Scientific Papers. Series E. Land Reclamation, Earth Observation & Surveying, Environmental Engineering. Vol. XIV, 2025
Print ISSN 2285-6064, CD-ROM ISSN 2285-6072, Online ISSN 2393-5138, ISSN-L 2285-6064

STUDIES AND MEASUREMENTS FOR THE IDENTIFICATION OF NOISE AND VIBRATION LEVELS IN A SITE IN BUCHAREST - CASE STUDY

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Abstract

Specific studies and research are necessary to find out the existing noise and vibrations coming from various zonal sources, in an urban area where a new building will be placed. Depending on the activity that will be carried out in the new building, it is necessary to obtain certain maximum values of the noise and vibration levels, inside the building, so that the psychoacoustic comfort of the inhabitants can be achieved during the period of use of the building. As part of a research contract, carried out by INCD URBAN INCERC, INCERC Bucharest Branch, for a client who wanted to build a new residential building for his family, on-site experiments were carried out at the client`s land located in Bucharest. The results of the acoustic measurements, the values of the noise levels, are presented in the article numerical and in graphic forms in the frequency range 12.5...20000 Hz. For vibrations the recordings are presented in the form of time-histories for accelerations and velocities, as well as Fourier spectra and response spectra.

Key words: *acoustics, vibrations, civil buildings, urban polluting sources.*

INTRODUCTION

The placement of a new building in an urban area requires specific studies and investigations to assess the existing levels of noise and vibrations at the site, originating from various local pollution sources (Zaharia, 2020). Depending on the intended use of the building, certain maximum permissible levels of noise and vibration must be established to ensure the psychoacoustic comfort of occupants throughout the building's operational lifespan (C125:2013).

The assessment of noise and vibration levels generated by metro networks at surface locations (or at specific elevations above ground) is a relevant issue in urban environments, where the propagation and potential attenuation or amplification of such disturbances may influence both the structural integrity of buildings and the acoustic comfort of their occupants (Mouzakis et al., 2019; Bratu et al., 2023; 2024).

To assess this impact, acoustic and vibration measurements were conducted during a preliminary phase of a real estate development project involving the construction of a G+2F residential building without a basement, situated within the metro’s minimum safety zone.

The research aimed to determine the noise levels generated by two categories of noise and vibration sources:

1) surface-level sources, including street traffic and human activity;
2) underground sources, specifically metro traffic, with the tunnel running beneath the measurement site.

The location of the land on which the measurements were conducted is shown in Figure 1. At the time of the measurements, the site was devoid of any constructions. The surrounding urban area predominantly comprises civil buildings, including both residential and office structures. Directly opposite the site, across the street, there is a building designated as a kindergarten.

Consequently, during the acoustic measurements, the sources of ambient noise included street-level human activities; road traffic from both nearby and more distant streets; air traffic, with noise levels enhanced by reflection from the cloud cover; bird songs from the trees adjacent to the site; and activities from a construction site located within the area, at an approximate distance of 50-70 m from the measurement location.

Figure 1. Land positioning in the urban area and positioning of measurement points P1 and P2

The acoustic measurements were conducted simultaneously at two distinct points, positioned as illustrated in Figures 2a and 2b, as follows:

a) the first measurement point, P1, to determine the noise level coming from underground noise sources – the metro, was placed in a pit with approximate dimensions of: length L=1.60 m, width l=1.10 m and depth H=1.35 m, at a height of 0.15 m from the bottom of the pit (microphone 1 placed at Measurement Point 1); this positioning of the microphone was done in order to simulate the position of the microphone at the base of the foundation of the future building and to be able to select the noise produced by the metro traffic at this level as relevant as possible.

b) the second measurement point, P2, to determine the noise level from surface noise sources, was located above ground level, at a height of h=1.30 m, (microphone 2 located at P2); this positioning of the microphone was done in order to simulate the microphone position two meters from the main facade of the future building and to be able to select the most relevant noise produced by surface sources at this level.

