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The application of the instruments of architectural planning and structural design for the compensation of road traffic noise to permissible levels in the urban development area

Abstract. The purpose of our research is aimed to fulfill the third provision of "Sustainable Development" – "Sound Health", which organically transitions to the implementation of the eleventh provision – "Sustainable Development of Cities and Communities". In general, the provision of "Sustainable Development" is the basis that allows modern cities to reach the level of Smart City. The methodology of research relies on the concept that forms the basis of the compensation technique aimed at reducing the harmful acoustic impact on people located in the adjacent territorySpecial pavilion-type "shelters" are placed on the noise-affected territory, in the middle of which the recreational function can be performed in conditions of significantly reduced harmful acoustic impact on people from external sources by architectural planning and structural design means. The findings of the study indicate that the acoustic calculation of the necessary noise protection of the external structures of the designed "shelters" of various volume-planning and structural solutions, located on the adjacent territory near the complex of residential buildings No.5 - No.12 with preschool educational institutions and a school (Fig. 6). Forecast of the expected isolation of airborne noise of "shelters" external enclosure was prepared, an assessment of the noise regime of "shelters" premises was carried out in comparison with the permissible noise norm. The originality of this research lies in the predictionof the noise regime inside the "shelters", performed within the framework of the energy and wave theory of applied acoustics. Calculation of the compensating action of the "shelters" takes into account the combined action of air noise by the structures of the external enclosure and the reduction of noise by the input units in the "shelters", presented in plain view by chamber mufflers. Special pavilion-type "shelters" allow protecting people who are in recreation areas in the territories adjacent to residential buildings in the process of performing recreational and other functions by them (people).

Keywords: traffic noise, smart city, shelter, soundproofing

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Introduction.

In the course of master planning of building development and downstream of engineering and construction, the impact on people of various types of sources of external noise pollution is studied, the sanitary and ecological condition of the territory and the buildings and structures located on it are assessed, practical recommendations are developed regarding its (sanitary and ecological condition) improvement. «Excessive occupational exposure to noise results in a well-recognized occupational hearing loss which is prevalent in many workplaces, and now it is taken as a global problem…" [1–5]. The hearing deficiency by workers depends not only on industrial noise, but also on household acoustic load conditions at off-work time. "Work – Everyday life - Rest" is the basis of urban planning. One of the external sources that has a significant negative impact on people in the conditions of residential buildings is traffic noise [6–13]. Modern scientific studies of traffic noise [6–13] refer to analyzing and forecasting its magnitude by means of forecasting or modeling. But it is not focused on the development of qualitative processes of recreation in adjacent territories, which require an acoustic comfort as well. Its achievement is the purpose of this study. The purpose of our research is aimed to fulfill the third provision of "Sustainable Development" – "Sound Health", which organically transitions to the implementation of the eleventh provision – "Sustainable Development of Cities and Communities". In general, the provision of "Sustainable Development" is the basis that allows modern cities to reach the level of Smart City [14, 15, 24].

In the improvement of practical approaches to enhancement of the livability of people who are in conditions of external disturbance of noise, who live in residential accommodation of apartments, are in non-residential premises of buildings, as well as in the territories adjacent to them, a method of their (people) protection has been developed and implemented into the practice of modern design and construction. At the same time, it is often necessary to draw up a reliable forecast regarding the possibility of ensuring the norm of permissible noise in urban development, including in adjacent territories.

The following idea is the basis of the compensation technique of the harmful acoustic impact on people staying in the adjacent territory. Special pavilion-type "shelters" are placed on the noise-affected territory, in the middle of which the recreational function can be performed in conditions of significantly reduced acoustic impact on people from external sources by architectural planning and structural design means.

The main part

Hereinafter referred to as some practical results are highlighted, with a list of the possible degree of acoustic efficiency and the quality of the means of compensation of road traffic noise up to the acceptable norm on the example of real projects of urban development. Below, the method of acoustic calculation of the sound insulation of "shelters" developed by the authors for the protection of people in adjacent territories from traffic noise is provided in order to check its (methodology) practical suitability for solving the assigned tasks.

At the current work completion stage, new means have been added to the existing practice of using compensation for the negative impact of noise from external sources on people. They (means) allow protecting people who are in recreation areas in the territories adjacent to residential buildings in the process of performing recreational and other functions by them (people).

The theoretical and practical expediency of such solutions is currently being tested and implemented in design and construction practice. Herein below are examples of implementation of the proposed approach in the practice of design and construction of two actually existing capital construction objects, as follows:

Hereinafter (Figs. 1–3) it is shown that near residential building No. 5, which is under construction, as part of accommodation units complex No. 5 – No. 12 with preschool educational institutions and a school, there is a direct acoustic field, taking into account the results of the calculated assessment of the noise regime of the surveyed area (see Fig. 1, 2 below), under conditions of practically non-existent acoustic shadows with equivalent noise levels of about $L_{Aeq.}$ = 63.2 dBA in the daytime period. As long as this value of the noise level is higher than the permissible standards, in the case of placement of functional objects within this territory, their protection is required. In order to improve the acoustic conditions of the performed function - the presence of people in the "territory immediately adjacent to the residential buildings" (line 42 of Appendix 1 (item 3) and line 8 of Appendix 2 (item 3) [10]), the study presents a technical solution "shelter" - a pavilion for the protection of people located in "Territories directly adjacent to residential buildings".

Hereinafter there is a space-planning and constructive solution of such a "shelter" intended for placing in it a part of the "territory directly adjacent to residential buildings". "Shelter" should be located on the territory of the allotment directly adjacent to the investigated residential buildings (on the example of residential building No. 5).

By engineering design, the proposed enclosing structures of this "shelter" compensate external negative effect of noise on people inside it, in the process of their staying in adjacent territories. Thus, the proposed "shelter" is arranged in order to ensure the reduction of external noise levels on the way of its propagation from the source of origin to the object of protection to acceptable levels (line 42 of Appendix 1 (item 3), line 8 of Appendix 2 (item 3) [16]). The numerical values of permissible levels of sound pressure, L_{Aeq} in dB, in octave band centre frequencies, Hz (NC) and permissible sound levels L_A and equivalent sound levels, L_{Aeq}, dBA in "the territories bordering on residential buildings", i.e., directly taken from the current Sanitary Regulations (line 42 of Appendix 1 (item 3), line 8 of Appendix 2 (item 3) [16]), listed in the table 1 in the following.

