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ASSESSMENT OF NOISE INDICATORS IN THE FACULTY OF ENGINEERING HUNEDOARA

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Abstract: The aim of the risk assessment is to help you decide what you need to do to ensure the health and safety of your employees who are exposed to noise. It is more than just taking measurements of noise - sometimes measurements may not even be necessary. Noise at work can cause hearing loss or damage that is permanent and disabling. Hearing loss can also be gradual through exposure to noise over time, which can lead to safety risks at work, putting people at risk of injury. This paper presents a study on noise assessment within the Faculty of Engineering Hunedoara. For the Faculty of Engineering Hunedoara, located along Republicii Avenue, the main source of noise is the road traffic. The noise assessment was done in accordance with the European and national legislation in force.
Keywords: Noise, noise pollution, Noise levels and indicators, Sound level and average sound level

1. INTRODUCTION

The noise is a sound vibration with a continuous spectrum, at least in a certain frequency band, that produces a subjective impression of inconvenience and discomfort for the subjects. The human ear is more sensitive to sound in the frequency range 1 kHz to 4 kHz than to sound at very low or high frequencies. This knowledge about the human ear is important in acoustic design and noise assessment.

There are endless sources of noise in the environment, from barely perceptible levels to "painful" sounds. The noise pollution is a component of environmental pollution produced by noises. The noise assessment is required because it can produce some negative effects on the ecosystem [1], in particular on the human health [2], [3], [4], i.e. hearing loss or impairment, cardiovascular problems, performance reduction, behavioural changes.

In the European Union, the Directive 49/2002 establishes a common basis for the assessment and control of environmental noise in the EU countries [5]. The national legislation in force can be found on the website of the Ministry of the Environment – the National Agency for Environmental Protection [6], [7].

2. NOISE LEVELS AND INDICATORS

— Sound level and average sound level

It is found experimentally that the sounds can only be heard when their intensity exceeds a certain value. The sound sensation is characterized by the so-called *level of sound intensity* which, according to Weber-Fechner experimental law [8], [9],[10], [11], is given by:

$$L_I = \lg\frac{I}{I_0} \tag{1}$$

where $I_0 = 10^{-12}\,\frac{W}{m^2}$ is the reference intensity. Although *L* is dimensionless, it has been agreed to be measured in certain units called *bels* (B). In practice, we use decibels dB = 10^{-1}B.

Therefore:

$$L_I(dB) = 10\lg\frac{I}{I_0} \tag{2}$$

Whereas $I = const\cdot p^2$, we can define the sound pressure level expressed in decibels, as follows:

$$L_p(dB) = 20\lg\frac{p}{p_0} \tag{3}$$

where *p* is the sound pressure of that sound, and $p_0=2\cdot10^{-5}$ Pa is the reference sound pressure.

The sound power level L_w, expressed in decibels, is given by:

$$L_w(dB) = 10\lg\frac{W}{W_0} \tag{4}$$

where *W* is the sound power of the source, and $W_0 = 10^{-12}$W is the reference sound power.

It can be seen that:

$$L_I = L_p = L_w = L \quad (5)$$

known, in short, as *sound level*.

When measuring the noise pollution level, we are not interested in the fact that several noise sources overlap at the same time, but in the mediation of sound intensities over a certain period of time. The sound level measurements are repeated at short intervals. A simple calculation can show that the average sound intensity can be expressed by:

$$\langle I \rangle = \frac{1}{N} \cdot I_0 \cdot \sum_{k=1}^{N} 10^{\frac{L_k}{10}} \quad (6)$$

where *N* is the number of measurements.

Then, the average sound level is calculated with the relation (2):

$$L_{average} = 10 \lg \frac{\langle I \rangle}{I_0} = 10 \cdot \lg \frac{\sum_{k=1}^{N} 10^{\frac{L_k}{10}}}{N} \quad (7)$$

— Noise indicators

The most used noise indicator is the day-evening-night noise indicator, L_{den}, defined by [5], [6], [7]:

$$L_{den}(dB) = 10 \lg \frac{1}{24} \left(12 \cdot 10^{\frac{L_{day}}{10}} + 4 \cdot 10^{\frac{L_{evening}+5}{10}} + 8 \cdot 10^{\frac{L_{night}+10}{10}} \right) \quad (8)$$

In the relation (8):

- L_{day} is the noise indicator for the day, and represents the weighted average sound level (A) when the reference time is the day, as defined in ISO 1996-2:1995 [7];
- $L_{evening}$ is the noise indicator for the evening, and represents the weighted average sound level (A) when the reference time is the evening, as defined in ISO 1996-2:1995 [7];
- L_{night} is the noise indicator for the night, and represents the weighted average sound level (A) when the reference time is the night, as defined in ISO 1996-2:1995 [7].