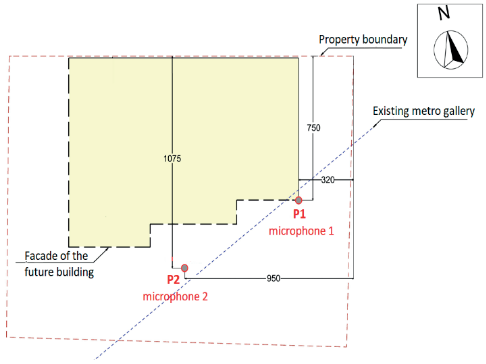


Figure 2a. Positioning of the measurement points, P1 and P2, on the site located in District 1 - Bucharest

Figure 2b. Positioning of the measurement point P1

To determine vibration levels, non-seismic sequential measurements were performed using four GMSPlus multichannel stations (GeoSIG), each comprising three data channels and internal triaxial transducers (model AC73i).
Vibration monitoring was carried out in distinct stages and at various locations, both during daytime and nighttime, under a range of conditions - from low-background noise environments to periods of active metro traffic - with time intervals of 10, 5, and 3 minutes between successive train passings. Stations ST02, ST03, and ST04 were installed at ground level, whereas station ST01M was positioned within an excavated pit at a depth of 1.35 m, as shown in Figure 3.

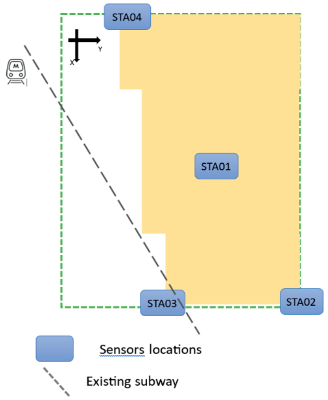


Figure 3. Location of GMSPlus digital stations/accelerometers (longitudinal direction - OY axis; transverse direction - OX axis)

MATERIALS AND METHODS

The in-situ acoustic measurement method used was provided for in the laboratory's acoustic procedure and in the legislation in force at the time the measurements were made, namely PTE– AC/03.02 and the measurement standards SR 6161-3:1982, SR 6161-1:2008, SR 6161-1/C91:2009 correlated with SR ISO 1996-2:2018 and with STAS 6156-86.

The following parameters were determined:

- L_{Aeq} - equivalent noise level (weighted average of noise levels recorded in a given time interval), recorded at the measurement point, in dB(A);
- L_{AF90} - background noise level, (exceeded in 90% of the measurement time), in dB(A);
- L_{AF10} - peak noise level, (exceeded in 10% of the measurement time), in dB(A).

“L_{Aeq}” corresponds to the notation “L_{ech}” in SR 6161-1:2008 and to the notation “L_{eqT}” in SR ISO 1996-2:2018; “L_{AF90}” and “L_{AF10}” correspond to the notation “$L_{N,T}$” in SR ISO 1996-2:2018.

The measurement situations were established in agreement with the future owner of the house and were determined in a such way as to be useful for the acoustic design of the future residential building.

For the noise measurements, two measurement points were established, to carry out effective acoustic measurements that could determine both the noise level coming from surface noise sources and the noise level coming from underground noise sources, namely the metro.

The determination of the equivalent noise level was carried out simultaneously at the two measurement points, P1 and P2.

The first measurement point, P1, was located on the ground in the area where the future building would be located with the facade and the corner of the building that could be most affected by the noise produced by the metro; In P1, the microphone was placed in a pit, with approximate dimensions of: length L=1.50 m, width l=1.50 m and depth H=1.35 m, at a height of 0.15 m from the bottom of the pit (microphone 1 placed at Measurement Point 1), arranged according to Figure 1, Figure 2a, Figure 2b and Figure 4. This positioning of the microphone was done to simulate the position of the microphone at the base of the foundation of the future building and to be able to detect the noise produced by the metro traffic at this level as relevant as possible.

