AN EVALUATION AND ANALYSIS OF NOISE CAUSED BY TRAFFIC IN A POPULATED AREA OF BRAILA CITY

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ABSTRACT:
THIS STUDY ANALYSES NOISE CAUSED BY TRAFFIC IN A HIGHLY POPULATED AREA OF BRAILA CITY. TO DETERMINE SOUND PRESSURE LEVEL AT GROUND LEVEL, 4 SOUND LEVEL METERS WERE PLACED INTO THE AREAS OF INTEREST. FOR THE SOUND PRESSURE LEVEL ANALYSIS 4 SOUND LEVEL METERS WERE PLACED IN THE NEARBY BLOCKS, INSIDE THE EXPOSED APARTMENTS, BETWEEN THE FIRST AND FOURTH FLOOR. OBSERVE THAT MAXIMUM SOUND PRESSURE LEVEL IS OBTAINED FOR ALL FREQUENCIES OF THE ANALYSED THIRD OCTAVE, THUS: FOR 63Hz FREQUENCY THE MAXIMUM SOUND PRESSURE LEVEL IS 99,9dB, FOR 125Hz, 119dB, AND FOR 250Hz, 108,3dB. THE EVALUATION OF NOISE IMPACT ON THE ENVIRONMENT IS IMPORTANT BOTH FOR DEVELOPERS AND AUTHORITIES. THE EVALUATION OF NOISE CAUSED BY TRAFFIC IS NECESSARY FOR EVALUATING AMBIENTAL AND RESIDUAL NOISE, AND ALSO FOR DESIGNING PROTECTION SOLUTIONS FOR RESIDENTIAL AREAS IN THE VICINITY.

KEY WORDS: NOISE, TRAFFIC, SOUND PRESSURE LEVEL

INTRODUCTION

The noise caused by traffic is one of the most persistent health problems in Europe. The effects that exposure to noise has on health represent an increasingly public health problem. Half of the European population lives in a noisy environment. A third of the population of this region is disturbed by the sound levels during sleep time [2], [4-5]. The effects of noise on human are based on its intensity and duration. To evaluate in which mode noise disturbs human activity, the following factors should be took into consideration: unexpected and/or intermittent noise disturbs more than continuous noise; noises with a spectrum rich in high frequencies disturb more than low frequency ones; activities based on attention are disturbed more than other; sensitivity to noise is higher in training activities than in routine work [1], [6].

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In order of occurrence, the first effects are on a psychological level (distraction, decrease of performance in tasks that use short term memory), vegetative (raising heart rate), auditory suffering and difficulties in movement coordination (Fig. 1). Noise pollution has been neglected so far, although it has a significant impact upon society, affecting human health [3].

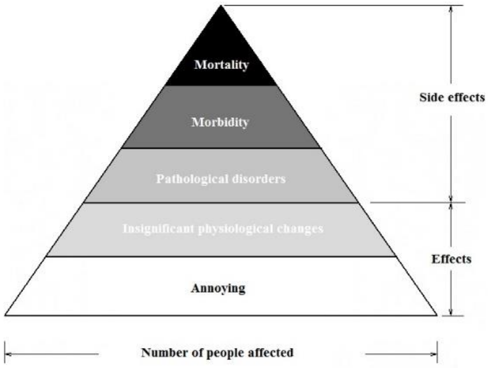

Fig. 1 Noise effects upon human health

EQUIPMENT USED IN EXPERIMENTS

Blue Solo sound level meters (Fig. 2) were used upon determining the level of noise caused by traffic in the analyzed area. The sound level meters are part of the "Interdisciplinary Laboratory for Vibro-Acoustical Measurements in the Occupational Environment" of University "Dunarea de Jos" Galati, completed through the "National Plan for Research, Development and Innovation 2007-2013", Capacities Programme. Measurements were taken during the fall of 2013.

