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Determination of Noise Exposure Values at Three Different Offices in Artvin/Turkey

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Abstract— *Noise is defined as unpleasant, unwanted, uncomfortable sound. One of the important factors, that affect the quality of the environment we live in and the human health, is the noise. The noise from daily activities can also cause intense complaints and severe physical and mental disturbances, especially hearing loss and sleep disturbances, as well as learning difficulties and distractions. Industrial and industrial areas are strictly inspected with the values specified in the regulation. However, working environments such as offices generally do not require any control because they have lower noise than limit values. However, this does not change the fact that office workers are exposed to noise. Especially when more than one employee shares the same office environment, employees mask their noises by listening to music with their headphones. Although this masking may seem effective against subjective noise, it directly affects employees' ear health negatively. In this study, noise measurements were made in three different office environments (three and one person) in Artvin Çoruh University and effects on employees were examined.*

Keywords— *Employee, health, measurement, noise, office.*

I. INTRODUCTION

The sound is an indispensable part of life for all humanity and directs humanity from its early ages [1]. The sound is defined in two aspects; namely, physically and physiologically. Physically sound; a source that makes periodic vibrations in a flexible environment causes changes in the equilibrium pressure of the medium and transmits these pressure changes to the far points of the medium with a constant speed and a certain phase difference. While physiologically, it is a perception resulting from the pressure changes that are transmitted to the brain with the communication mechanism in the ear [2]. The lowest pressure change that a healthy young human ear can perceive is 2x10-5 Pascal (Pa) or 0 decibels (dB) [3].

Noise, on the other hand, is a different kind of voice and it has begun to be seen as a social problem after the industrial revolution. However, this problem has begun to be studied in acoustics in the past century. Noise is a complicated, generally high-volume ensemble of sounds that are physically random and do not have compatible tonal components. Noise is generally defined as high level, unpleasant, undesirable sound. In order that noise has emerged in the urbanization process due to transportation and the development of the industry, it can be considered as a kind of technology boost [4]. The noise, which is seen as a problem of urban and developed countries, is also present in every environment inhabited by people and in developing countries [5].

The undesirable and unwanted state of the affliction of noise can vary from person to person due to the different influences of people's psychology, nervous system, and performance. However, the effect, which usually does not differ is the effect on hearing. There are two types of noise exposure, those directly related to the noise source and those using the environment in which the noise source is located or indirectly related to it. In the first group, the influence of noise is higher, however, the influence in the second group is more common and the number of affected people is higher [6].

Noise effects are examined in four groups including; physical (temporary or permanent hearing damage), physiological (changes in body activity, blood pressure increase, circulatory disturbances, acceleration in breathing, acceleration in heartbeat, sudden reflexes, sleep disturbance), psychological (behavioral disorders, anger, fainting, general discomfort emotion) and performance (decrease in work efficiency, impairment of concentration, inhibition of movements). The noise levels were tried to be graded by the researchers, depending on the negative effects they created. The information prepared according to this is given in Table I [6].

TABLE I. Noise levels and effects.

Degree	L (dB)	Felt discomfort
1. Degree	30-65	Incommodity, discomfort, anger, huffiness, concentration and sleep disturbance
2. Degree	65-90	Physiological responses, blood pressure increase, acceleration in heartbeat and breathing decreased pressure in the brain fluid, sudden reflexes
3. Degree	90-120	Increased physiological reactions, headaches
4. Degree	>120	Constant damage to the inner ear and impaired balance
5. Degree	>140	Serious brain damage

It is thought that the people who say they are not disturbed by noise in society are getting used to noise. Adapting to noise, slowing down in terms of reactions due to personal differences, among the noise types which kind is possible to accept, and the level of adaptation, if any, depending on past experience are scientifically debated issues. According to many experts, adaptation to noise is not really correct, and

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biological effects and changes cannot be prevented even if it is thought to be accustomed [6].

In the measurements, A-weighted sound pressure levels (dB(A)) are generally used, which are related to the frequencies to which the human ear is susceptible. The effect of noise on the human being is dependent on the duration of exposure to noise as well as the sound intensity of the source. For this reason, the equivalent voice level expression (L_{eq}) is used. Equivalent sound level indicates the average value of the sound pressure level that lasts for a given period [7].