As a source of noise generation, the traffic routes of aircrafts while performing the operations of flight take-off are considered. Hereinafter there is the acoustic design of the airborne noise isolation of the adopted space-planning and constructive decisions of the proposed "shelters". The task of such a calculation is to check the acoustic efficiency of the engineering solutions adopted to ensure the sanitary standard of permissible noise for "territories directly adjacent to the residential buildings" [15]. The first of the proposed "shelters" is a rectangular pavilion with dimensions of about 12 x 12 meters and a height of about 3 meters (Figs. 3-5). The Fig. 3-5 hereinafter presents the space-planning decision of the pavilion in the place of its location.

Hereinbelow there are the results of the assessment and analysis of the noise regime in the territory inside the "shelter" for the "territory immediately adjacent to residential buildings", i.e., to residential building No.5 before and after the application of measures (placement of "shelters") that compensate for noise.

The availability with adjacent territories of sufficient size in residential buildings makes it possible to place objects of various functional purposes on it. The adjacent territory of buildings No.5-No.12 is in the direct sound field, taking into account the results of the calculated assessment of the noise regime of the surveyed area with noise levels of the order $L_{aeq.day}$ = 63.2 dBA (Fig. 1). Since the numerical value of the predicted noise level in the adjacent territory is higher than the permissible norm [10], which is, accordingly, $L_{Aeq.day}$ = 55.0 dBA, compensation for the negative effect of the noise of the aircraft source on the "territory directly adjacent to the residential buildings" is required. The table 1 shows the numerical values of permissible sound pressure levels $L_{Aeq.}$in dB, in octave bands with geometric mean frequencies, Hz and permissible sound levels L_A and equivalent sound levels, $L_{Aeq.}$, dBA in the "territory immediately adjacent to the residential buildings", (line 42 of Appendix 1 (item 3), line 8 of Appendix 2 (item 3) [16]).

The development of protection measures against external noise in the area directly bordering on residential buildings is connected with the need to conduct a preliminary special acoustic design, which takes place in the following sequence:

1) The noise regime of the study area of the residential development was determined. The initial values of indicators of this noise regime are presented for the reference point on the adjacent territory near residential buildings (Fig. 1).

2) As the location area of the calculation point, CP1 was chosen - a place on the area of the territory adjacent to residential building No. 5, which is being designed (Fig. 1).

Table 1 – Normalized parameters of noise in octave frequency bands, equivalent and maximum sound levels of penetrating noise in the premises of residential and public buildings and noise in the countryside territory according to SSC (line 42 of Appendix 1 (item 3), line 8 of Appendix 2 (item 3) [16])

Page no.	The location of the settlement point	Time of day	Equivalent sound levels (L_{eq} dB) in octave-frequency bands, Hz (NC)								
			31,5	63	125	250	500	1000	2000	4000	8000
42	The territory directly adjacent to residential buildings	from 8 a.am to 10 p.am	90	75	66	59	54	50	47	45	44

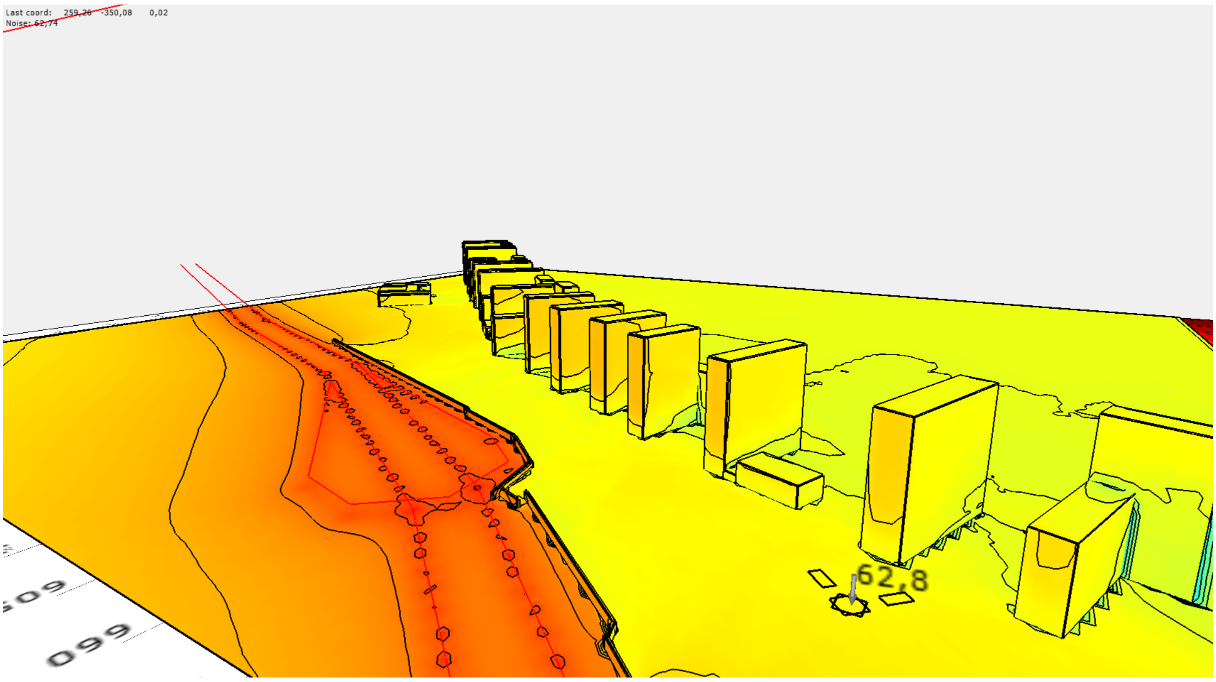

Figure 1 – Map (estimation) of sound fields of equivalent corrected sound levels of the studied "territory directly adjacent to the residential buildings" (to residential building No. 5)

