sound absorbing screens of the type proposed in the paper, the industrial noise level can be significantly reduced. The tested screen has a low weight, the possibility to manufacture them in different shapes and their configuration in according with available space, permits them to be utilised in the all work environments, where the noise level is high.

The tests show that using spongi-flu screen type can reduce the noise level by 2.80 dB, which means a decreasing of acoustic pressure by 9%. In the case of d_2 screen thickness the noise level is reduced by 5.60 dB, with the acoustic pressure decreases by 25% and for the d_3 thickness, the acoustic pressure is reduced by 35%.

This sound absorbing screen type utilisation permits, from the point of view of occupational health, an unacceptable noise level to be transformed into an acceptable one.

Using screens with a composite type structure screens can reduce the sound pressure with significant values even at low thicknesses. The work environment improvement by sound absorbing screens should lead to a decrease in hearing loss illnesses, because all the space work operators will benefit of their existence.

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