The aim of this study is to measure noise levels in different interiors in Artvin Çoruh University's City and Seyitler Campuses and to reveal possible contagions of those working in these areas.

II. Material and Method

A. Noise Level Measurements

The measurements were made taking into account the ISO 1996-1 and ISO 1996-2 standards and their requirements. The wind speed effect, which is a very important parameter in environmental noise measurements, has been neglected since the measurements are carried out indoors. All measurements were made on a tripod and on the unrestricted areas where the dimensions of the areas were identified by measuring with a laser meter. A calibrator was used before and after the measurement. Noise measurements were made with CESVA SC310 brand Type I device, which is calibration and certification are newly made.

B. Identification of Measurement Locations

Three different locations were chosen for the study. By taking the required permissions from the university, an office where three people work together, another office where one person works, and another office where again only one person works with a larger volume are selected. The first two offices are located on the city campus of the university, while the other office is located on the Seyitler campus, which is further away from the city and traffic.

Fig. 1. Seyitler Campus settlement plan and the building that the office is in [8].

The Seyitler Campus is about 10 km away from the city center and is relatively in a quiet location in terms of both the vehicle and the human population (Fig. 1). The campus is officially located within the village boundaries in the current situation. In this campus, there are Faculty of Forestry, Faculty of Engineering, Faculty of Science and Letters, Rectorate Building, lodgings, cafeteria, social facilities, dormitories and various laboratory buildings. The red arrows indicate the offices at buildings.

Whereas the second settlement, the City Campus, is parallel to the highway of Erzurum-Artvin D010 and the Çoruh River and is located in a more densely populated area than both vehicle and the human population. As for in this settlement, there are Faculty of Health Sciences, Faculty of Educational Sciences, Artvin Vocational School, Health Services Vocational School, library, social equipment and congress and cultural center. There is also a riverside hiking trail, which is open to everyone during working hours (Fig. 2).

Fig. 2. City Campus settlement plan and the building that the offices are in [8].

III. Results

The L_{eq} value is used to minimize the temporal error between noise measurements made at different times. L_{eq} values for all measurements are calculated according to Equation 1 and Equation 2 [9].

$$L_{eq} = 10\log_{10}\frac{1}{T_M}\int_0^{T_M}\left(\frac{P_A(t)}{P_0}\right)^2 dt \qquad \text{Eq. 1}$$

$$\text{Total } L_{eq} = 10\log\left(\frac{10^{\frac{L_{eq1}}{10}} + 10^{\frac{L_{eq2}}{10}} + 10^{\frac{L_{eq3}}{10}} + \ldots + 10^{\frac{L_{eqn}}{10}}}{n}\right) \qquad \text{Eq. 2}$$

The noise measurement, area and volume values at three different locations are given in Table II.

TABLE II. Obtained averages of measured values.

Location	L_{eq} (dBA)	Area (m^2)	Volume (m^3)
Three-person office (City Campus)	58.18	45.6	162.8
Single-person office (City Campus)	32.80	12	30.68
Single-person office (Seyitler Campus)	47.33	20.99	69.90

The three-person office is closer to the D010 highway than the office at City Campus and has a glass roadside frontage. The office is a student affairs office and is used extensively. Amongst the offices that measurements are taken, this office, that has the biggest area and volume, and other offices have

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the same ceiling covering materials. However, while the floor covering in the offices at City Campus is laminated flooring, the floor covering at Seyitler Campus is ceramic. In the single-person City Campus office measurement, the employee had stayed in the office but door knockings or telephone calls did not occur. The given values are obtained only from the working conditions at the computer. Yet, in the single-person office at Seyitler Campus within the measurement period, the phone rang once and a short speech in normal tone was performed. The daily ordinary working conditions of the named offices are examined in this way.

According to the results, it is seen that there is a considerable difference in noise levels as ΔL_{eq} 25.38 dB(A), between the values of three-person office and single-person office. Since the dB is evaluated logarithmically, 6 dB difference fundamentally shows a 100% of increase. When the obtained values are considered from this point of view, the size of the difference is much clearer. Since there were no human voice or telephone ringing occurred during the measurement of single-person office on the City campus, obtained results are much less when compared to the Seyitler campus.