Figure 4a. Positioning of measurement points P1 and P2

The second measurement point, P2, was placed on the ground above ground level, at a height of h=1.30 m, (microphone 2 placed at Measurement Point 2), arranged according to Figures 4a and 4b; this positioning of the microphone was done to simulate the microphone position two meters from the main facade of the future building and to be able to select the noise produced by surface sources at this level as relevant as possible.

The *in situ* acoustic measurements, implicitly the recordings of the equivalent noise level "L_{Aeq}", in dB(A), were carried out at night and during the day, on one day in April 2019, as follows: starting with the night time period (23:00-07:00) in the time interval 04:51-07:00, continuing in the day time period (07:00- 23:00) in the time interval 07:00-08:35, according to the technical regulations in force at that date, respectively: STAS 6161-3:1982 "Acoustics in constructions. Measurement of noise levels in urban localities. Measurement methods", SR 6161-1:2008 "Acoustics in constructions. Measurement of noise levels in civil constructions. Measurement methods", SR 6161-1/C91:2009) and SR ISO 1996-2:2018 "Acoustics. Description, measurement and evaluation of ambient noise. Part 2: Determination of ambient noise levels", correlated with STAS 6156-86 "Acoustics in buildings. Protection against noise in civil and socio-cultural buildings. Admissible limits and acoustic insulation parameters".

Figure 4b. Positioning of measurement point P2

Considering the above, the sampling of the measurement intervals was done by choosing time periods of max. approx. 20, 15, 10, 5 and 1 minutes, depending on the measurement situation. It is mentioned that the measurement time intervals, specific for P1 and those for P2, do not overlap 100%, due to the slightly different stop-start times of the two sound level meters used for the recordings.

The following devices were used to measure and record the equivalent noise level:

- Sound calibrator Bruel & Kjaer type 4231 - 94 dB (+/- 0.2 dB), series 2671272;
- Real-time noise level analyzer, (Sound level meter), Bruel & Kjaer type 2250, series: 2559226;
- Real-time noise level analyzer, (Sound level meter), Bruel & Kjaer type 2250, series: 3010381;
- Thermo hygro barometer TESTO 622, series 39515263.

During the recording of noise levels, the outdoor temperature was between 9.9 and 10.3°C and the humidity between 83 and 87%. In this regard, it is mentioned that the day of the measurements was a cloudy day, with a compact cloud ceiling and with temporary light drizzle conditions.

During the acoustic measurements and recordings, a plywood was installed over the space in the pit where the measurement point P1 was positioned, as shown in Figure 5 and Figure 6, to create an *acoustic shadow* against the noise coming from surface sources.

Figure 5. Position of a plywood which was installed over the space measurement point P1, in day time

Figure 6. Position of a plywood which was installed over the space measurement point P1, in night time

For the microphone location at measurement point P2, mounted on a tripod, the microphone height from the ground was 1.30 m, as shown in Figure 7a and Figure 7b The microphone was protected with a windscreen.

Figure 7a. Position of microphone in measurement point P2, in night time

Figure 7b. Position of microphone in measurement point P2, in night time

On the other hand, the methodology for data acquisition and processing involves the following steps (Dragomir et al., 2019):

- Establish the locations of the seismic stations based on the objectives;
- Develop layout schemes for the sensors;
- Effectively position the seismic stations according to the pre-established schemes;
- Connect the stations to the equipment and laptop;
- Start the multichannel recording stations and the laptop, and launch the communication application with the equipment;
- Conduct recordings, verification, and calibration tests following the procedures specified by the equipment supplier;
- Trigger recordings to capture ambient vibrations, ensuring that at least five sets of recordings (two minutes each) are made at the same location;
- Verify each recording upon completion using the available monitoring tools;
- Process the data to generate graphical representations of the time histories of accelerations, velocities, and displacements;
- For each time history, specify the maximum amplitude obtained in that recording.

This structured approach will ensure accurate data collection and processing for seismic analysis (Dragomir et al., 2021; Dobre et al., 2015).

