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1. Alexandra GOGA BODNÁROVÁ, 2. Zuzana FARKAŠOVSKÁ, 3. Ervin LUMNITZER

EFFECT OF NOISE ON DETERMINATION OF INDEX SOUND INSULATION OF THE SEPARATING ELEMENTS IN ENGINEERING MANUFACTURE

1-3. Technical University of Košice, Park Komenského 5, 042 00 Košice, SLOVAKIA

Abstract: The aim of this paper is to give a general description and analysis of the method for measuring airborne sound insulation separating structures according to STN EN ISO 140-4, STN EN ISO 140-14 and STN EN ISO 717-1 and develop guidance on the evaluation of airborne sound insulation of these structures in the software program NorBuild 1028 and examine if the choice of excitation signal has an effect on the measurement results. This paper describes an accurate measurement procedure, including a description of the used measurement technique that was used in measuring the sound insulation of the selected partition walls at different excitation sound field.
Keywords: airborne sound insulation, NordBuild software

1. BACKGROUND

Engineering and construction practices currently convinces us that we can´t satisfactorily eliminate all negative environmental factors. One of these factors is noise, and therefore solution of noise reduction issue is nowadays an essential requirement to ensure acoustic comfort home and work environment. This requirement is also reflected in the engineering, construction and in other kind of industries, where are applied all kinds of partition elements and structures. In the design and determination of partition elements and structures in engineering and other operations are currently using a computer and special software programs. Using such software is the entire measurement and evaluation process much easier and allows you to create designs on the high standard of quality.

2. SOUND PROPAGATION IN THE BUILDING STRUCTURE AND ELEMENTS

The sound from the source, which is located in volume room spreads through sound waves and falls on the building structure and it also radiates into space the receiving room. The thickness of the building structure is smaller than the wavelength of the incident sound wave in a wide range of frequencies. This leads to wave propagation in separating elements and also to partial re-transmitting to volume room but especially to the receiving room (depending on the sound insulation of walls). [1]

3. AIR- BORNE SOUND INSULATION

Airborne sound insulation of building structures is the ability of separating construction transmit sound power airborne from the source to the protected room but much weaker. (Figure 1) [1]

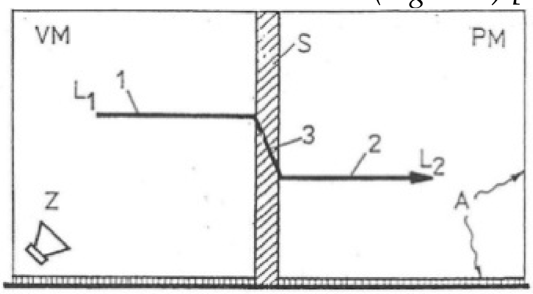


Figure 1. The principle of definition airborne sound insulation of the building construction
Figure description: L_1 – medium level of the sound pressure in volume room [dB], L_2 – medium level of the sound pressure in receiving room [dB], 3 - decrease in the level of the sound pressure influence of sound insulation of the building structure.

The main criterion for sound insulation evaluation of separating structures is the degree of the laboratory airborne sound insulation R [dB] and of the building airborne sound insulation R [dB] and laboratory index of the sound insulation Rw [dB] and building index of the sound insulation R'w [dB]. We compare the measured value of the building index sound insulation with the minimum requirements set out in the standard STN 73 0532. [1]

3.1. Laboratory level of the airborne sound insulation

Sound energy which is falling to the separating structure is transmitted to the receiving room just with its area. We talk about laboratory airborne sound insulation. In this case it doesn´t occur to the sound propagation by ancillary ways.

The levels of the sound pressure are preferentially measured in the third octave band in the receiving and volume room.