Fig. 2 Blue Solo sound level meter

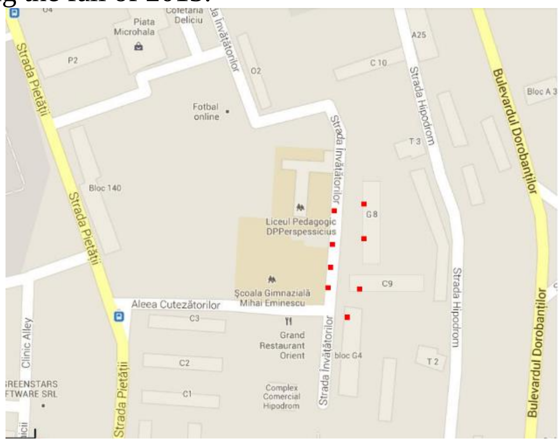

Fig. 3 Sound level meters positioning (■)

SOUND LEVEL MEASUREMENTS LOCATION

Upon accurately measuring sound pressure level, sound level meters were placed in different locations at ground level and in apartments exposed directly to noise pollution (Fig. 3). The locations are determined based on the purpose of measuring and the nature of the acoustic field, thus [7-10]:

For determining if noise pollution is within exposure limits inside apartments, sound pressure levels are measured in a point situated near the subject's ear, regardless of the acoustic field nature. Acoustical measurements for determining sound pressure level in adjoining rooms are taken in at least 5 points inside the room and afterwards an average of the values is made upon determining technical solutions for noise reduction. The maximum distance between two measuring points is 15m and the maximum distance between one point and the wall next to the noise source is 5 m. Every time acoustical measurements are taken, the minimum distance between the walls, the person that takes the measurement and the microphone must be at least 0.5m and at 1.3m from the floor.

ACOUSTIC PRESSURE LEVEL DETERMINATION FOR MULTIPLE SOUND SOURCES

This calculation is based on [7-10].

Phase 1: Average acoustic pressure level on contour measurement is calculated:

$$\overline{L}_p = 10\lg\left[\frac{1}{N}\sum_{i=1}^{N}10^{0.1L_{pi}}\right][\mathrm{dB}] \qquad (1)$$

where $\overline{L}_p$ is the acoustic pressure level in octave band, averaged on contour measurement, and L_{pi} is the acoustic pressure level in octave band, at i position on contour measurement.

Phase 2: If a value of L_{pi} exceeds $\overline{L}_p$ average with more than 5 dB, another contour measurement is picked at a larger distance from the equipment. If this is not possible, all of L_{pi} values that exceed $\overline{L}_p$ average with more than 5 dB, are replaced with $L_{pi}^a = \overline{L}_p + 5dB$.

Phase 3: A secondary corrected acoustic pressure level is calculated on contour measurement $\overline{L}^*_p$, for every octave band, with the following formula:

$$\overline{L}^*_p = 10\lg\left[\frac{1}{N}\sum_{i=1}^{N}10^{0.1L^*_{pi}}\right][dB] \qquad (2)$$

where L^*_{pi} is the acoustic pressure level in octave bands at position i.

Phase 4: A surface term is calculated, ΔL_S [dB], for surface measurement (S_m), with the following formula:

$$\Delta L_M = 10\lg(2S_m + hl)/S_0 \ [dB] \qquad (3)$$

where S_0 is a reference surface equal $1m^2$.

Phase 5: A correction term is calculated for near field, ΔL_F with:

$$\Delta L_F = \lg\frac{\overline{d}}{\sqrt[4]{S_p}} \ [dB] \qquad (4)$$

where S_p is the surface of the sound source [m^2].

Phase 6: A microphone correction term is calculated, ΔL_M [dB], with:

$$\Delta L_M = 3\left(1 - \frac{\theta}{90}\right)[dB] \qquad (5)$$

where ΔL_M=0dB for an omnidirectional microphone.

Phase 7: An acoustic attenuation coefficient is calculated (because of the atmospheric absorption), ΔL_α [dB], with:

$$\Delta L_\alpha = 0{,}5\alpha\sqrt{S_m} \ [dB] \qquad (6)$$

Typical values for α are presented in Table 4.1.

Table 1 L_p decrease at free propagation caused by air absorption

Central frequencies of octave bands [Hz]	31	63	125	250	500	1000	2000	4000	8000
α [dB/m]	0	0	0	0,001	0,002	0,005	0,010	0,026	0,046

The values for every octave band shown in Table 1 are available at a temperature of 15ºC and an average relative humidity of 70%. In case atmospheric conditions are much different than the specified ones, use the corresponding values of air absorption for temperature and relative humidity from the moment of noise measurement.

