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EXPERIMENTAL JUSTIFICATION OF LIGHT-WEIGHT PANEL CONSTRUCTION FOR PORTABLE ACOUSTIC SCREENS

Statement of the problem. To reduce noise levels to accepted standard values, in industrial premises with permanent and temporary workplaces there is a need for the development of the facilitated and quickly erected internal partitions and acoustic screens. Obligatory requirements for these partitions are the small mass of the design, the simplified installation and disassembling, transportation and storage. These requirements resulted in a search for a rational design of panels and acoustic screens on the condition of their acoustic efficiency.

Results. The design of the facilitated panel which can be used for quickly installed and disassembled partitions in premises as well as for acoustic screens is proposed. For the developed design it is proposed to use polymeric film materials. The results of pilot studies confirm their high soundproofing properties which are unrivalled by acoustic efficiency of partitions from materials of higher density.

Conclusions. The results of pilot studies allow the conclusion that the proposed design of the facilitated panel, a partition or a screen possesses high acoustic efficiency and allows to improve the operational properties of developed portable acoustic screens being in loss of dimensions of a design that simplifies its installation and dismantling, transportation and storage.

Keywords: acoustic screens, noise reduction, sound insulation, sound insulation partitions and panels, construction.

Introduction

One of the most common measures to improve and promote health in workplaces in industrial facilities in this country is to combat noise levels that are harmful to humans. A reduction of noise levels to the accepted standards helps to avoid injury in the workplace, decrease the number of industrial errors and injuries and improve the performance [1].

Industrial noises can be removed only as a result of certain measures taken to improve the technological process and equipment. But these measures do not always prove effective and noise reduction cannot always be addressed by planning and designing and acoustic measures (Fig. 1a). There are normally different industrial operations that involve high noise levels.

Technological operations are often temporary. There is a need to make some changes to the planning of a facility to protect the staff from excessive noise levels which involves building a temporary screen or sound insulation partition (Fig. 1b).

a) b)

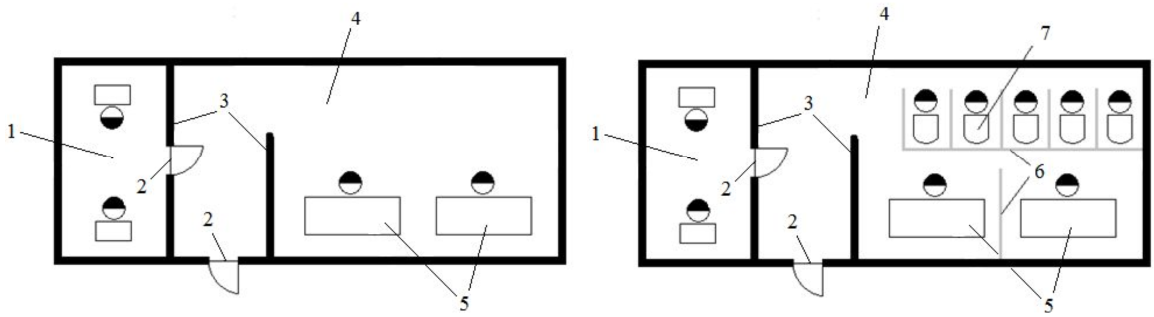


Fig. 1. Schematic of an industrial facility:
a) with permanent workplaces; b) with temporary workplaces;
1 office facility; 2 door; 3 partition walls between the rooms; 4 manufacturing area; 5 permanent workplaces; 6 temporary erected partition (screens); 7 temporary workplaces

1. Criteria requirements for the design of a facilitated panel for portable acoustic screens and tasks facing an experimental study

Effectiveness of a sound insulation partition (screen) is known to depend on its thickness and material density and acoustic screens are dependent on their size as well [3 5]. Traditional materials are not suitable in order to develop the design of erected partitions and acoustic screens and this is first of all due to their large mass [7 9].

Therefore there is a need to search for and substantiate facilitated structures based on polymer film materials.

There are therefore the following requirements for the design of temporary sound insulation partitions (panels) and screens: 1) small mass; 2) simpler installation-disassembly for an easier use and time saving; 3) high sound insulation properties that is unrivalled by traditional materials.

Sound damping structured panel is one of the best technological solutions for facilitated panels that can be used as partitions or screens. This structure is made to be a two-layer one from cardboard or polymer materials (up to 1-2 mm thick) with a rigid corrugated carcass in between the layers.

However, this technological solution for a sound insulation structure puts a restraint on the functional installation-disassembly, transportation and storage.