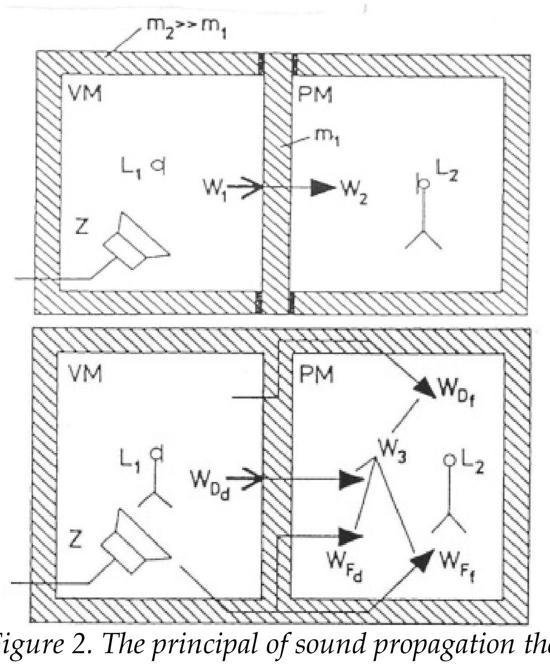


Figure 2. The principal of sound propagation the building structure with suppression of sideways (left), the principal of sound propagation the structure with designation of sideways (STN EN ISO 140-4) (right) Figure description: W_{Dd} – sound power which enter to the wall and from the wall is again directly radiated [W]. W_{Df}- sound power which enter to the wall and is radiated with sides stuctures [W]. W_{Fd}- sound power which entersnto sides structures but is radiated directly from the wall [W]. W_{Ff}- sound power which enters to sides structures but is also radiated from sides structures [W]. W_{Otv}- sound power which is transferred (by air) without a gap [W]. ***Error! Reference source not found.***

3.2. Level of the building sound insulation

If we know spectral course of airborne sound insulation which is measured directly in building, we talk about building sound insulation R´ [dB)]. In this case the airborne sound insulation R´ has negative affect to sound propagation with sides ways or holes, leaks, joints, cracks, leap etc. The sides ways are usually defined by the radiated sound power in the individual ways of propagation according to Figure 4.

4. METHODOLOGY FOR MEASURING BUILDING SOUND INSULATION INDEX FOR CONSTRUCTION R'W AND INSTANCE OF SEEMINGLY SOUND INSULATION R' ACCORDING TO EN ISO 140-4

Sound insulation in buildings is measured in one-third - octave bands has first been agreed measurement in octaves. In the volume room must be built steady sound with a continuous spectrum in this frequency range. Most used is a broadband signal that can be adapted to the reception room to ensure the same high frequencies the signal - noise. As a source of noise we use omnidirectional speaker, which provides us with a uniform omnidirectional radiation according to the specifications. It can also be used more sound sources, but must be the same type and uncorrelated signal transmitted at the same level. When using a single sound source, this source is placed in at least two positions. If you have a different room volumes as a broadcasting room is used more of them. [2]

To evaluate the apparent sound insulation can be used the results obtained in one direction or in both directions. Speaker position must either be in the same room or the measurement must be repeated. In the opposite direction during the process of volume and receiving rooms with one or more positions of power in two rooms of buildings. Speakers are placed so as to achieve the highest sound field diffusion. Distance from the side and bulkheads must be such that doesn´t predominate directivity of such elements. [2]

4.1. The positions of microphone placement and position of the source (according to STN EN ISO 140-4)

In determining the direct sound pressure levels may be used one microphone (moved from one place to another place) or an assembly of stationary microphones, microphones moving on circular track or continuously moving microphone. If we have different positions of the microphone location and must determine the average energy. [2]

4.2. The real source location

Location source was placed at two designated sites in the volume room.

- *1.0 m distance from the side walls of the room,*
- *9.5 m distance from the measured building structure,*
- *4.0 m distance between resources,*
- *1.7 m distance from the first microphone position.*

4.3. The real location of microphones

When measuring the sound insulation according to STN EN ISO 140-14 shall designate ten measurement points in volume room and ten measurement points in the receiving room. The first measuring point shall be located closer than one meter from the source. Other data points you select in the volume and receiving room freely, and we must ensure that they are distributed evenly. The following schematic drawing (Figure 3) shows us the location of the measurement points according to STN EN ISO 140-14.