Regarding the values of the maximum regulated noise limits (valid in 2019 year), correlated with the residential function of the rooms in the future residential building, for specific periods (daytime and nighttime), for this studied case, the principal admissible limits are presented according to the regulations in force, respectively from C125 - 2013 "Normative regarding Acoustics in Constructions and Urban Areas" as follows:

1) "In cases where the background noise (in the absence of external noise sources) is less than 30 dB(A), the equivalent indoor noise level due to all noise sources external to the functional unit must not exceed the background noise level by more than 5 units".
2) Parameter 2: Noise level outside residential buildings, located in quiet residential areas in an agglomeration with a population of more than 100,000 inhabitants, measured at 2.00 m from the building facade (according to SR 6161-1 and SR 6161-1/C91):
$$L_{ech} = 50 \text{ dB(A)}$$
3) Parameter 4: The noise level outside residential buildings, measured at 2.00 m from the building facade (according to SR 6161-1 and SR 6161-1/C91), in the case of buildings located in areas where the background noise level, L_{AF90}, is less than 50 dB(A), will be chosen as the minimum value between the value of 50dB(A) and L_{ech} calculated with the relationship below:
$$L_{ech} = L_{AF90} + 5 \text{ dB(A)}$$
4) Parameter 5: In the case of the design of new buildings, the noise level outside residential buildings, measured at 2.00 m from the building facade (according to SR 6161-1 and SR 6161-1/C91):
$$L_{ech} = 50 \text{ dB(A)}$$
5) For Apartments in Residential Buildings, the permissible limit of the equivalent indoor noise level is 35 dB(A) (Cz 30).

According to the provisions of the standard SR 10009:2017 "Acoustics. Admissible limits of the ambient noise level", the admissible limit of the external noise level at the facade of the residential building that is most exposed to the sound action of a noise source external to the building, respectively the equivalent continuous A-weighted acoustic pressure level, L_{AeqT}, is 50dB(A), for any type of residential building or similar to it, considering that the most exposed facade of the building is understood as that facade of the building that is closest to an external noise source.

"If the value of the background noise level L_{AF90T} is less than 45 dB, then the admissible limit is calculated with the relationship:

$$L_{AeqT}\ [dB] = L_{AF90T} + 5\ dB".$$

In addition, there is another Romanian legal act applicable to the residential buildings (Order of the Ministry of Health, no. 119 of February 4, 2014, for the approval of the Hygiene and Public Health Norms regarding the population's living environment, published in the Official Gazette of Romania, no. 127 of February 21, 2014, which states the following:

- "For the purposes of these norms, the following terms are defined as follows: a) living room: rooms with living room and bedroom functions".
- "The sizing of sanitary protection zones will be done in a such way that in the protected territories the limit values of the noise indicators will be ensured and respected, as follows: a) during the day, the A-weighted equivalent continuous acoustic pressure level (L_{AeqT}), measured outside the dwelling according to the SR ISO 1996/2-2018 standard, at 1.5 m height from the ground, shall not exceed 55 dB and the noise curve Cz 50; b) during the night, between hours 23:00 and 7:00, the equivalent continuous A-weighted sound pressure level (L_{AeqT}), measured outside the dwelling according to the SR ISO 1996/2-2018 standard, at 1.5 m above the ground, shall not exceed 45 dB and, respectively, the noise curve Cz 40".
- "For dwellings, the equivalent continuous A-weighted sound pressure level (L_{AeqT}), measured during the day, inside the room with the windows closed, shall not exceed 35 dB(A) and, respectively, the noise curve Cz 30. During the night (hours 23:00- 7:00), the L_{AeqT} noise level shall not exceed 30 dB and, respectively, the Cz curve 25".

One important criterion for evaluating the impact of vibrations on buildings is the velocity criterion (Dragomir et al., 2023; Bratu et al., 2024). Velocity is significant in this assessment because it provides a reliable indication across different vibration frequencies, and there is a strong statistical correlation with data related to structural degradation (Rybak, 2016). The allowable vibration levels are detailed in Table 1, according to DIN 4150-3/1999 regarding vibrations in buildings, and in Table 2, according to the norm on acoustics in buildings and urban areas (C 125/4-2013).