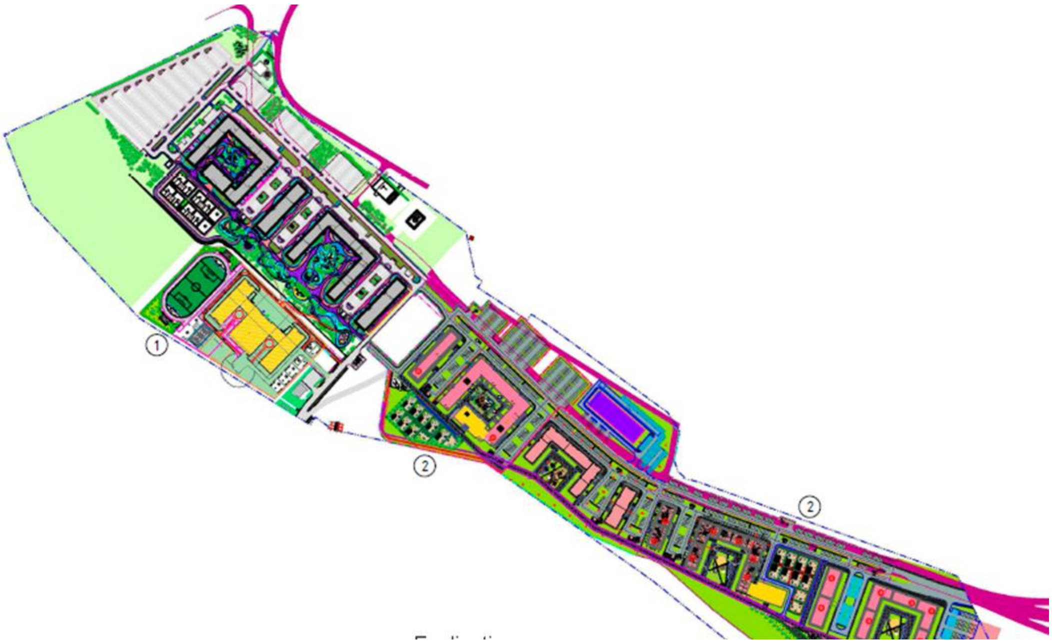

Figure 2 – Scheme of the general building plan with explanation of functional zones

Figure 3 – General location plan of the placement of the soundproof "shelter" on adjacent territories near residential building No. 5 made of a steel frame with an external fence made of window blocks as part of a triple-pane glass TPG 3.3.1-16-6M1-8-4M1

Forecasting the noise regime of the objects of protection under investigation is reduced to the calculation of sound levels in them based on data on the acoustic characteristics of active Lp sources, taking into account the patterns of their external noise distribution in the adjacent buildings of the study area. The values of the measured levels of the noise characteristics of the Lp sound sources are taken as the initial data for the acoustic calculation.

The above-mentioned ratios are implemented as a special program for PC "AcousticLab" (CSIP of Ukraine certificate #43927) [17-21]. With the help of it, an assessment was made, a forecast was made, and the noise regime of the investigated protection objects was visualized. The estimation models are presented in the form of a map of sound fields in the following way.

The constructed diagram (3D model) of the studied area with noise sources and protection objects marked on it is placed in the Cartesian coordinate system. The sound levels of all main external sources were determined by calculation and using the results of instrumental field measurements.

At the second stage of the assessment of the noise regime of the studied territory, a theoretical calculation was carried out, and the following visualization of the sound fields with an indication of the numerical values of the expected sound levels at the most characteristic calculation points, which were selected as follows:

- near the facades of residential buildings (2 m from their facades of residential building No. 5, Fig. 1 and further in the text);

- on the territory of the residential development, at a height of 1.5 m from the ground level (Fig. 1 and further in the text). The evaluation model is presented in the form of a map of sound fields of equivalent corrected sound levels in fig. 1. The assessment and nalysis of the noise regime in the studied area, taking into account the action of the road traffic noise source in the "shelter", was carried out, but not presented due to the awkwardness of such a calculation.

Fig. 2 shows the general plan of the building, with an explanation of the functional areas subject to protection from traffic noise: Pos. 1 The territory is adjacent to secondary school; Pos. 2; The territory is adjacent to two playgrounds (places for children to walk); Pos. 3 Recreation area in the leisure area of the residential complex (recreation area).

Evaluation of the noise regime in the "shelter"

A structure in the form of a pavilion is accepted as an acoustic "shelter" of the adjacent territories. The scheme of the general building plan with the explanation of the functional zones is presented in Fig. 2, and the situational plan of the location of the noise protection "shelter" in Fig. 3.

The general view of the plan of sheltering with a fence in the form of window blocks as part of a triple-pane glass TPG 3.3.1-16-6M1-8-4M1 (it is also permissible to use glass units or other translucent structures with a similar or greater parameter of air noise insulation) is schematically shown in Fig. 4 and the location of the "shelters" is marked in fig. 3, which presents a situational plan for the location of the "shelter" for the residential buildings made of a steel frame with an outer shell made of window blocks as part of a triple-pane glass TPG 3.3.1-16-6M1-8-4M1.

The Fig. 4 shows visualized schemes of the space-planning decision and the overview of this "shelter". The Fig. 4 shows the scheme of the plan and facades in axes 1-7, A-G of the pavilion - a "shelter" made of a steel frame with an external fence made of window blocks as part of a triple-pane glass TPG 3.3.1-16-6M1-8-4M1, to compensate for the negative effect aircraft noise on people located in the territory adjacent to the residential buildings under investigation. The fig. 5 shows a general view of "shelters" of both types on adjacent territories.

The calculation of airborne noise insulation by external structures that protect from window blocks as part of a triple-pane glass TPG 3.3.1-16-6M1-8-4M1, is graphically presented in Fig. 6. The scheme of the plan of the pavilion - "shelter" of a rounded shape is given in Fig. 7.