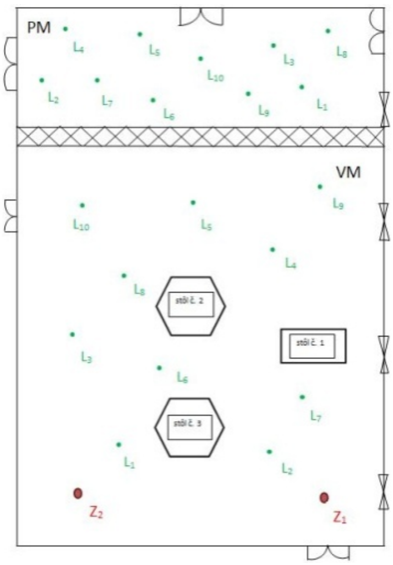


Figure 3. Positions of the microphones location in the receiving and volume room

A reverberation measurement with source location in two positions in receiving room. Location of microphone was in three positions and totally it was six positions. We used impulse method for reverberation measurement (balloon).

5. INSTRUMENT EQUIPMENT

5.1. Sound level meter NORSONIC Nor 140 *(Figure 4 –a) it is the impulse integrating sound level meter of the immediate maximum and minimum equivalent sound level A and C, sound exposure and upper level. Accuracy class of the sound level meter is 1. The dynamic range is 120 dB. Instrument je equipped with a parallel measurement with filters A and C or Z. In the instrument is implemented function for measurement building acoustic magnitude.*

5.2. Noise generator Nor 280 *(Figure 4 – b) it is the equipment which generate white or pink noise. These kinds of the noise bindes to piezoelectric and magneto-dynamic changers.*

5.3. Omnidirectional sound source NORSONIC 270 *(Figure 4 – c) is the equipment which radiates acoustic energy evenly to the all directions. The equipment has a spherical shape from 12 loudspeakers and they are connected serial-parallel.*

Figure 4 a) Sound level meter NORSONIC Nor 140. b) Noise generator Nor 280, c) Omnidirectional sound source NORSONIC 270

6. DETERMINATION OF THE SOUND INSOLUTION INDEX R'W AND INSTANCE A SEEMINGLY SOUND INSULATION R 'SELECTED WALLS IN DIFFERENT SOUND FIELD EXCITATION

6.1. Excitation of the sound field in volume room using pink noise with excitation interval 75-78 [db]

Measured building structure is situated in the area of Technical University in Košice in Environment Department. The partition is situated on the first floor among two rooms number 19 and 20. Thickness of the partition is 16 cm and is made from brick blocks and without holes.

a. Configuration of the experiment

The measurement was carried in the rooms No. 19 and 20 with sound level meter Nor 140 (manufacturer NORWAY, serial number 1403867, microphone NORSONIC, Nor1225 type, serial number 112818, accuracy class 1) at Department of the Environment. The measuring device has been verified in accordance with applicable regulations metrology.

As a first step was to calculate and mark the measuring points in the volume room (room no. 19) and also in the receiving room (room no. 20).

Before the measuring it was necessary to draw and contrain receiving and volume room. To determine the dimensions of the room was used plastic tape measure (manufacturer STRATEG and type 2 meters finder DISTO D5, serial number 390951175). It was also necessary made a volume calculation of volume and receiving room and calculation of common area measured building partition which is situated between rooms No. 19 and No. 20.

To create white noise and pink noise generator was used Nor 280 (manufacturer NORSONIC AS NORWAY, serial number 2803632), which was placed in volume room on the floor. When measuring the sound insulation of building partition is used omnidirectional sound source Nor 270 (NORSONIC manufacture, serial number 30756) which are moved from point Z_1 to point Z_2 and opposite. Hearing protection from adverse impact of pink and white noise was necessary to use a hearing protector manufacturer ČERVA type 1310.

