THE FACTOR OF NOISE POLLUTION IN THE ORGANIZATION OF THE REST AREAS

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The present work is devoted to the assessment of noise pollution in the residential quarter, located in Bolshoye Savino in city of Perm from aircraft Municipal Airport .The authors conducted a quantitative and qualitative assessment of the acoustic characteristics of the noise source, represented by flying over an aircraft, by theoretical calculations and by the computer simulation and optimization, in accordance with current Russian sanitary regulation for noise. Conducted evaluation of existing sound levels at the objects of protection. Exceeded regulatory allowable values of the expected sound levels at the objects of protection. Developed science-based list of activities for the noise protection of the surveyed objects based on the effectiveness of sound proofing. The design of a special noise-reducing hiding areas recreation area in the study area.

Keywords: noise characteristics, sources of noise, aircraft, computer simulation, noise protection

The present work is devoted to the assessment of noise pollution in the residential district, Bolshoye Savino in Perm aircraft from the city airport. Considered noise regime of the territory of the recreation area.

Purpose of the study

Establishing compliance with the acoustic conditions of stay of people in areas recreation areas located in the area of noise impact of air transport. The goal is achieved by means of the following tasks:

1. Identification of the main sources of noise affecting persons on the territory of the recreation area of the neighborhood.
2. Analytical review of the existing Russian system of sanitary, technical and construction standardization in the field of sound proofing and confirmation of the justification of the applicability of these rules of acceptable noise for local objects.
3. Comparison of analytical results with current Russian sanitary norms of acceptable noise in the territory of the inspected object and detecting deviations from them.
4. Develop a list and focus on practical recommendations for sound insulation in case of exceeding the norms of allowable noise.

Materials and methods of research

The task of creating an acoustically safe environment of location of population in residential areas of noise protection measures was decided on the basis of system approach. Analytical studies were carried out using the methods of applied acoustics, mathematical statistics and computer simulation.

Results of research and their discussion

According to the SN 2.2.4/2.1.8.562-96 "Noise at workplaces, in residential and public buildings and residential areas" [3] and BNR 23-03-2003 "noise Protection" of the updated version 2011 [4] the calculation and assessment of traffic noise shall be as the maximum $L_{A\max}$ sound levels (in dBA) and the equivalent sound levels L_{Aeqv} (in dBA) created in our case aviation source close to residential areas.

Rationing is set for regulated intervals daytime. Regulated time intervals are 16 hours of day time (from 7-00 to 23-00). The main source of noise presented individual aircraft that are flying in the zone of the airport in Perm

In the evaluation of community noise to sanitary and hygienic requirements are governed by the maximum permissible noise levels at rest areas. In Table 1 given the criteria for the regulation of noise on areas and rest areas [3].

Table 1

Normalized levels of SN 2.2.4/2.1.8.562-96 (Table 3) [3] for protected areas recreation facilities

The location of the estimated point	Time	The sound levels and equivalent sound levels L_{Aeqv} dB(A)	Maximum sound levels, $L_{A\max}$ dB(A)
Recreation area on the territory of microdistricts and groups of houses	daytime (7:00 to 23:00)	45	60

Prediction of the noise regime of the studied objects of protection is reduced to the calculation of sound levels in them on the basis of acoustic characteristics of the source L_p, subject to the laws of distribution of external noise in the surrounding development the study area. As data input for the acoustic calculation of the accepted value of the measured levels of sound characteristics of sound sources L_p.

The above relation is implemented in the form of a special PC program. With its help estimation, the forecast and the visualization of the noise regime of the investigated objects of protection. The estimated models are presented in the form of maps of sound fields in the following way. The scheme (3D model [1, 2]) of the study area shows the sources of noise and objects of protection are placed in a Cartesian coordinate system. By calculation and using the results of the instrumental field measurements to determine the levels of the sound source.

In the second stage estimation the noise regime in the study area carried out the theoretical calculation and subsequent visualization of sound fields indicating the numerical values of the expected sound levels in the most typical design points that were selected:

– the facade of a residential building № 2 at 2 m from the facade of the building on the second and fifth floor at a height of 6 and 17 m from ground level);

– on-site residential development at a height of 1,5 m from ground level.

The estimated model is presented in the form of maps of sound fields in Fig. 1. Evaluation and review of the noise regime in the study area taking into account the effect of aircraft noise in "shelter" are presented below in Tables 1–7.

