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EXPERIMENTAL DETERMINATION OF SOUND ABSORBING COEFFICIENT FOR SELECTED GRANULAR MATERIALS

SUMMARY

The results of investigations of sound absorption coefficients for selected granular materials (polypropylene, polystyrene and garvelite granulates, high-silica sand) being often applied as sound absorbing cores in double-wall partitions are presented in the paper. The results confirmed good sound absorbing properties of granular materials, which placed them in the group of sound absorbing materials applicable in constructions limiting noises of machines and devices.

***Keywords**: sound absorption coefficient, sound absorbing materials, noise control of machines*

DOŚWIADCZALNE OKREŚLENIE WSPÓŁCZYNNIKA POCHŁANIANIA DŹWIĘKU WYBRANYCH MATERIAŁÓW ZIARNISTYCH

W artykule przedstawiono wyniki badań fizycznego współczynnika pochłaniania dźwięku dla wybranych materiałów ziarnistych (granulaty z polipropylenu, polistyrenu i keramzytu, piasek kwarcowy) mających zastosowanie jako rdzenie dźwiękochłonne w przegrodach dwuściennych. Wyniki badań potwierdzają dobre własności dźwiękochłonne materiałów ziarnistych, a co za tym idzie – ich należne miejsce w grupie materiałów dźwiękochłonnych stosowanych w rozwiązaniach konstrukcyjnych ograniczających hałas maszyn i urządzeń.

***Słowa kluczowe**: współczynnik pochłaniania dźwięku, materiały dźwiękochłonne, zwalczanie hałasu maszyn i urządzeń*

1. INTRODUCTION

In constructions of partitions limiting excessive acoustic activity of machines and devices (Engel and Sikora 1998), two kinds of materials are usually used: sound absorbing and sound insulating. There are four main groups of materials, which due to their structure and material properties, can be applied in vibro-acoustic protections. Good sound absorbing properties have materials of honeycomb structure, prous ones, fibrons ones and grannal ones. This last group of materials has special application in integrated enclosures (Engel *et al.* 1999). The authors deve-loped several pro-totype partitions, with granular materials constituting their sound absorbing core, characterised by very efficient acoustic insulation at a relatively small thickness of the partition (10–20 mm). Examples of such solutions are given in Figures 1 and 2.

Sound absorbing cores were made of granular materials (Sikora 2005, Sikora and Turkiewicz 2005) such as: lead shot, granulated products from plastics and building aggregates, high-silica sand. There is a total lack of information concerning sound absorbing properties of this type of materials in the scientific and technological literature. This situation has prompted the authors to start tests, from which the preliminary, promising results are presented in the paper.

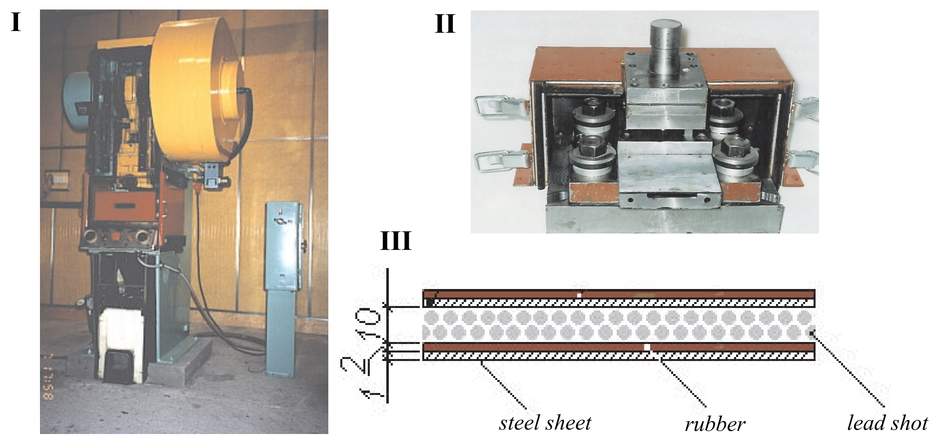

Fig. 1. Lead shot in a double-wall partition (III) of the integrated sound absorbing and insulating enclosure of the punching die (II) in the eccentric mechanical press (I)