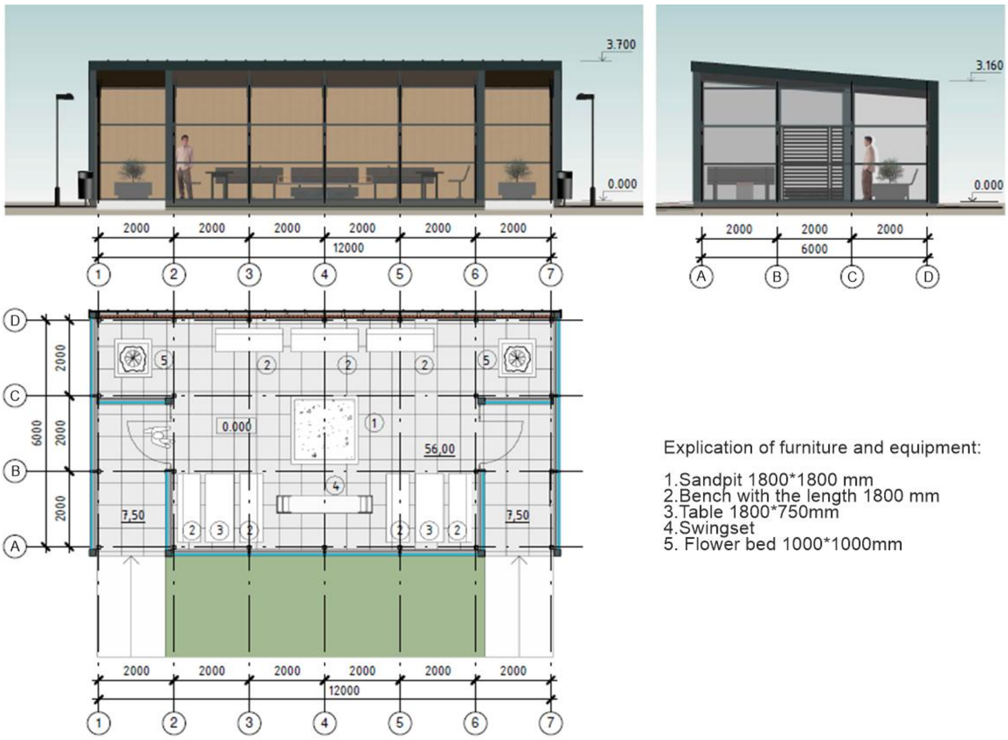

Figure 4 – Scheme of the plan of the pavilion - shelter made of a steel frame with an external fence made of window blocks as part of a triple-pane glass TPG 3.3.1-16-6M1-8-4M1, to compensate for the negative impact of traffic noise on people on adjacent territories.

Figure 5 – General view of "shelters" of both types in adjacent territories

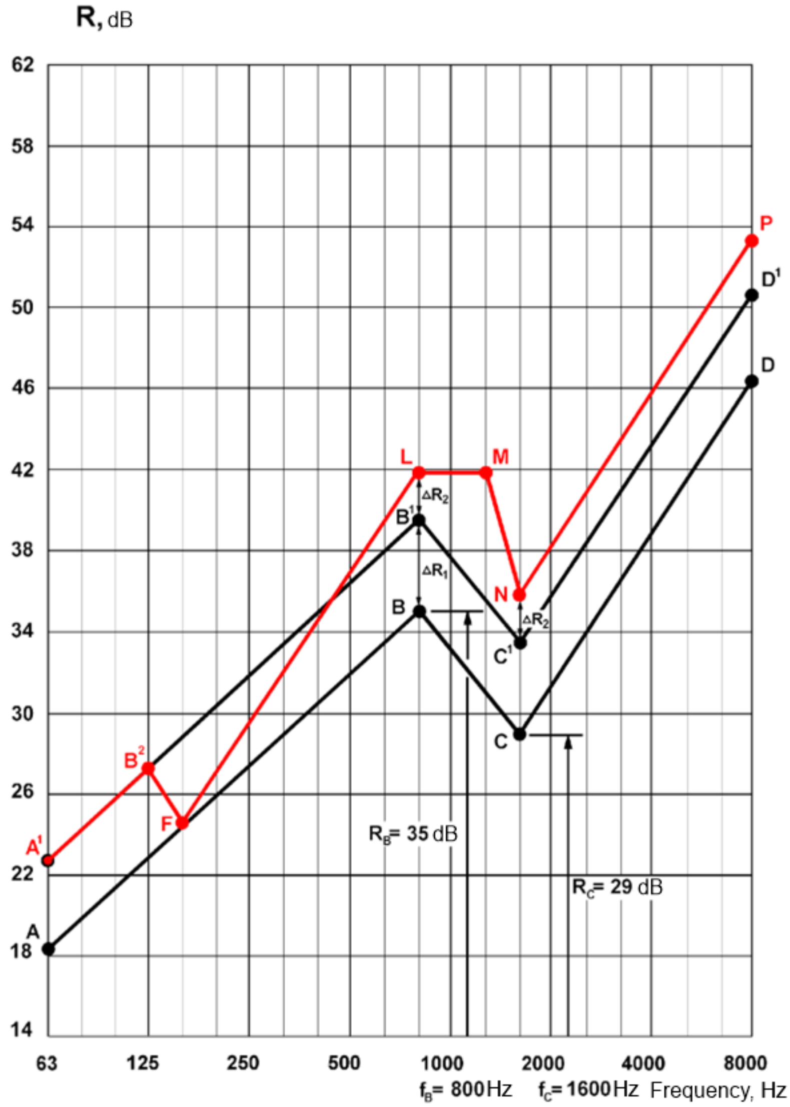

Figure 6 – Calculation of airborne noise insulation by external enclosing structures of a triple-pane glass made of glass with thickness and air gaps according to the TPG formula 3.3.1-16-6M1-8-4M1