From Fig. 1 shows that the expected maximum levels of external noise in the protected area are compared to 71,0 dBA.

Estimation of a noise mode in the "shelter"

In the shelter children's play and recreation facilities, adopted a pergola of steel frame with cladding made of organic glass (Plexiglas Soudstop) density 1190 kg/m3 thickness of 25 mm. Its space planning solution represented in Fig. 2. Calculation of airborne sound insulation of enclosing structures made of monolithic organic glass (Plexiglas Soudstop) density 1190 kg/m^3 25 mm thick and is graphically presented in Fig. 2. In all calculation methods are taken from [5].

The calculation of expected sound insulation of the shelter Plexiglas Soudstop $h = 25$ mm, surface mass of material $m = 29{,}7$ kg/m^2:

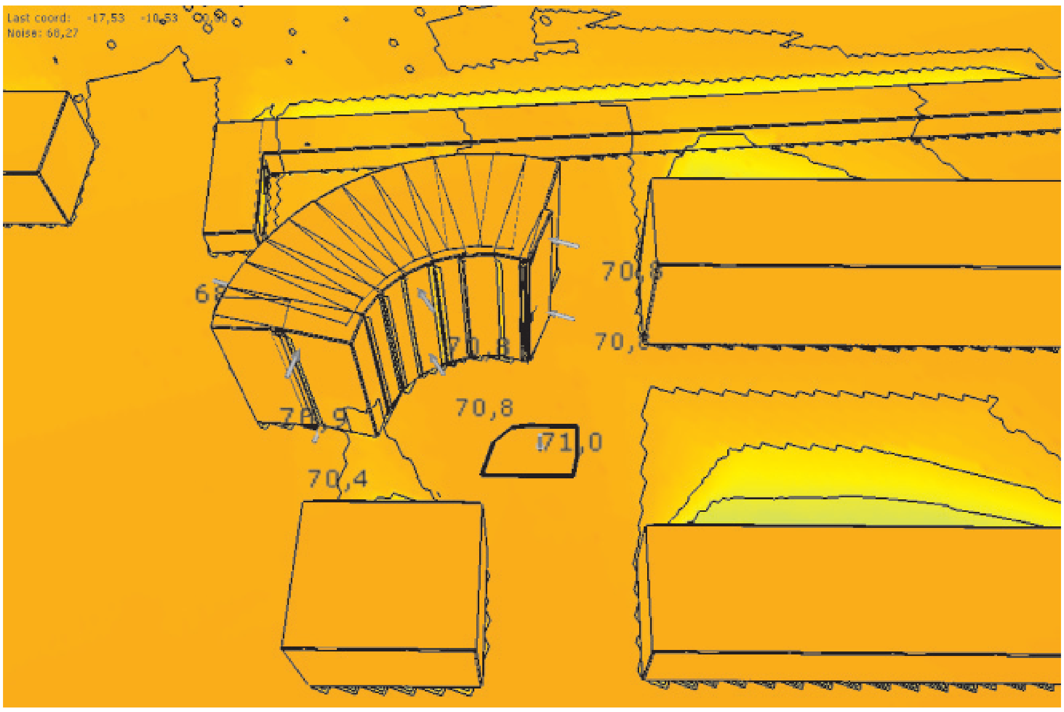