Table 1. Permissible vibration level (DIN 4150-3/1999)

Structure type	Frequency at foundation level			Combined frequency (at ground floor/upper floor level)
	<10 Hz	10...50 Hz	50...100 Hz	
Commercial, industrial buildings	20 mm/s	20...40 mm/s	40...50 mm/s	40 mm/s
Residential buildings	5 mm/s	5...15 mm/s	15...20 mm/s	15 mm/s
Buildings other than those in 1 and 2	3 mm/s	3...8 mm/s	8...10 mm/s	8 mm/s

Table 2. Permissible vibration level, Parameter 9 (C 125/4-2013)

Historical monuments		Any building (except monuments)
1-50 Hz	50-90 Hz	1-100 Hz
<8mm/s	8-12 mm/s	<12-20mm/s

RESULTS AND DISCUSSIONS

The results of the acoustic measurements, the values of the noise levels, are presented in numerical and in graphic forms in the frequency range 12.5...20000 Hz, and for vibrations the recordings are presented in the form of time-histories for accelerations and velocities, as well as Fourier spectra and response spectra.

This chapter presents the results of the acoustic measurements carried out, for each of the specific measurement situations considered, in number of 19, each corresponding to one of the two sound level meters, (Project 1, …. Project 10, for measurement point 1, P1, and Project 1, …. Project 9, for measurement point 2, P2), with the recorded values.

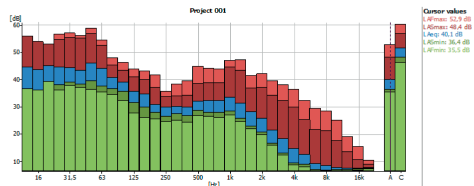
The results of the acoustic measurements were studied, considering the specificity of human acoustic perception, namely the spectrally recorded noise levels weighted in frequency with A-weighting specific to human hearing perception, L_{Aeq}, expressed in decibels (dB(A)), specified in the legislation and technical regulations in force, as well as time-weighted noise levels.

Acoustic recordings were made for the central frequencies of the 1/3 octave band, respectively the nominal frequency range: 6.3 Hz, 8.0 Hz, 10 Hz, 12.5 Hz, 16 Hz, 20 Hz, 25 Hz, 31.5 Hz, 40 Hz, 50 Hz, 63 Hz, 80 Hz, 100 Hz, 125 Hz, 160 Hz, 200 Hz, 250 Hz, 315 Hz, 400 Hz, 500 Hz, 630 Hz, 800 Hz, 1000 Hz, 1250 Hz, 1600 Hz, 2000 Hz, 2500 Hz, 3150 Hz, 4000 Hz, 5000 Hz, 6300 Hz, 8000 Hz, 1000 Hz, 125 Hz, 16000 Hz, 20000 Hz.

Determining the number of metros that circulated during the hourly intervals of acoustic measurement and recording, for the specific number of metros on the two underground metro lines (round trip), the hourly intervals were correlated with the determination of the vibration level coming from the metro, received at the study site, were used.