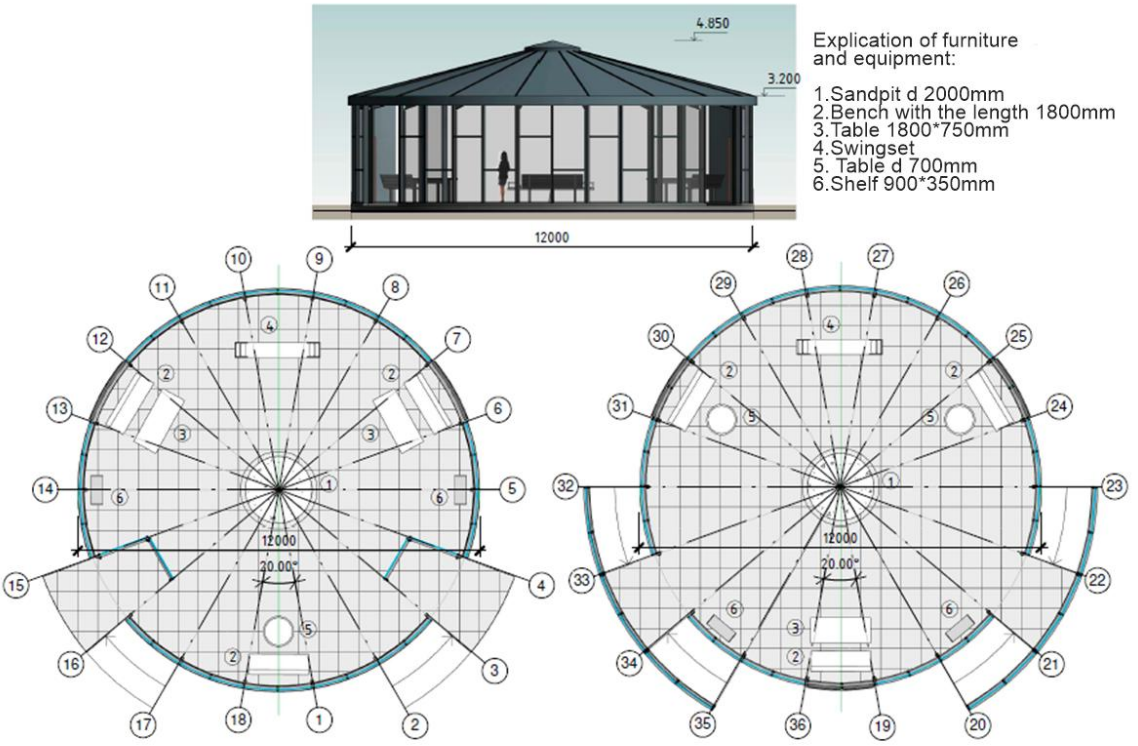

Figure 7. – cheme of the plan of the pavilion - a shelter made of a steel frame with an external fence of window blocks as part of a triple-pane glass TPG 3.3.1-16-6M1-8-4M1, to compensate for the negative impact of traffic noise on people staying at adjacent territories.

The theoretical idea of this approach is shown in the following application example:

After the acoustic design and comparison of the predicted values of the noise levels in different residential areas in each of the three above-mentioned protected zones, a space-planning and constructive solution for the "shelter" buildings, which are designed to compensate for the negative impact of aircraft noise in all "shelters" that are protected, up to permissible levels; A test of the hypothesis regarding the pass/fail of the "shelter" of the appropriate type to ensure the norm of permissible noise in the "territory immediately adjacent to residential buildings" is carried out.

Hereinafter referred to as, the results of such a methodological approach to the solution of this task are presented on the example of the protection against AN of the territory adjacent to residential building No. 5 in the project of a residential complex.

Calculation of the expected sound insulation of the "shelter".

The outer shell of the pavilion is made of window blocks consisting of a triple-pane glass TPG 3.3.1-16-6M1-8-4M1, h_1 = 3.1.3 mm, h_2 = 3.1.3 mm, h_3 = 4 mm and air gaps: 16 and 8 mm.

The calculation is made for the following conditions: isolation of air noise by a fixed window with a triple-pane glass, h_1 = 7 mm, h_2 = 6 mm, h_3 = 4 mm and air gaps of 16 and 8 mm is determined in accordance with Clause 9.4 [21] as follows:

a) The frequency response characteristic of airborne noise insulation by one glass is constructed. The coordinates of points B and C were found according to the table. 10 [21]:

f_B = 6000 : 7 = 857 Hz (we accept the nearest 1/3 octave of 800 Hz); R_B = 35 dB;

f_C = 12000 : 7 = 1714 Hz (we accept the nearest 1/3 octave of 1600 Hz); R_C = 29 dB,

Points plotted on the graph (Fig. 6) and then connected. From the point down, a segment BA with a slope of 4.5 dB per octave is drawn. From the point above, a CD segment is drawn with a rise of 7.5 dB per octave. The obtained polyline ABCD is the frequency characteristic of air noise insulation with a single glass surface density m_1 = 15.95 kg/m^2. The total surface density of all glasses is equal to: m_{gen} = 15.95 + 15 = 30.95 kg/m^2, hence m_{gen} / m_1 = 1.94. From the table 11 [23] it follows that R_1 = 4.3 dB. An auxiliary polyline A^1B^1 is constructed parallel to the ABCD curve 4.3 dB higher. The obtained intermediate curve $A^1B^1C^1D^1$ characterizes the sound insulation of a window made of two glasses 3,1,3 and 6 mm thick without taking into account the air gap. The calculation of the air gap is carried out as follows: b) the frequency of the main resonance of the structure is determined:

$$f_p = 60\sqrt{\frac{15,95+15}{0,016\cdot 15,95\cdot 15}} = 170,6Hz. \qquad (1)$$

The value of the resonant frequency of 170.6 Hz is rounded off to the nearest 1/3 octave, that is, to 160 Hz,

Up to a frequency of 0.8 fp = 125 Hz, inclusive, the frequency characteristic of the sound insulation of the window coincides with the auxiliary line $A^1B^1C^1D^1$. Next, point F is indicated at the frequency fp with the ordinate 4.0 dB below the A'B' line. At the frequency of eight resonant frequencies (1250 Hz), point K is indicated with an ordinate 22.0 dB greater than the ordinate of point F, i.e. 46.8 dBA.

Since the point K is outside the frequency range, we mark the point L at the frequency f_B = 800 Hz and the intersection of the line FK (the line FK itself can be drawn only from point F to point L with a coordinate of 41.9 dBA). At the frequency f_C = 1600 Hz, we mark point M, which is higher than point C^1 by R_2 = 2.6 dB.

ΔR_2 – is the excess of point L above the line $A^1B^1C^1D^1$.

From point M, we continue to draw a segment with a slope of 7.5 dB per octave.

According to the current methods, it is theoretically impossible to determine the overall sound-insulation value of a window in the presence of a third glass in the double-glazed unit.