Fig. 1. Map of the sound fields of the study area

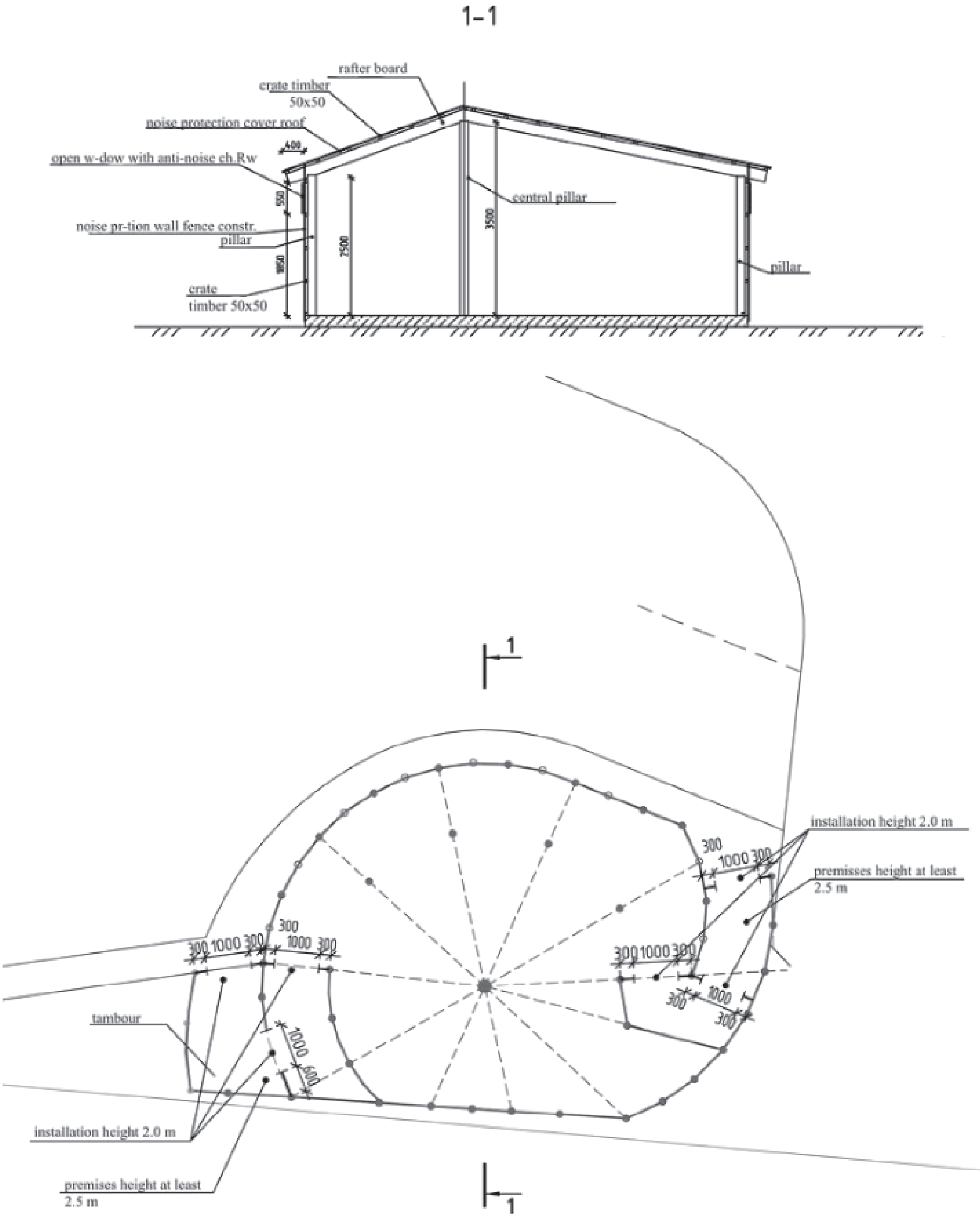

Fig. 2. Scheme plan acoustic cover

Built the frequency characteristics of airborne sound insulation one Plexiglas Soudstop. Found the coordinates of the points *B* and *C* at the Table 11 [5]: f_B = 17000/25 = 680 Hz; take the next teractive 630 Hz. R_B = 37 dB; f_C = 34000/25 = 1360 Hz; take the next teractive 1250 Hz. R_C = 30 dB. Plotted on a graph (Fig.3) the points *B* and *C* and then bridged. From point To cut down conducted the *VA* with a slope of 4,5 dB per octave, from point C up held cut a CD with a rise of 7,5 dB per octave. Received broken line *ABCD* represents the frequency characteristic of airborne sound insulation of a single layer of Plexiglas Soudstop surface density m_1 = 25 kg/m^2.