The noise indicator for day-evening-night, L_{den}, is the noise indicator generally associated with discomfort, the noise indicator for day, L_{day}, will mean the noise indicator for discomfort during the day, and the noise indicator for evening, $L_{evening}$, will mean the noise indicator for discomfort during the evening.

It is considered that the day has 12 hours, the evening has 4 hours and the night has 8 hours, for all the analysed sources of noise. The day reference interval is 7:00 AM – 7:00 PM, the evening reference interval is 7:00 PM – 11:00 PM, and the night reference interval is 11:00 PM – 7:00 AM.

The maximum allowed value for the L_{den} indicator is given in the legislation in force (Directive 2002/49/EC of the European Parliament and of the Council of 25 June 2002 relating to the assessment and management of environmental noise), [2], [3], [4]. Thus, the maximum value allowed for the L_{den} indicator at the most exposed façade of buildings is 55 dB(A).

3. MEASUREMENT, PROCESSING AND INTERPRETATION OF EXPERIMENTAL RESULTS

The most exposed façade of the Faculty of Engineering Hunedoara to the noise produced by road traffic is the “C” building façade. For 30 minutes, the indicators L_{day}, $L_{evening}$, and L_{night} will be measured every 2 minutes, in the appropriate time intervals, in front of the “C” building. Their averages will be then calculated, as well as the L_{den} noise indicator, and the results will be compared with the maximum allowed value stipulated by the legislation in force.

For the measurements related to this paper, we will use a Trotec BS06 sound level meter. The BS06 sound level meter can be used to measure the weighted sound level at various noise sources, in dB(A). The "A" curve is used in the standard determinations of acoustic pressure, which corresponds to the acoustic pressure relative to the human hearing, in other words the *compensated sound level*.

In order to determine the noise level on the façade of the building, we will choose a measuring point in close proximity to the “C” building, which meets the conditions stipulated by law [5], [6].

For each sample, a bar chart will show: the evolution of the values within the 30-minute interval, the minimum, maximum and average value of the sound level, the start time and the end time.

The sample no. 1 contains daytime measurements for the sound level on the façade of the “C” building (Figure 1).

- Minimum value: 51.6 dB(A); maximum value: 72.2 dB(A); average value: 65.54163 dB(A), calculated with the relation (7), in which it was considered (6):
- Start time: 12 PM; End time: 12:30 PM.

The sample no. 2 contains evening measurements for the sound level on the façade of the “C” building (Figure 2).

- Minimum value: 37.7 dB(A); maximum value: 71.4 dB(A); average value: 64.16929 dB(A)
- Start time: 7:30 PM; End time: 8:00 PM.

The sample no. 3 contains night measurements for the sound level on the façade of the "C" building – Figure 3.
- Minimum value: 17.7 dB(A); maximum value: 38.5 dB(A); average value: 30.74888 dB(A)
- Start time: 4 AM; End time: 4:30 AM.

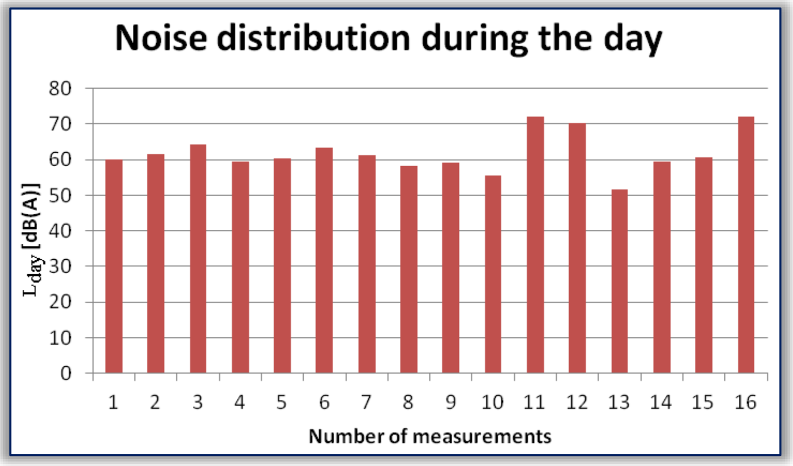

Figure 1. Daytime measurements for the sound level on the façade of the "C" building