In fig. 6. curve A^1B^2FLMNP is the insulation of airborne noise by the construction of a triple-pane glass window made of glass with a thickness and air gaps according to the TPG formula 3.3.1-16-6M1-8-4M1. In the closed position, it (window assembly) has an acoustic efficiency of at least Δ=35.1 dBA. The table 2 presents the calculation of airborne noise isolation by external structures protecting vestibule 1 in axes 1-2 and E-I and vestibule 2 in axes 2-2 and A-U of the shelter adopted window blocks as part of a triple-pane glass TPG 3.3.1-16-6M1 -8-4I.

The table 3 shows the calculation of the penetrating airborne noise from the territory through the enclosing structures of vestibule 1 in axes 1-2 and E-I of vestibule 2 in axes 2-2 and A-У of the shelter. In table 4, the calculation of penetrating noise from the vestibule to the shelter is carried out.

All calculations presented in table 2-9 are performed according to the methods discussed above in the text (see section 2) taking into account ratios (2) and (3). Reduction of sound insulation through a gap (entrance to the vestibule) is carried out according to formula (2):

$$_{\Delta}R = 10\lg\left\{\left[1+\frac{S_g}{S_f}\cdot 10^{0,1\cdot R_O}\right]\cdot\left[1+\frac{S_g}{S_f}\right]^{-1}\right\} \qquad (2)$$

where: S_g, S_f – respectively, the area of the gap (for ventilation of the shelter) and the deaf part of the fence, м^2. As a deaf part of the shelter fence, window blocks are used as part of a triple-pane glass TPG 3.3.1-16-6M1-8-4M1

R_O – sound insulation of the blind part of the fence (in our case, sound insulation of window units as part of a triple-pane glass TPG 3.3.1-16-6M1-8-4M1, shown by curve A^1B^2FLMNP in Fig. 6), dB.

The areas and the amount of sound insulation of the deaf part of the fence are presented in Table 7. Sound insulation is necessary when spreading noise from the free space (from the adjacent territory) into the room being isolated (vestibule 1 and 2).

$$R_{NC} = L_t - L_p - 10\lg(B_I / B_0) + \\ +10\lg(S_i / S_0) + 10\lg m + 6 \qquad (3)$$

Where L_p is the permissible octave level of sound pressure at the calculation point, dB; L_t – total octave sound power level of all noise sources, dB; B_I – acoustic level of vestibule 1, 2, м^2; B_0 = 1m; S_1 is the area of the first enclosure structure of the isolated room.

According to the conducted cumbersome acoustic calculation, which is omitted in this text, adjusted according to the "A" scale, the equivalent noise level inside the shelter was 52.7 dBA at the permissible norm of 55.0 dBA for the "territory adjacent to the residential buildings" (line 42 of Appendix 1 (item 3) and line 8 of Appendix 2 (item 3) [24]).

Thus, the real "shelter" ensures the norm of permissible noise (with a margin of 2.3 dBA) in the "territory immediately adjacent to the residential buildings" (line 14 of Table 3 [23]).

Further on in the text, the acoustic calculation of the "shelter" of another volume-planning solution is given. The figure 5 shows the scheme of the plan and facades in axes 23-32 of the shelter pavilion made of a steel frame with an external fence made of window blocks as part of a triple-pane glass TPG 3.3.1-16-6M1-8-4M1, to compensate for the negative impact of aircraft noise on people who are on the territory adjacent to the surveyed residential buildings.

According to the acoustic calculation, which is also not given in this text for the above reasons, adjusted according to the "A" scale, the equivalent noise level inside the shelter was 53.6 dBA at the permissible norm of 55.0 dBA for the "territory adjacent to the residential buildings", (line 14 of table 3 [23]).

Thus, real "shelters" provide the norm of permissible noise (with a margin of 1.4 - 2.3 dBA) in the "territory immediately adjacent to the residential buildings" (line 42 of Appendix 1 (item 3) and line 8 of Appendix 2 (item 3) [24]).

Conclusions

In the course of performance of this work, an investigation of the current state of acoustic pollution of capital construction objects under construction was carried out - residential building No.5, which is being built as part of a complex of residential buildings No.5 - No.12 with preschool educational institutions and a school, which are part of the residential development, under the action of an aviation source.

During the implementation of this work, the acoustic calculation of the necessary noise protection of the external structures of the designed "shelters" of various volume-planning and structural solutions, located on the adjacent territory near the complex of residential buildings No.5 - No.12 with preschool educational institutions and a school (Fig. 6) and a forecast of the expected isolation of airborne noise of its external enclosure was prepared, an assessment of the noise regime of their premises was carried out in comparison with the permissible noise norm.

The acoustic calculation was carried out in order to determine the possibility of ensuring the norm of permissible noise by applying the proposed construction-acoustic and constructive-technical measures that compensate for the AN in protection objects with normalized noise levels (in residential areas).

Conducting an acoustic design of the expected noise levels inside the premises of "shelters" in order to further compare them with the permissible norm and make a decision on the possibility/impossibility of its (permissible norm) compliance, carried out taking into account the shielding ability in terms of air noise isolation by wall materials and structures of the designed "shelter" (taking into account the applied design solutions of external walls, glazing and coating, the possibilities of solving the functional purpose of protected premises, etc.). The acoustic design of sound levels before and after the application of measures that compensate for AN was carried out for each of the inspected premises of "shelters" located on the adjacent territory of the residential complex as part of buildings No.5 - No.12 with preschool educational institutions and a school.

Forecasting was implemented on the basis of theoretical calculation of expected values of sound levels inside both rooms of "shelters" located near building No.11 before and after carrying out the construction-acoustic and constructive-technical arrangements that compensate for noise. Such a decision is due to the fact that high levels of aircraft noise are observed in the premises of the "shelters". The possibility of ensuring the sanitary norm of permissible noise levels in the premises of "shelters" on the adjacent territory protected near building No.11 during the implementation of the proposed noise compensation measures indicates the possibility of achieving the sanitary norm of permissible noise levels through the implementation of the same measures in all other places, where there are smaller or the same levels of external aircraft noise and have similar functional, volume-planning and constructive solutions.

It is clear from the materials given above by text that the practical implementation of the proposed noise compensation measures will have sufficient acoustic efficiency to ensure the norm of permissible sound levels regulated (line 42 of Appendix 1 (item 3) and line 8 of Appendix 2 (item 3) [23]) in all premises of the proposed "shelters" that will be located near residential buildings.