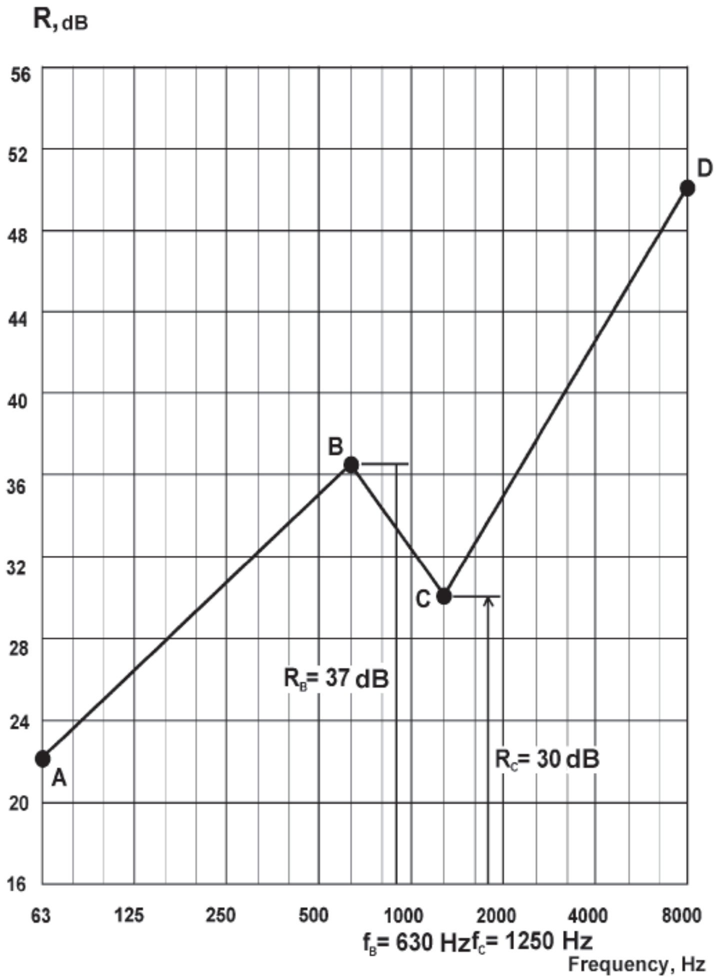

Fig. 3. Calculation of airborne sound insulation of enclosing structures made of organic glass (Plexiglas Soudstop) density 1190 kg/m^3 25 mm

The calculation of expected sound-proofing sliding doors at the entrances to the shelter Plexiglas Soudstop $h = 15$ mm, surface mass of material $m = 17{,}8$ kg/m^2.

Built the frequency characteristics of airborne sound insulation one Plexiglas Soudstop. Found the coordinates of the points *B* and *C* at the Table 11 [5]: $f_B = 17000/15 = 1133$ Hz; take the next teractive 1250 Hz. $R_B = 37$ dB; $f_C = 34000/15 = 2266$ Hz; take the next teractive 2500 Hz. $R_C = 30$ dB. Plotted on a graph (Fig.4) the points *B* and *C* and then bridged. From point To cut down conducted the *VA* with a slope of 4,5 dB per octave, from point C up held cut a CD with a rise of 7,5 dB per octave. Received broken line *ABCD* represents the frequency characteristic of airborne sound insulation of a single layer of Plexiglas Soudstop surface density $m_1 = 15$ kg/m^2.

The acoustic effectiveness of sliding doors

Calculation of acoustic efficiency of the installation of doors in the shelter of Plexiglas Soudstop 15 mm thick carried out тas follows.

1. Taken during a full door opening for entry and exit of people – 20 minutes during the hour in the daytime.

2. It is known that the sum of the two noise levels for a larger correction 0 dB when the difference between folding levels more than 20 dB. In our case, the equivalent noise level in front of the door to the shelter 71 dBA, and the acoustic performance of the door of Plexiglas Soudstop 15 mm or 24,3 dB (see Table 3).

3. Calculation of equivalent (by energy) of the noise level in the entrance vestibule of the shelter after the passage of the door (closed 40 minutes – acoustic efficiency of

24,3 dB and open a 20 – minute acoustic performance – 0 dBA) will carry out in a known manner, applied acoustics.

4. Calculation of noise passed through the door open for 20 minutes during the hour according to known methods applied acoustics gave the result 66,2 dB. Consequently the acoustic efficiency of application of sliding doors open 20 minutes during the hours of operation will be:

$$71 \text{ dBA} - 66{,}2 \text{ dB} = 4{,}8 \text{ dB}.$$

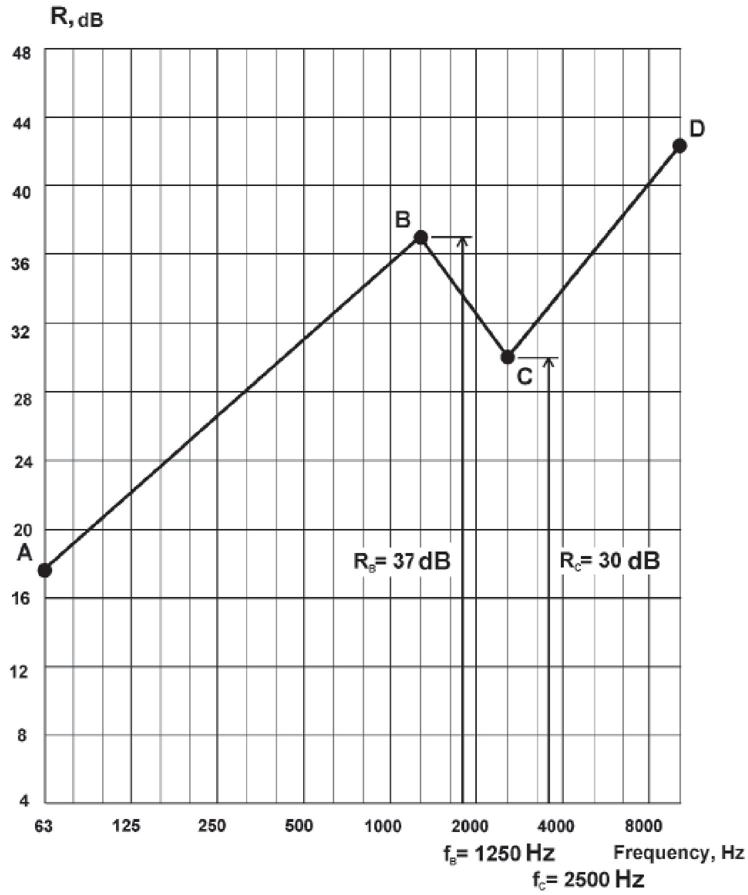

Fig. 4. Calculation of airborne sound insulation of enclosing structures made of organic glass (Plexiglas Soudstop) density 1190 kg/m³ 15 mm

Table 2

The calculation of the average (RCP) sound insulation of external enclosing structures made of organic glass for the designed "shelter"

Number	Shelter	Sound levels in dB, in octave bands with geometric mean frequencies, Hz								L_A, dBA
		63	125	250	500	1000	2000	4000	8000	
1	Plexiglas Soudstop 25 mm	22	26,5	31	35,5	32,5	35	42,5	50	**34,8**

Table 3

The calculation of the average (RCP) sound insulation sliding door made of organic glass for the designed "shelter"

Number	Door	Sound levels in dB, in octave bands with geometric mean frequencies, Hz								L_A, dBA
		63	125	250	500	1000	2000	4000	8000	
1	Plexiglas Soudstop 15 mm	17,5	22	26,5	31	35,5	32,5	35	42,5	**24,3**

Table 4

The desired soundproofing (R_{req}) enclosure designed for the shelter from the street to the platform

Number	Value	Geometric mean frequency octave bands, Hz							
		63	125	250	500	1000	2000	4000	8000
1	L_p	–	62,4	60,4	61,3	54,3	46,1	–	–
2	L_d	–	57	49	44	40	37	–	–
3	B_0	–	1	1	1	1	1	–	–
4	V_N	–	235,6	235,6	235,6	235,6	235,6	–	–
5	B^N_{1000}	–	157,1	157,1	157,1	157,1	157,1	–	–
6	μ	–	0,75	0,7	0,8	1	1,4	–	–
7	B_N	–	117,8	110,0	125,7	157,1	219,9	–	–
8	V_I	–	30,3	30,3	30,3	30,3	30,3	–	–
9	B^I_{1000}	–	20,2	20,2	20,2	20,2	20,2	–	–
10	μ	–	0,75	0,7	0,8	1	1,4	–	–
11	B_I	–	15,1	14,1	16,2	20,2	28,3	–	–
12	S_i	–	14,4	14,4	14,4	14,4	14,4	–	–
13	S_0	–	1	1	1	1	1	–	–
14	m	–	2	2	2	2	2	–	–
15	R_{req}	–	–6,5	0,1	4,8	–0,1	–8,3	–	–

Table 5

Average soundproofing of enclosing structures for the design of the vestibule of the shelter with an open doorway the size of 1,0 by 1,85 m

Number of the room	Value
R_1	34,8
R_2	4,8
S_1	39,30
S_2	1,85
R_{mid}	18,2

Conclusions

1. The acoustic effectiveness of the decision of the shelter (Fig. 2) is determined by the following factors: – Input nodes in the shelter are equipped with vestibules, where the front surface of the sound energy takes place not less than 90°.