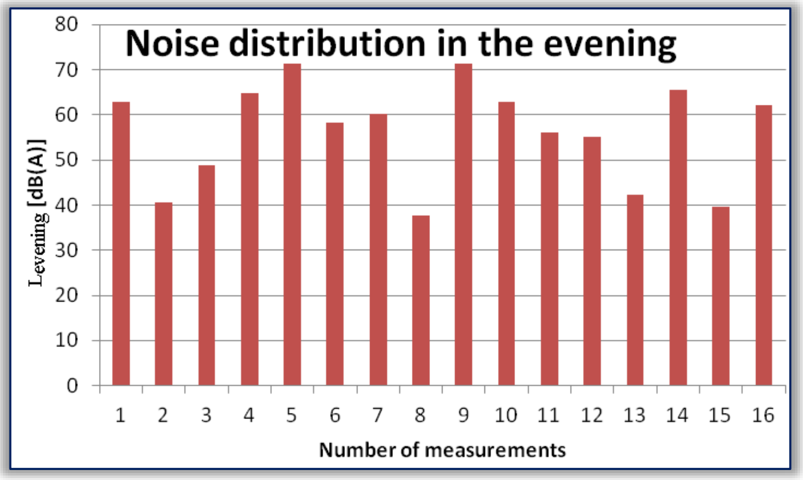

Figure 2 Evening measurements for the sound level on the façade of the "C" building

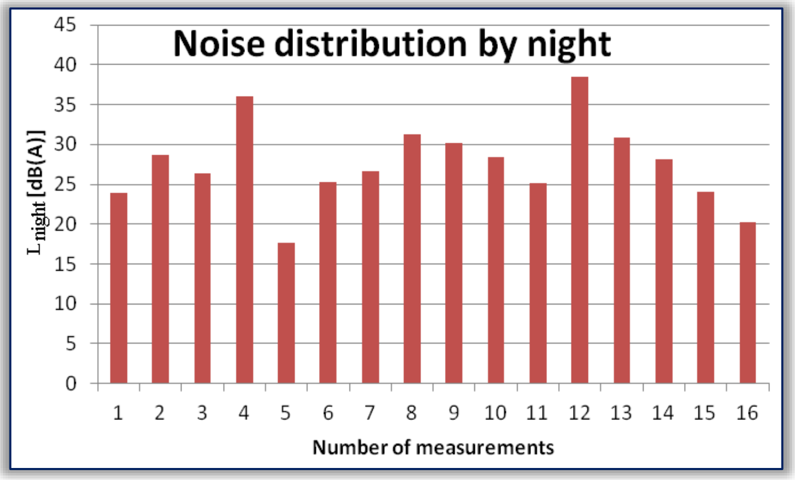

Figure 3. Night measurements for the sound level on the façade of the "C" building

Then, the L_{den} indicator is calculated with the relation (8). $L_{den} = 65.01281 dB(A)$. If this value is compared with the maximum allowed value on the most exposed façade of the buildings, i.e. 55 dB(A), we see that the value is exceeded by about 10 dB. These results require finding effective solutions to reduce the noise.

4. CONCLUSIONS

According to the study conducted and presented in this paper, for the "C" building of the Faculty of Engineering Hunedoara, certain noise reduction measures would be required: from soundproofing of the street side walls to banning the traffic of higher tonnage vehicles on this street [12], [13]. Very welcome would be the traffic restrictions within certain time intervals when the courses are held in the faculty [12], [13].

A recent study shows that in the countries of the European Union [14] about 40% of the population is exposed to traffic noise, having a sound pressure level equivalent to 55 dB(A) during the day, and 20% are exposed to levels exceeding 65 dB(A). More than 30% are exposed during the night to sound pressure levels exceeding 55 dB(A), which disturb their sleep. Also, the noise is a serious problem in the cities of the developing countries [15], being especially generated by traffic. In these cases, the sound pressure levels can reach up to 75-80 dB(A).

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