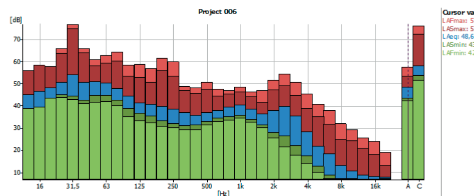
Next, also for acoustic analysis reasons, considering *human psychoacoustic perception*, correlated with the human audibility range and time weighting, the time-weighted noise levels F and S, $L_{xy}(t)$, where x is A for A weighting, and y is F for Fast weighting, L_{AFmax} , L_{AFmin} , or S for Slow weighting, L_{ASmax} , L_{ASmin}, which take into account the exponential time constants and averaging times, expressed in seconds or milliseconds, corresponding to the equipment (sound level meters) used to perform acoustic measurements. The time-weighted acoustic level is a continuous function of time and is expressed in decibels (dB). For these reasons, in Figure 8 … Figure 15, which presents a part of the results of the acoustic measurements carried out, both the recorded values for the equivalent noise level, L_{ech} , in dB(A) are given, in order to be able to compare them with the values of the admissible limits specified in the technical regulations in force, and, additionally, the values of the other types of time-weighted levels, respectively L_{AFmax} , L_{AFmin} , and L_{ASmax} , L_{ASmin}. It can be estimated that L_{ASmin} is approx. equivalent to the minimum noise level, L_{AF95}, and L_{ASmax} is approx. equivalent to the peak noise level, L_{AF05}; also, L_{AFmin} is approx. equivalent to the minimum peak noise level, L_{AF99}, and L_{AFmax} is approx. equivalent to the maximum peak noise level, L_{AF01}. The noise levels recorded at measurement point P1, were between minimum L_{Aeq} = 30.3 dB(A) (in Project 1, in the early morning, hours 04:55) when the metro train was not running, and maximum L_{Aeq} = 41.9 dB(A) (in Project 10, in the morning, hours 08:35) when the metro train is running and also with specific street noise. The noise levels recorded at measurement point P2, were between minimum L_{Aeq} = 40.1 dB(A) (in Project 1, in the early morning, hours 04:55) when the metro train was not running, and maximum L_{Aeq} = 52.0 dB(A) (in Project 09, in the morning, hours 08:35) when the metro train is running and also from specific street noise. The noise levels recorded at measurement point P2, related to some of the 9 projects in the sound level meter whose microphone was placed in P2, are exemplary presented graphically, with the corresponding values tabulated, according to the sound level meter data, in Figures 8-10.

Additionally, analyses of each type of recorded noise levels were also performed (L_{Aeq}, L_{AF90}, L_{AF10}, L_{AFmax}, L_{AFmin}, and L_{ASmax}, L_{Asmin}) and represented on the same graph, for the same type of noise level, of its values recorded in the two measurement points, P1 and P2, for all 19 projects in the two sound level meters, (Project 1, … Project 10, for measurement point 1, P1, and Project 1, … Project 9, for measurement point 2, P2). These graphs are presented below, in Figure 11 to Figure 15.



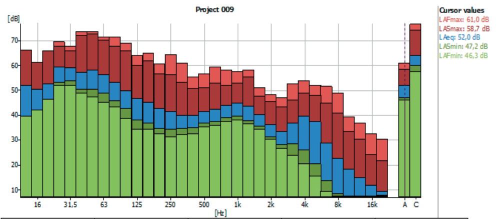
L_{AFmax} (dB)	L_{ASmax} (dB)	**L_{Aeq} (dB)**	L_{ASmin} (dB)	L_{AFmin} (dB)
52.9	48.4	**40.1**	36.4	35.5

Figure 8. Graphic and values of Project 1



L_{AFmax} (dB)	L_{ASmax} (dB)	**L_{Aeq} (dB)**	L_{ASmin} (dB)	L_{AFmin} (dB)
57.5	53.7	**48.6**	43.5	42.5

Figure 9. Graphic and values of Project 6



LAF_{max} (dB)	LAS_{max} (dB)	**LA_{eq} (dB)**	LAS_{min} (dB)	LAF_{min} (dB)
61.0	58.7	**52.0**	47.2	46.3