The most viable technical solution for a sound insulation partition or acoustic screen would be an easily folded (transformed) corrugated panel (looking like a sleeve).

Therefore the experimental study needed to address the following:

– to estimate a sound insulation performance of a facilitated panel depending on the angle of a corrugated profile of the reflecting capacity;

– to estimate sound insulation performance of facilitated panels depending on the combination of the surface geometrical profiles;

– to compare sound insulation performances of a more efficient structure of a facilitated panel with samples of more dense materials.

2. Experimental study method for acoustic performance of a facilitated panel

A setup was used as shown in Fig. 2 for an experimental study of acoustic properties of variant panels. The setup consists of two dismountable chambers (A and B) with a sound source and receiver with a sample panel between them.

In all the series of the experiments a 1mm cardboard was used to make the examined panels. A noise measure device ОКТАВА 110 А was used for the acoustic measurements.

An acoustic system connected to PC was used as a sound source.

A spectral characteristic of this sound source is shown in Table 1.

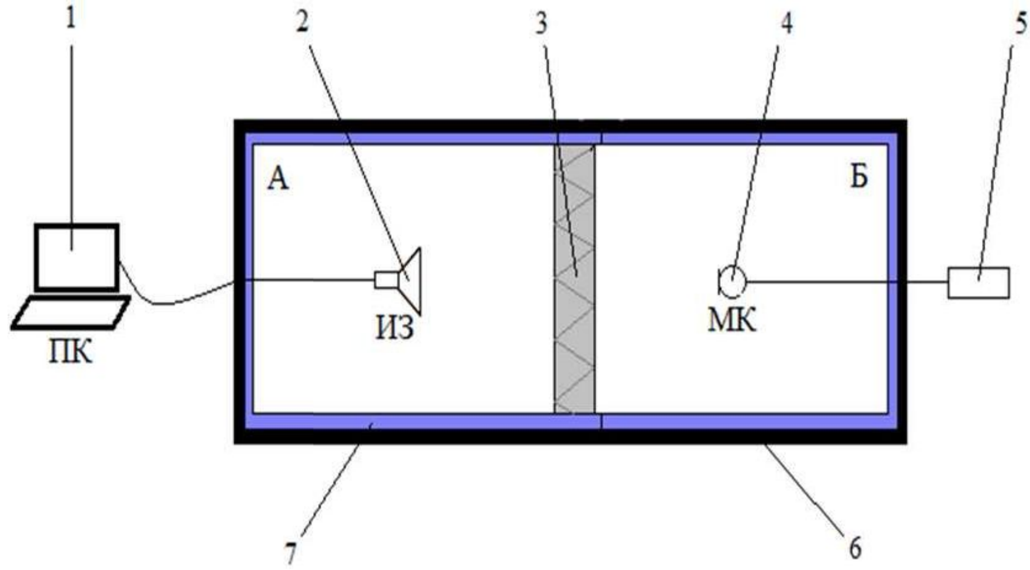


Fig. 2. Schematic of the experiment to determine sound insulation performance:
1 acoustic signal generator; 2 sound source; 3 examined panel structure;
4 microphone; 5 noise measure device; 6 dismountable sound insulation body of the setup; 7 sound damping interior setup

Table 1

Spectral characteristic of a sound source

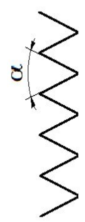
Average geometric frequency, Hz								Sound level, dB
63	125	250	500	1000	2000	4000	8000	
Sound pressure levels, dB								
51.1	41.0	59.4	64.3	65.6	68.1	75.9	64.6	77.7

In order to establish the dependence of acoustic properties of the panel structure on the profile angle of its reflective capacity, the samples with the angles of 0 (or 180), 30 , 60 , 90 were studied. Spectral characteristics of sound insulation performance depending on the angle of geometric profile of reflecting capacity are in Table 2. Table 2 suggests that the variation of geometric angle of reflecting capacity is not much influential on the acoustic performance of the structure.

Therefore an angle of geometric profile of reflecting capacity of the structure surface was further accepted to be 60 .

Table 2

Spectral characteristics of sound insulation performance of a panel with angle variation of geometric profile of reflecting capacity

Profile view	Geometric profile angle of a surface α	Average geometric frequency, Hz								Sound level, dB
		63	125	250	500	1000	2000	4000	8000	
		Sound pressure levels, dB								
	0 /180	44.5	33.5	55.3	56.3	64.5	57.5	61.1	53.0	66.0
	30	35.9	33.8	56.1	60.0	63.9	60.0	64.1	54.0	66.2
	60	44.1	35.0	54.9	58.8	59.8	57.9	62.9	53.8	65.7
	90	47.3	36.0	55.8	56.9	62.0	56.8	61.8	53.9	65.9

3. Reasoning behind the design of a facilitated panel following the experimental study

In the process of a search for the most viable construction solution the above sound damping structured panel was taken into detailed consideration [6].