Phase 8: The sound power level in octave bands is calculated, L_W, [dB] with:

$$L_W = \overline{L}_p + \Delta L_S + \Delta L_F + \Delta L_M + \Delta L_\alpha \qquad [dB] \qquad (7)$$

If phases 2 and 3 are used, $\overline{L}_p$ is replaced with cu $\overline{L}^*_p$.

Phase 9: If necessary, the A weighted sound power level is calculated, L_{WA} [dB] with:

$$L_{WA} = 10\lg\left[\sum_{j=1}^{N} 10^{0.1(L_W + C_j)}\right][dB] \qquad (8)$$

where C_j is the A weighting correction for j octave band. The sum is calculated on corresponding octave bands.

NOISE ANALYSIS BASED ON FREQUENCY ON GROUND LEVEL

Noise analysis based on frequency, in each case, between 7:45 and 8:00 AM on 22 October 2013, are shown in Fig. 4-7. The minimum indicator was placed at 16 Hz, while the maximum one was placed at 125 Hz.

Observe from Fig. 4 (Invatatorilor Alley and Cutezatorilor Alley – “M. Eminescu” School) that at 16 Hz frequency the sound pressure level is 61,9 dB (recorded minimum), and at 125 Hz the sound pressure level is 102,9 dB. The recorded maximum is 108,3 dB at 250 Hz. Fig. 5 (in the middle of the parking lot on Cutezatorilor Alley) shows that at 16 Hz frequency the sound pressure level is 57,9 dB (recorded minimum), and at 125 Hz the sound pressure level is 119,0 dB (recorded maximum). Fig. 6 (in front of block G8 on Invatatorilor Alley) shows that at 16 Hz frequency the sound pressure level is 71,6 dB and at 125 Hz the sound pressure level is 91,9 dB. The recorded minimum is 64,5 dB at 8 kHz frequency. The recorded maximum is 99,9 dB at 63 Hz frequency. Fig. 7 (in the middle of the parking lot on Invatatorilor Alley – “D.P. Perpessicius” high school) shows that at 16 Hz frequency the sound pressure level is 62,8 dB (recorded minimum), and at 125 Hz the sound pressure level is 98,6 dB. The recorded maximum is 99,3 dB at 250 Hz frequency.

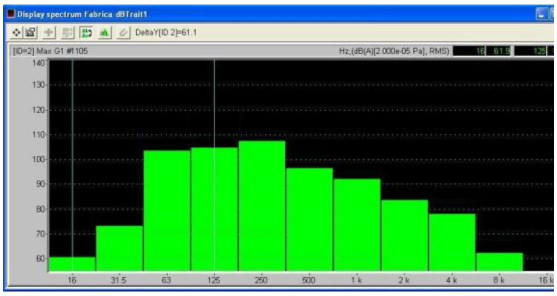

Fig. 4 Noise evaluation at Invatatorilor Alley and Cutezatorilor Alley between 7:45 and 8:00 AM (22 Oct 2012)

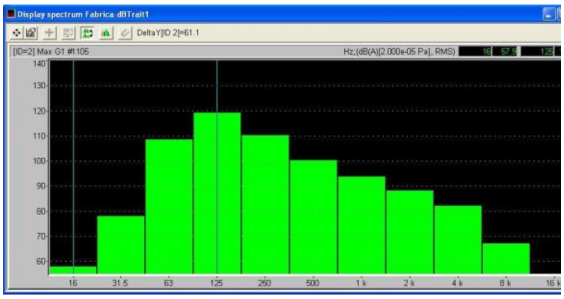

Fig. 5 Noise evaluation in the middle of the parking lot on Invatatorilor Alley (“M. Eminescu” school) between 7:45 and 8:00 AM (22 Oct 2012)