Figure 10. Graphic and values of Project 9

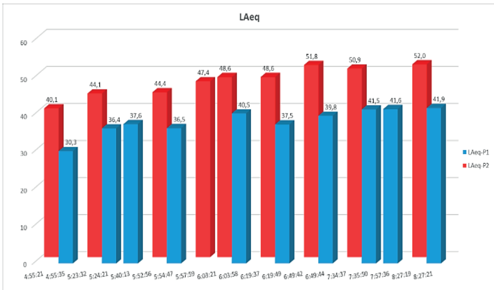


Figure 11. Values of L_{Aeq} in measurement point P1 and measurement point P2

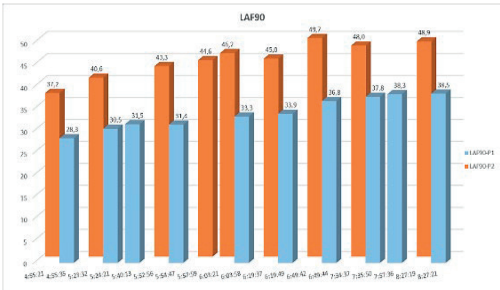


Figure 12. Values of L_{AF90} in measurement point P1 and measurement point P2

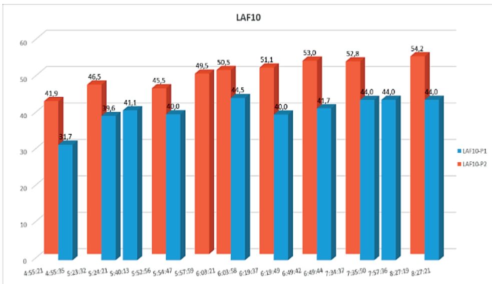


Figure 13. Values of L_{AF10} in measurement point P1 and measurement point P2

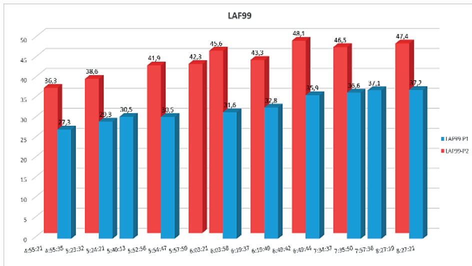


Figure 14. Values of L_{AF99} (L_{AFmin}) in measurement point P1 and measurement point P2

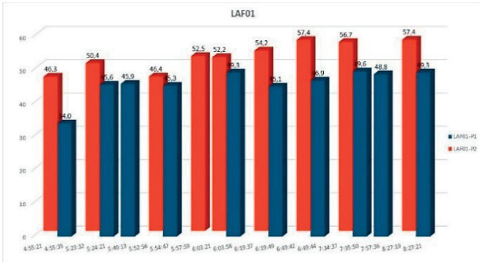


Figure 15. Values of L_{AF01} (L_{AFmax}) in measurement point P1 and measurement point P2

From the analysis and comparison of the results obtained from the acoustic research and measurements carried out, corroborated with the values of the maximum noise limits regulated by the legislation in force and correlated with the living function of the rooms in the future residential building that is intended to be built, the following observations emerge:

a) Regarding the measurements carried out at measurement point P1, for underground noise sources, mainly coming from metro traffic and with somewhat significant influences also from the noise produced simultaneously aboveground (depending on the type of surface noise sources, coming from human street activities, road traffic, air traffic noise - an airplane, birdsong, etc.), the noise level produced by metro traffic will not influence the noise level inside the rooms of the future residential building that is intended to be built on the studied site; a judicious acoustic design, combined with vibration protection of all construction elements of the future residential building, will be able to meet the requirements regarding the maximum admissible noise levels inside the rooms of this building. It is mentioned that certain peak noise levels recorded were due to isolated actions (in the context of the entire reference period, for which the admissible level is established), for example: birds chirping, sirens in street traffic, slamming car doors, noise from the construction site, etc.

b) Regarding the measurements carried out at measurement point P2 for the surface noise sources, coming from human street activities, street road traffic, air traffic noise (an airplane), birdsong, etc., the analysis of these values shows that the noise level outside residential buildings, $L_{ech} = L_{AF90} + 5$ dB(A), measured at 2.00 m from the building facade, will be able to be met according to the recommendations of the legislation in force, for the future residential building that is intended to be built on the studied site. It is mentioned that the noise produced by the metro will not significantly influence the noise level outside the future residential building, measured at 2.00 m from its facade. Also, through a judicious acoustic design of the closing construction elements and the facades of the future residential building, the requirements regarding the maximum permissible noise level inside the rooms of this building will be met. All noise levels presented in the previous chapters, levels existing in the technical regulations and legislation in force, will have to be met through a judicious acoustic design of the future residential building G+2F, without basement, which is intended to be located on the studied land in District 1 - Bucharest.