– The parameter determining the effectiveness of shelter is the surface density of organic glass (Plexiglas Soudstop – 1190 kg/m^3) thickness of 25 mm the Geometry of the premises of the shelter and its volume will affect the acoustic performance is not significantly.

2. Octave sound levels in the shelter exceeds the sanitary standard at a frequency of 500 Hz, 0,9 dB, respectively (see Table. 7 p. 8). In accordance with the provisions of applied acoustics, exceeding in the spectrum allowed in 3 octaves up to 3 dB, in the absence of exceeding the corrected sound level in dBA (in our case in room 45 dBA expected levels consists of 43,5 dBA.

3. Total equivalent corrected level of sound on a scale of A shelter is 43,5 dBA, which exceeds the norm corrected permissible sound levels for recreation facilities on the territory of microdistricts and groups of apartment houses, component of 45 dB. Equivalent sound level in the territory of 57,3 dBA, it follows that the noise-reducing efficiency of the shelter is 13,8 dB.

4. As an additional option to achieve the norms of a device sliding tambour doors at the entrance to the shelter that will be opened for pass of people within 20 minutes of the hours of operation. This event will have an efficiency of 4,8 dB. Doors are made of Plexiglas Soudstop single thickness of 15 mm.

Table 6

The required sound insulation (R_{req}) of the external protecting designs for designed "shelter" from the platform to "shelter"

Number	Value	Geometric mean frequency octave bands, Hz							
		63	125	250	500	1000	2000	4000	8000
1	V	–	235,6	235,6	235,6	235,6	235,6	–	–
2	μ	–	0,75	0,7	0,8	1	1,4	–	–
3	B_{1000}	–	11,8	11,8	11,8	11,8	11,8	–	–
4	L_N	–	**68,6**	**66,3**	**67,8**	**61,8**	**55**	–	–
5	B_I	–	8,8	8,2	9,4	11,8	16,5	–	–
6	S	–	172,8	172,8	172,8	172,8	172,8	–	–
7	L_{more}	–	57	49	44	40	37	–	–
8	k	–	1,25	1,25	1,25	1,25	1,25	–	–
9	R_{req}	–	23,5	29,5	35,5	32,5	27,2	–	–
10	R_{mid}	–	18,2	18,2	18,2	18,2	18,2	–	–
11	ΔR	–	–5,4	–11,4	–17,3	–14,3	–9,1	–	–
12	The sound level inside shelter (p. 7, p. 11)	–	62,4	60,4	61,3	54,3	46,1	–	–

Table 7

Decrease in octava levels of a sound taking into account turns from the street to the platform and "shelter", changes of sections between entrances and the main rooms of the platform and "shelter"

Number	Link	Geometric mean frequency octave bands, Hz							
		63	125	250	500	1000	2000	4000	8000
1	ΔL_p formula(70) in BNR II-12-**77**	–	0,93	0,93	0,93	0,93	0,93	–	–
2	Table. 21 in BNR II-12-**77**	–	7	5	3	3	3	–	–
3	Table. 3 p. 15 – (p. 1 – p. 2)	–	–14,5	–5,9	0,9	–4,0	–12,2	–	–
4	L_N in the shelter after passing through the vestibule Table. 3 p. 2 + p. 3	–	42,5	43,1	44,9	36,0	24,8	–	–
5	The sound level on site Table. 5 p. 4	–	53,8	54,3	53,9	47,3	39,5	–	–
6	L_N in the shelter after passing through the walls and roof p. 5 – Table. 1 p. 1	–	27,3	23,3	18,4	14,8	4,5	–	–
7	Total $L_{shelter}$ p. 4 + p. 6	–	42,7	43,2	44,9	36,0	24,8	–	–
8	Compared to the norm Table. 5 p. 7 – p. 7	–	14,3	5,8	**–0,9**	4,0	12,2	–	–

Note. In 1 and 2 PL. 7 apply the classical method of calculation of noise reduction developed by E.Y. Yudin, with reference to the formula and the table is not dejstvuyuschego Russia (but relevant on this issue) BNR II-12-77.

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