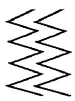
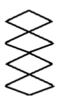
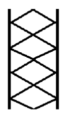
In compliance with the above criterion requirement for installation-disassembly, transportation and storage of a portable panel, its structure should be corrugated. It was therefore necessary to make an experimental study into different variants of combinations of geometric profiles.

The results of the study are identified in Table 3.

The best acoustic performance results are seen in panel structure № 6 whose operational external view is shown in Fig. 3. The panel is installed and disassembled along the curvature lines, which resulted in the structure losing its voluminosity and being easy to transport and taking up little space.

Table 3

Sound insulation performance of the panels depending on the combination of geometric surface profiles

Variation number	Profile combination		Average geometric frequency, Hz								Sound levels, dB
	Profile schematic	Description	63	125	250	500	1000	2000	4000	8000	
			Sound pressure levels, dB								
1		1 flat partition	44.4	46.9	57.3	61.2	62.3	55.1	62.4	48.2	66.7
2		2 flat labeled partitions	43.6	42.1	54.7	61.0	62.2	45.5	51.2	36.1	63.7
3		1 corrugated partitions	44.4	46.9	57.3	61.2	62.3	55.1	62.4	48.2	66.3
4		2 corrugated labeled partitions	42.1	40.7	62.0	63.0	61.1	52.0	55.3	41.1	64.3
5		Rhomb-shaped partition	39.4	39.7	59.7	59.8	63.1	58.2	54.3	42.4	63.2
6		Rhomb-shaped partition between two flat ones	39.3	34.8	50.3	56.0	55.5	49.4	46.9	24.0	58.1

The third stage of the experimental study to establish the correlation of structure variation № 6 to the criterion requirement for high sound insulation properties that are unrivalled by panels from more dense materials. Steel sheet panels (2mm thick) and resin-bonded chipboard (15 mm thick) was used for the comparative assessment.

The results are identified in Table 4.

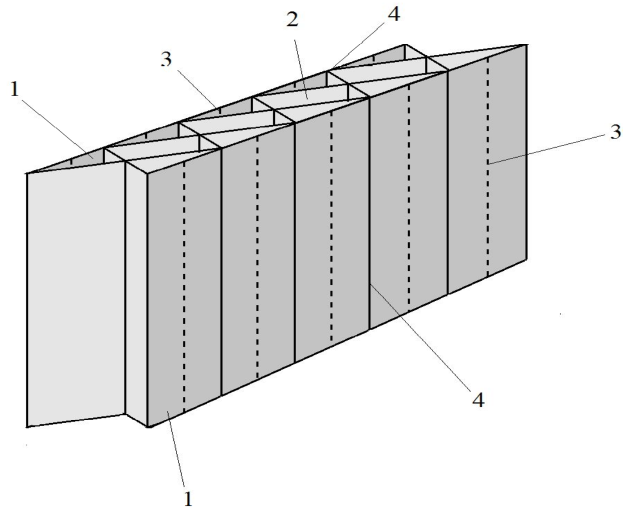


Fig. 3. Rhomb-shaped partition between two flat ones:

1 flat partition;
2 rhomb-shaped partition;
3 curvature line;
4 attaching point of the straight partition to the rhomb-shaped one

Table 4

Comparative table of sound insulation performance of structure № 6 and some materials

Examined sample	Average geometric frequency, Hz								Sound levels, dB
	63	125	250	500	1000	2000	4000	8000	
	Sound pressure levels, dB								
2 mm thick steel	37.4	37.6	49.6	52.8	53.9	48.6	55.3	37.4	58.9
15 mm thick resin-bonded chipboard	38.6	38.0	55.1	56.6	56.0	53.7	51.4	42.7	60.2
Rhomb-shaped partition between two flat ones (variation № 6)	39.3	34.8	50.3	56.0	55.5	49.4	46.9	24.0	58.1

Conclusions

1. It is obvious that the developed facilitated panel (according to variation № 6) outperforms the other samples examined in terms of its sound insulation properties. This is due to its structure features.

2. The developed structure of a facilitated panel for a portable acoustic screen thus has a high acoustic performance compared to panels from more dense materials.

3. The suggested construction solution for a facilitated panel is helpful in improving its operational properties of a portable acoustic screen due to loss of volumonisity, which makes it easier to install-disassemble, transport and store it.

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