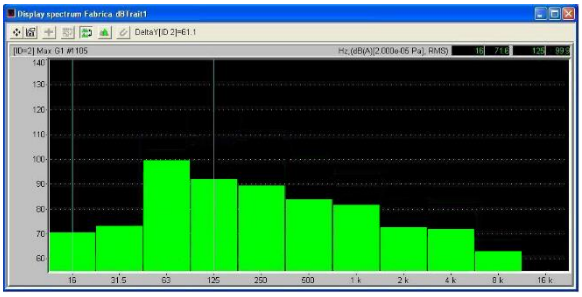

Fig. 6 Noise evaluation in front of block G8 on Invatatorilor Alley between 7:45 and 8:00 AM (22 Oct 2012)

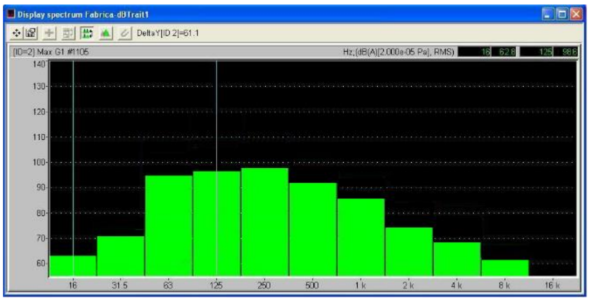

Fig. 7 Noise evaluation in the middle of the parking lot on Invatatorilor Alley („D. P. Perspessicius” high school) between 7:45 and 8:00 AM (22 Oct 2012)

Noise analysis based on frequency, in each case, between 7:45 and 8:00 AM on 12 August 2013, are shown in Fig. 8-11. The minimum indicator was placed at 16 Hz, while the maximum one was placed at 125 Hz. Observe from Fig. 8 (Invatatorilor Alley and Cutezatorilor Alley – “M. Eminescu” School) that at 16 Hz frequency the sound pressure level is 24,8 dB and at 125 Hz the sound pressure level is 44,8 dB. The recorded minimum is 22,1 dB at 8 kHz frequency and the maximum is 46,3 dB at 250 Hz. Fig. 9 (in the middle of the parking lot on Cutezatorilor Alley) shows that at 16 Hz frequency the sound pressure level is 22,6 dB (recorded minimum), and at 125 Hz the sound pressure level is 33,5 dB. The recorded maximum is 44,2 dB at 63 Hz. Fig. 10 (in front of block G8 on Invatatorilor Alley) shows that at 16 Hz frequency the sound pressure level is 28,6 dB and at 125 Hz the sound pressure level is 41,9 dB. The recorded minimum is 21,4 dB at 8 kHz frequency. The recorded maximum is 45,6 dB at 250 Hz frequency. Fig. 7 (in the middle of the parking lot on Invatatorilor Alley – "D.P. Perpessicius" high school) shows that at 16 Hz frequency the sound pressure level is 31,6 dB and at 125 Hz the sound pressure level is 42,9 dB (recorded maximum). The recorded minimum is 25,3 dB at 8 kHz.

Fig. 8 Noise evaluation at Invatatorilor Alley and Cutezatorilor Alley between 7:45 and 8:00 AM (12 August 2013)

Fig. 9 Noise evaluation in the middle of the parking lot on Invatatorilor Alley ("M. Eminescu" school) between 7:45 and 8:00 AM (12 August 2013)

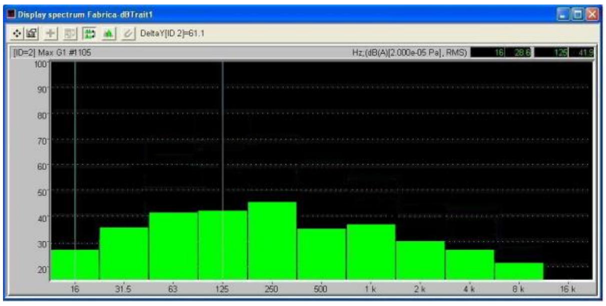

Fig. 10 Noise evaluation in front of block G8 on Invatatorilor Alley between 7:45 and 8:00 AM (12 August 2013)

Fig. 11 Noise evaluation in the middle of the parking lot on Invatatorilor Alley („D. P. Perspessicius" high school) between 7:45 and 8:00 AM (12 august 2013)

Fig. 12-14 show the variation in time of sound pressure level between 10:45 and 12:00 AM on 22 November 2013.