b. Volume of both rooms

The volume of the receiving room: $V = 64.7\ m^3$

Volume of the volume room: $V = 220.2\ m^3$

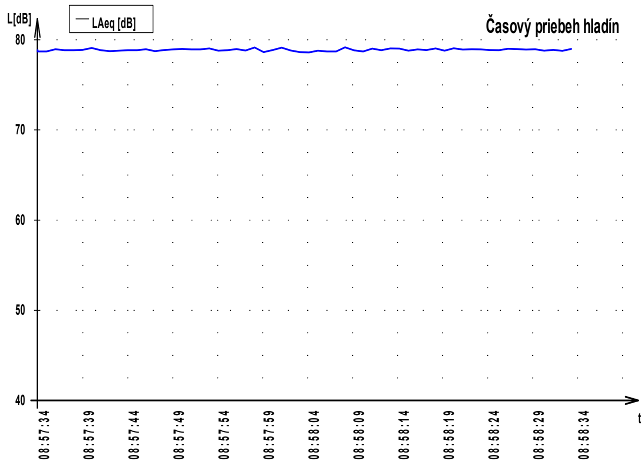
c. Area used to calculation R′

The common area of partition structure: $S = 20.80\ m^2$

d. Measurement of sound pressure level of background noise L_b and the sound pressure level of background noise L_{b1} through L_{b10} in different locations receiving room as well as measuring the average reverberation time T and the receiving room reverberation T_1 to T_6 in different locations receiving room were performed only once.

e. The excitation characteristic

In the volume room we used for excitation pink noise. Equivalent sound pressure level LAeq values reached 75 to 78 [dB] and to the farthest and closest measuring point from the source. The time course of noise excitation is shown in Figure 5 (left). From the picture it is clear that it is a continuous uniform sound. Frequency Response excited noise is shown in Figure 5 (right).



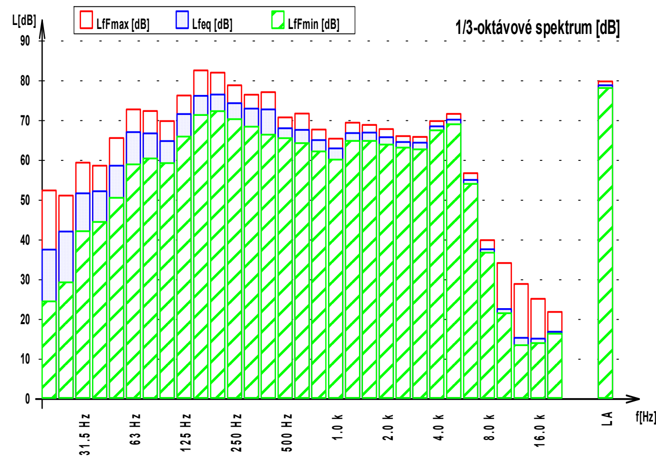


Figure 5. Time course of the levels of pink noise excitation interval 75-78 [dB] volume room (left), frequency response for pink noise excitation interval 75-78 [dB] volume room (right)

6.2. Sound field excitation in broadcast room with white noise excitation interval 75-78 [dB]

Description and identification of building structure, the test configuration, the volume of both rooms and space used to compute R is the same in terms of sound field excitation in volume room using pink noise excitation interval 75-78 [dB].

Measurement of sound pressure level of background noise L_b and the sound pressure level of background noise L_{b1} through L_{b10} in different locations receiving rooms as well as measuring the average reverberation time T and the receiving room reverberation T_1 to T_6 in different locations receiving room were performed only once.

a. The excitation characteristic

In volume room, we used to excitation white noise. Equivalent sound pressure level LA_{eq} values reached 75-78 [dB] and to the farthest and closest measuring point from the source. The time course of the noise excitation is shown in Figure 6 (left). From the picture it is clear that it is a continuous uniform sound. Frequency characteristic of excited noise is shown in Figure 6 (right).