The statistical distributions of the noise level measurement data made in three different offices are given in Table III. L99 shows the noise level at 99% of the measurement time, but can also be regarded as background noise when the background measurements cannot be performed properly.

TABLE III. Statistical distributions of measurement data of the settlements.

Three person office -City Campus (dBA)						
L1	L5	L10	L50	L90	L95	L99
68.4	64	62.1	53.1	43.6	41.5	39.5
Single person office -City Campus (dBA)						
L1	L5	L10	L50	L90	L95	L99
42.4	37.6	34.8	29.1	27.3	26.9	26.3
Single person office -Seyitler Campus (dBA)						
L1	L5	L10	L50	L90	L95	L99
58.6	43.9	34.8	28.1	25.2	24.8	24.4

If the statistical data in Table III are to be examined, while 99% of the measurement time of the three-person office on the city campus is 39.5 dB(A), this value in single-person office in the same campus and in the same building is measured as 26.3 dB(A). In the single-person office on Seyitler campus, however, a value of 24.4 dB(A) is obtained. When slices of 1% are examined, values of 68.4, 42.4 and 58.6 dB(A) are determined, respectively.

IV. DISCUSSION

Considering the results of statistics with 99%, that can be used as a background noise, the office with the least noise is considered as the office in which one person works, in Seyitler Campus. Although this single-person office is covered with ceramic, which is more reflective than the others, one of the main reasons why it is the least noised office is the campus is far from city noise and roads. The intensive use of the office for 3 people, the frontage of the windows are looking to the D010 highway and made with totally glass are the factors that increase the noise. When single-person offices are compared, it is seen that the average value increases in Seyitler Campus' office, which is larger in terms volume, when activities such as telephone interview or speech done, and it affects the values of L1 and L5. L10 and L50 levels are very similar in single-person offices.

In a study done in the United Kingdom, the quiet office environment was defined as 40-50 dB (A) [10]. The measured value in the 3-person office environment in this study shows a non-silent working environment with L_{eq} 58.18 dB(A).

In the Noise Regulation that became effective after being published in the Official Gazette No. 28721 dated 28 July 2013 the exposure action and the exposure limit values for workers are shown. These regulations in Turkey are compatible with European Union law. According to that, the lowest exposure action value is 80 dB(A). Also, the highest exposure action value is determined as 85 dB(A) and the exposure limit value as 87 dB(A). In addition, the weekly noise exposure level should not exceed 87 dB(A) [11]. Office environments are generally known to be much quieter than the industry sector, and therefore detailed noise measurements are not made, particularly in small offices. Employees in the industrial sector are protected by different methods, such as replacing noise sources with quieter ones, environmental isolation and Personal Protective Equipment (PPE). Although the level of noise measured in office workers is much lower than the legal limit, workers prefer to listen to music with a headset to protect themselves from noise which.is a subjective concept. Within the scope of this study, when the employees are asked verbally for their reasons, they have expressed that, they are cleared of the external noises and concentrate more easily on their works.

V. CONCLUSION

In this study which is made in Artvin Province for the first time, it has been determined that the environmental conditions in which the buildings are located and its front can affect the noise level in the offices, and that the noise level increased significantly with the human activity and that the amount of noise is directly proportional to the human.

As a result, to add appropriate sound insulation to the buildings that will be constructed in noisy places, to add sound insulation if necessary in the existing buildings, to change of continuous working and sound producing devices such as air conditioner and computer with more modern and quiet ones, and to make regular maintenance and repair, will help the employees to work in quieter environments and at higher concentrations. On the condition that quieter office environments cannot be provided, employees are listening to music with their headphones to mask the noise coming to them, which can lead to a hearing loss in the long term.

Performing more detailed measurements such as 1/3 octave band analysis will increase the success in precautions against noise. Moreover, ceiling and floor coverings must be selected appropriately for the work being done. The recessed placement of books and/or files in offices will help spread the voice more appropriately. Applying the questionnaire to the

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employees by taking the necessary permissions will add the employee factor to the noise measurements. In this regard, not only lean digital noise measurement values, but also employees' wishes, desires and evaluations will help in the process of taking precautions. Such studies can be applied to all sectors.

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