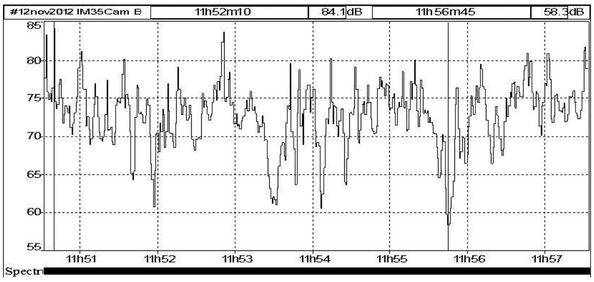

Fig. 12 Variation in time of sound pressure level between 10:45 and 12:00 AM for Invatatorilor Alley and Cutezatorilor Alley on 22 November 2013.

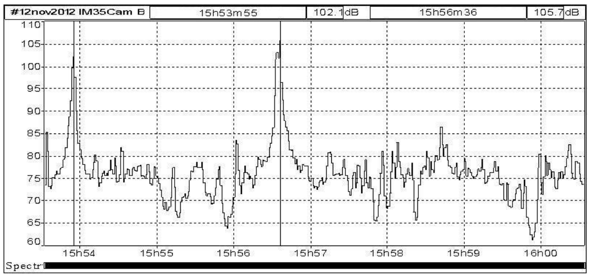

Fig. 13 Variation in time of sound pressure level between 15:45 and 17:00 for Invatatorilor Alley and Cutezatorilor Alley on 22 November 2013.

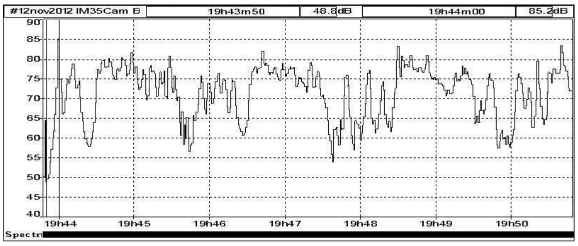

Fig. 14 Variation in time of sound pressure level between 19:45 and 20:00 for Invatatorilor Alley and Cutezatorilor Alley on 22 November 2013.

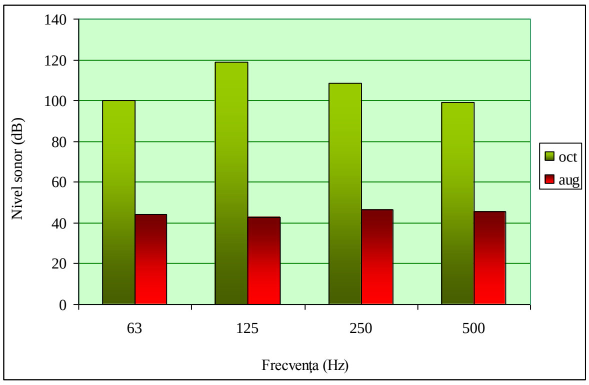

Fig. 15 Comparison between the averages of sound leve pressure maximums from October and August 2013

It is observed that maximums are obtained for all analyzed frequencies of the third octave:

Frequency (Hz)	Sound level maximum (dB)
63	99,9
125	119,0
250	108,3
	99,3

By comparing sound pressure level maximums from a school day (22 Oct. 2013) and holyday (12 Aug. 2013) (Fig. 15) it can be observed that holydays are more quiet than school days with 36%-46%.

CONCLUSION

In the fight against noise pollution, the European Union defines a common approach meant to avoid, prevent and reduce the effects of long term exposure to noise. This approach is based on common methods of noise exposure mapping through informing the population and by implementing action plans at local level. Also, the directive must stand as foundation for developing common measures regarding noise sources.

Evaluating the impact of noise upon the environment is important both for developers and authorities. Evaluating noise caused by traffic is necessary for:

- Evaluating ambiental and residual noise;
- Designing solutions for protecting residential areas in the vicinity.

The impact study is meant to evaluate the impact upon the environment of new projects and developing/decommissioning current ones.

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