Therefore, in this paper in the initial approximation, a hypothesis has turned up its evidence for possibility of carrying out the assessment, analysis and forecast of quantitative indicators of noise regime up to permissible standards in the premises of designed "shelters" in adjacent territories, that are located near residential and non-residential buildings as part of urban development, which are protected from adverse effects of road traffic noise.

References

1.Natarajan, N., Batts, S., & Stankovic, K. M. (2023). Noise-induced hearing loss. *Journal of Clinical Medicine, 12*(6), 2347. https://doi.org/10.3390/jcm12062347

2.Asensio, C., Gasco, L., De Arcas, G., López, J. M., & Alonso, J. (2018). Assessment of Residents' Exposure to Leisure Noise in Málaga (Spain). *Environments*, 5(12), 134. https://doi.org/10.3390/environments5120134

3.Basner, M., Babisch, W., Davis, A., Brink, M., Clark, C., Janssen, S., & Stansfeld, S. (2014). Auditory and non-auditory effects of noise on health. *The Lancet, 383*(9925), 1325–1332. https://doi.org/10.1016/S0140-6736(13)61613-X

4.Knobloch, K., Manoha, E., Atinault, O., Barrier, R., Polacsek, C., Lorteau, M., Casalino, D., Ragni, D., Romani, G., & others. (2022). Future aircraft and the future of aircraft noise. In *Aviation noise impact management: Technologies, regulations, and societal well-being in Europe* (pp. 117–139). Springer. https://doi.org/10.1007/978-3-030-91194-2_5

5. Chebil, J., Ghaeb, J., Fekih, M. A., & Habaebi, M. H. (2019). Assessment of road traffic noise: A case study in Monastir City. *Jordan Journal of Mechanical and Industrial Engineering, 13*(3).

6.Bouzir, T. A. K., Berkouk, D., Schwela, D., & Lahlouh, M. (2023). A review of noise pollution policies in the Arab world. Acoustics Australia, 51(2), 183–200. https://doi.org/10.1007/s40857-023-00294-9

7.Forssén, J., Estévez Mauriz, L., Gustafson, A., & Kropp, W. (2020). How can we plan for a good urban sound environment, focusing on road traffic noise? *IOP Conference Series: Earth and Environmental Science, 588*, Article 052037. https://doi.org/10.1088/1755-1315/588/5/052037

1. Natarajan, N., Batts, S., & Stankovic, K. M. (2023). Noise-induced hearing loss. *Journal of Clinical Medicine, 12*(6), 2347. https://doi.org/10.3390/jcm12062347

2. Asensio, C., Gasco, L., De Arcas, G., López, J. M., & Alonso, J. (2018). Assessment of Residents' Exposure to Leisure Noise in Málaga (Spain). *Environments*, 5(12), 134. https://doi.org/10.3390/environments5120134

3. Basner, M., Babisch, W., Davis, A., Brink, M., Clark, C., Janssen, S., & Stansfeld, S. (2014). Auditory and non-auditory effects of noise on health. *The Lancet, 383*(9925), 1325–1332. https://doi.org/10.1016/S0140-6736(13)61613-X

4. Knobloch, K., Manoha, E., Atinault, O., Barrier, R., Polacsek, C., Lorteau, M., Casalino, D., Ragni, D., Romani, G., & others. (2022). Future aircraft and the future of aircraft noise. In *Aviation noise impact management: Technologies, regulations, and societal well-being in Europe* (pp. 117–139). Springer. https://doi.org/10.1007/978-3-030-91194-2_5

5. Chebil, J., Ghaeb, J., Fekih, M. A., & Habaebi, M. H. (2019). Assessment of road traffic noise: A case study in Monastir City. *Jordan Journal of Mechanical and Industrial Engineering, 13*(3).

6. Bouzir, T. A. K., Berkouk, D., Schwela, D., & Lahlouh, M. (2023). A review of noise pollution policies in the Arab world. Acoustics Australia, 51(2), 183–200. https://doi.org/10.1007/s40857-023-00294-9

7. Forssén, J., Estévez Mauriz, L., Gustafson, A., & Kropp, W. (2020). How can we plan for a good urban sound environment, focusing on road traffic noise? *IOP Conference Series: Earth and Environmental Science, 588*, Article 052037. https://doi.org/10.1088/1755-1315/588/5/052037

8.Sankov, P., Zakharov, Y., Zakharov, V., & Tkach, N. (2025). Assessing the reliability of noise simulation models in a built-up area. *Academic Journal. Industrial Machine Building, Civil Engineering, 2*(65), 91–96. https://doi.org/10.26906/znp.2025.65.4216

9.Mishra, R., Mishra, A. R., & Kumar, A. S. (2019). Traffic noise analysis using RLS-90 model in urban city. In *INTER-NOISE and NOISE-CON Congress and Conference Proceedings* (Vol. 259, No. 3, pp. 6490–6502). Institute of Noise Control Engineering.

10. World Health Organization Regional Office for Europe. (2018). *Environmental noise guidelines for the European region*. WHO Regional Office for Europe. https://www.euro.who.int/en/health-topics/environment-and-health/noise/publications/2018/environmental-noise-guidelines-for-the-european-region-2018

11. Rebah, M. (2022, April 29). *Algérie: Gaspillage alimentaire et nuisances sonores*. JNE Association. https://jne-asso.org/2022/04/29/algerie-gaspillage-alimentaire-et-nuisances-sonores/

12. Mann, S., & Singh, G. (2022). Traffic noise monitoring and modelling—An overview. *Environmental Science and Pollution Research, 29*(37), 55568–55579. https://doi.org/10.1007/s11356-022-21413-z

13. Sankov, P., Tkach, N., Dikarev, K., Blyzniuk, A., & Hvadzhaia, B. (2018). Effect of motor transport on the working places in the service infrastructure (by noise factor and urban air pollution in the city center of Dnipro). *Science and Innovation, 14*(3), 59–66. https://doi.org/10.15407/scine14.03.059

14. Sankov, P., Dikarev, K., Kushnir, Y., & Tkach, N. (2020). Modern smart city concept considering population safety issues. In *Smart technologies in urban engineering* (pp. 225–234). Springer. https://doi.org/10.1007/978-3-030-42939-3_24

15. Sankov, P., Zakharov, Y., Tkach, N., Chashyn, D., & Yurin, O. (2023). Innovative program of quality assessment of cities for the compliance with smart city category. *Lecture Notes in Civil Engineering, 299*, 517–525. https://doi.org/10.1007/978-3-031-17385-1_41

16. Ministry of Health of Ukraine. (2019). *Approval of the state sanitary norms for permissible noise levels in residential and public buildings and on the territory of residential development* (Order No. 463). https://zakon.rada.gov.ua/laws/show/z0281-19

17. Ministry of Regional Development of Ukraine. (2013). *Guidelines for the calculation and design of noise protection in rural areas* (Order No. 306).