Regarding the part of the study dedicated to vibrations, the measurements made in the 20 files recorded in the two stages - quiet and metro/zonal traffic - led to time domains of accelerations, velocities and displacements, with response spectra in the range 0.016 - 100 Hz. By analysing the results obtained, it will be ascertained whether the vibration level falls within the admissible limits recommended by the technical regulations in force.

During the quiet phase, the highest velocity was noted in the z direction at STO1M (from the response spectrum), while the maximum values in the x and y directions were recorded at ST03 and ST02, respectively. In the metro/zonal traffic (noise) phase, the situation is presented comparatively in Figure 16.

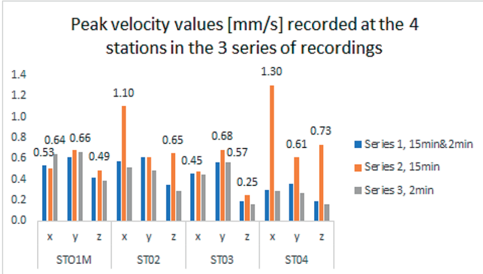


Figure 16. Variation of velocities in recordings

The analysis of the velocity time histories and the Fourier spectra revealed the following findings:

- the maximum velocity recorded in the excavated pit was 0.67 mm/s, while at the ground surface, in the center of the area, the recorded velocity was 1.27 mm/s;
- the Fourier spectra identified ranges for amplifications at 10 Hz, 30 Hz, and between 40 and 90 Hz.

The vibration propagation mode is highlighted. There is a trendline indicating a correlation between the maximum velocities recorded by the STO1M and STO3 sensors. The STO1M sensor measures velocities from a depth point, while the STO3 sensor measures them from a surface point. This trendline has a correlation coefficient of 0.84 (Figure 17).

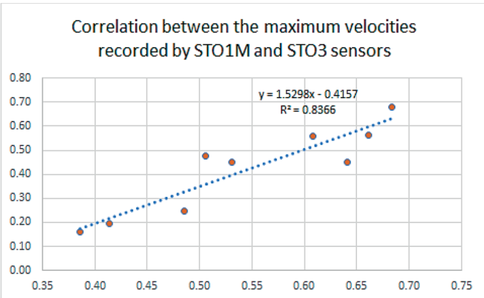


Figure 17. Propagation of vibrations between two points (STO1M and STO3 sensors)

Additionally, there is a trendline for the maximum velocities recorded by STO2 and STO4, both of which are situated at surface points along a diagonal of the study area. This trendline has a correlation coefficient of 0.88.

Print ISSN 2285-6064, CD-ROM ISSN 2285-6072, Online ISSN 2393-5138, ISSN-L 2285-6064

CONCLUSIONS

An acoustic characterization, as efficient as possible, of the studied area, namely the identification of the noise and vibration level in the study site in Bucharest, was achieved by performing acoustic measurements of the noise level coming from both surface noise sources and underground noise sources, namely the metro. The measurement situations were determined in a such way as to be useful for the design of a future residential building. The results of acoustic measurements show that the noise level produced by metro traffic will not influence the noise level inside the rooms of the future residential building that is intended to be built on the studied site in Sector 1 – Bucharest, because a judicious acoustic design, combined with vibration protection, of all construction elements of the future residential building, will be able to meet the requirements regarding the maximum admissible noise levels inside the rooms of the future building.

Although the recorded velocity values do not exceed the permissible limits (they are below 3 mm/sec), special attention is required in the design to avoid possible overlaps of vibration frequencies (from the soil-structure interaction).

ACKNOWLEDGMENTS

This research work was done within the "Nucleu" Programme in PNCDI 2022-2027, with the support of MCDI, Project PN 23 35 and Contract no. 10804 / 06.02.2019.

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