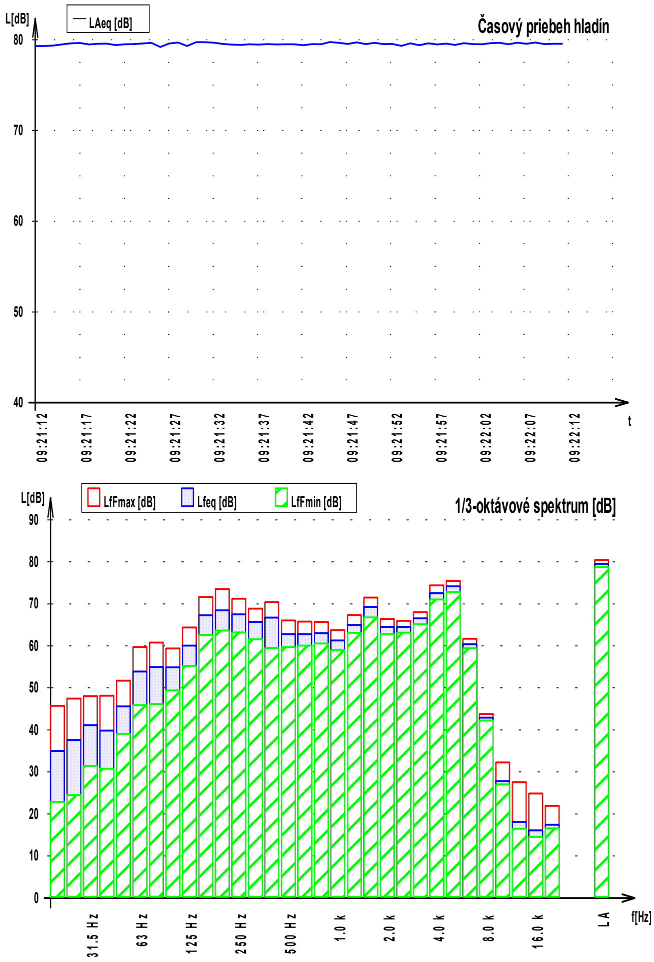


Figure 6. Time course of levels for white noise with excitation interval 75-78 [dB] of the volume room (left), frequency response for white noise with excitation interval 75-78 [dB] of the volume room (left)

7. MEASUREMENT RESULTS

Next tab. 1 shows measurement results. From these results of measurement is obviously the values in individual standards exhibit no important divergences. The values of building index sound insulation moves in level 38-39 dB in two instances. In pursuance of finding results we can say that the choise of noise signal for generation sound field depends on an expert which realizes the measurement.

Table 1. Excitation interval of the pink and white noise and index of the building sound insulation for pink and white noise

Excitation interval pink noise [dB]	Excitation interval white noise [dB]	Index of the building sound insulation R'_w pink noise [dB]	Index of the building sound insulation R'_w white noise [dB]
75÷ 78	75÷ 78	38 (-1; -3)	39 (-1; -2)
80÷ 83	79÷ 83	39 (-2; -3)	39 (-1; -2)
85÷ 88	84÷ 89	38 (-1; -2)	39 (-1; -2)
90÷ 93	89÷ 94	39 (-1; -2)	39 (-1; -2)
95÷ 98	98÷ 94	38 (0; -2)	39 (-1; -2)
98÷ 102	98÷ 102	38 (-1; -2)	39 (-1; -2)

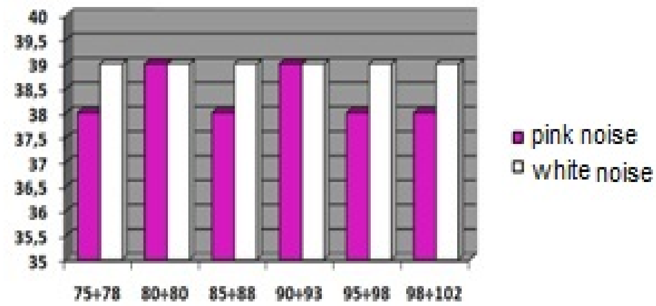


Figure 7. Graphic display of the results and their comparison

8. CONCLUSION

The objective of these measurements was to determine the effect of noise when measuring sound insulation of building walls as in the measurement process is currently using two standards. STN EN ISO 140-4 recommends the use of white noise, and the standard STN EN ISO 717-1 pink noise. Making measurements showed that the measurement standard can be used at the discretion of the expert, since significant differences were found in the results of measurements by different standards.

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