18. International Civil Aviation Organization. (2008). *Guidance on the balanced approach to aircraft noise management* (ICAO Doc 9829, 2nd ed.). ICAO.

19. International Organization for Standardization. (2002). *ISO 15910:2002. Information technology—Process for creating user documentation*.

20. State Intellectual Property Service of Ukraine. (2012). *Computer program "AcousticLab"* (Patent of Ukraine No. 43927).

8. Sankov, P., Zakharov, Y., Zakharov, V., & Tkach, N. (2025). Assessing the reliability of noise simulation models in a built-up area. *Academic Journal. Industrial Machine Building, Civil Engineering, 2*(65), 91–96. https://doi.org/10.26906/znp.2025.65.4216

9. Mishra, R., Mishra, A. R., & Kumar, A. S. (2019). Traffic noise analysis using RLS-90 model in urban city. In *INTER-NOISE and NOISE-CON Congress and Conference Proceedings* (Vol. 259, No. 3, pp. 6490–6502). Institute of Noise Control Engineering.

10. World Health Organization Regional Office for Europe. (2018). *Environmental noise guidelines for the European region*. WHO Regional Office for Europe. https://www.euro.who.int/en/health-topics/environment-and-health/noise/publications/2018/environmental-noise-guidelines-for-the-european-region-2018

11. Rebah, M. (2022, April 29). *Algérie: Gaspillage alimentaire et nuisances sonores*. JNE Association. https://jne-asso.org/2022/04/29/algerie-gaspillage-alimentaire-et-nuisances-sonores/

12. Mann, S., & Singh, G. (2022). Traffic noise monitoring and modelling—An overview. *Environmental Science and Pollution Research, 29*(37), 55568–55579. https://doi.org/10.1007/s11356-022-21413-z

13. Sankov, P., Tkach, N., Dikarev, K., Blyzniuk, A., & Hvadzhaia, B. (2018). Effect of motor transport on the working places in the service infrastructure (by noise factor and urban air pollution in the city center of Dnipro). *Science and Innovation, 14*(3), 59–66. https://doi.org/10.15407/scine14.03.059

14. Sankov, P., Dikarev, K., Kushnir, Y., & Tkach, N. (2020). Modern smart city concept considering population safety issues. In *Smart technologies in urban engineering* (pp. 225–234). Springer. https://doi.org/10.1007/978-3-030-42939-3_24

15. Sankov, P., Zakharov, Y., Tkach, N., Chashyn, D., & Yurin, O. (2023). Innovative program of quality assessment of cities for the compliance with smart city category. *Lecture Notes in Civil Engineering, 299*, 517–525. https://doi.org/10.1007/978-3-031-17385-1_41

16. Ministry of Health of Ukraine. (2019). *Approval of the state sanitary norms for permissible noise levels in residential and public buildings and on the territory of residential development* (Order No. 463). https://zakon.rada.gov.ua/laws/show/z0281-19

17. Ministry of Regional Development of Ukraine. (2013). *Guidelines for the calculation and design of noise protection in rural areas* (Order No. 306).

18. International Civil Aviation Organization. (2008). *Guidance on the balanced approach to aircraft noise management* (ICAO Doc 9829, 2nd ed.). ICAO.

19. International Organization for Standardization. (2002). *ISO 15910:2002. Information technology—Process for creating user documentation*.

20. State Intellectual Property Service of Ukraine. (2012). *Computer program "AcousticLab"* (Patent of Ukraine No. 43927).

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Застосування інструментів архітектурного планування та структурного проектування для компенсації шуму дорожнього руху до допустимих рівнів у міській забудові

Аннотація. Метою дослідження є виконання третього положення «Сталого розвитку» – «Міцне здоров'я», яке органічно переходить до реалізації одинадцятого положення – «Сталий розвиток міст та громад». Загалом, положення «Сталого розвитку» є основою, яка дозволяє сучасним містам досягти рівня Розумного міста. В основі методики компенсації шкідливого акустичного впливу на людей, які перебувають на прилеглій території, лежить наступна ідея. На території, що зазнає впливу шуму, розміщуються спеціальні «укриття» павільйонного типу, посеред яких рекреаційна функція може виконуватися в умовах значно зниженого шкідливого акустичного впливу на людей від зовнішніх джерел за допомогою архітектурно-планувальних та структурних проектних засобів. Під час виконання цієї роботи було проведено акустичний розрахунок необхідного шумозахисту зовнішніх конструкцій проектованих «укриттів» різних об'ємно-планувальних та конструктивних рішень, розташованих на прилеглій території поблизу комплексу житлових будинків № 5 - № 12 з дошкільними навчальними закладами та школою (рис. 6). Було підготовлено прогноз очікуваної ізоляції повітряного шуму зовнішнього огородження «укриттів», проведено оцінку шумового режиму приміщень «укриттів» у порівнянні з допустимою нормою шуму. Прогнозування шумового режиму всередині «укриттів», виконане в рамках енергетичної та хвильової теорії прикладної акустики. Розрахунок компенсуючої дії «укриттів» враховує комбіновану дію повітряного шуму конструкціями зовнішнього огородження та зниження шуму вхідними блоками в «укриттях», представленими на видноті камерними глушниками. Практична цінність результатів полягає в тому, що спеціальні «укриття» павільйонного типу дозволяють захистити людей, які перебувають у зонах відпочинку на територіях, прилеглих до житлових будинків, у процесі виконання ними (людьми) рекреаційних та інших функцій.

Ключові слова: шум транспорту, розумне місто, укриття, звукоізоляція.

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