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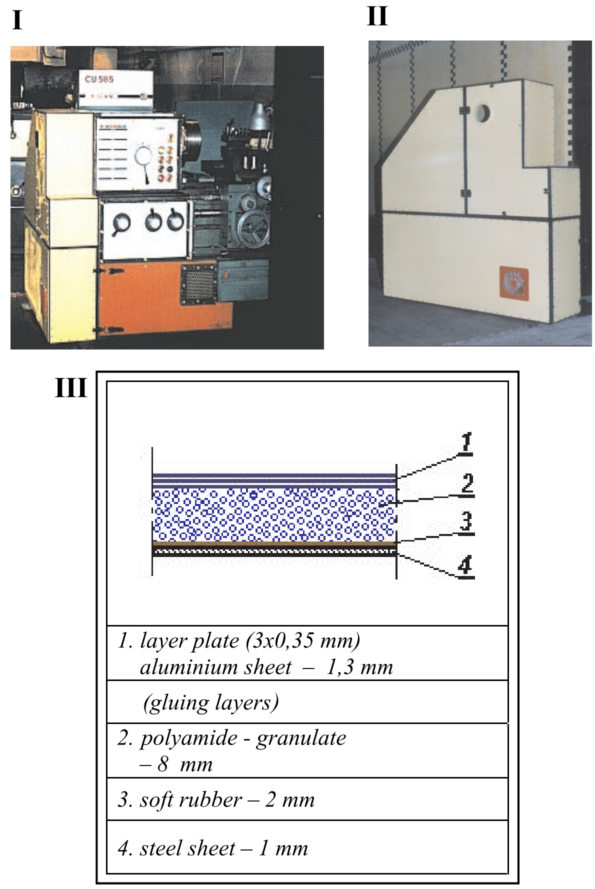

Fig. 2. "Tarnamid" granulate in a double-wall partition (III) of the modified enclosure of driving kinematic chains (II) of the engine lathe (I)

2. EXPERIMENTAL PART

Investigations of physical sound absorption coefficients (at a perpendicular incidence of sound wave on the absorbing surface) were performed for four kinds of granular materials (used previously as sound absorbing cores in double-wall partitions): polypropylene, polystyrene and gravelite granulates, high-silica sand (Fig. 3).

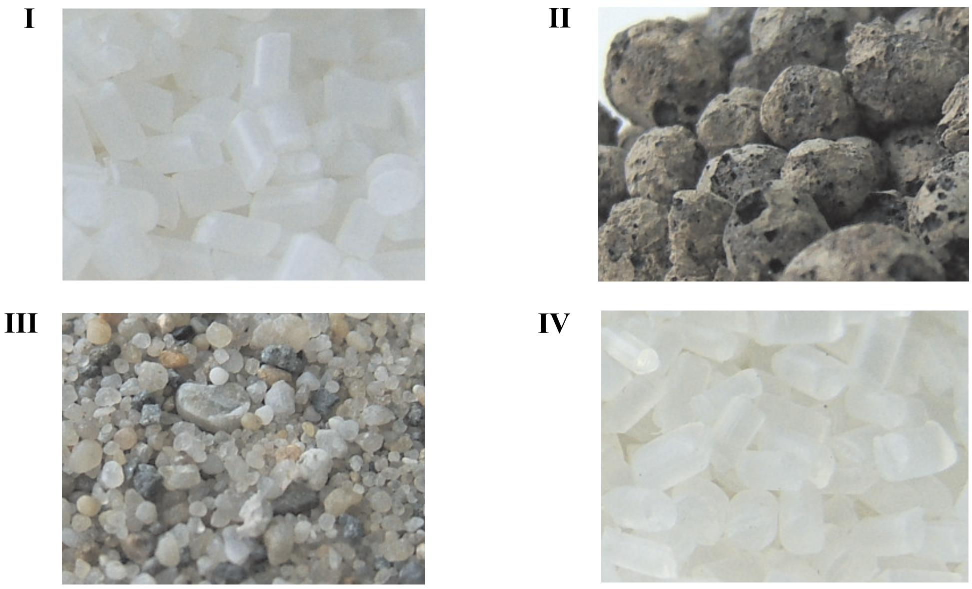

Fig. 3. Granular materials for which tests were made:
I – polypropylene, II – garvelite, III – high-silica sand, IV – polystyrene

The impedance tube (Kundt's tube) was applied in tests since it allows to determine the sound absorption coefficient by means of the method utilizing the coefficient of stationary wave. This method is useful for a conceptual approach as well as for preliminary tests enabling assessing the suitability of new materials with a view to their sound absorbing properties. Small samples of material, discs of a diameter 30 and 100 mm are sufficient for performing tests.

Material samples of a layer thickness: 20 and 50 mm were tested. Individual materials were placed in specially developed plastic sleeves closed on one side by solid walls and on the other side (the one from the side of the wave incidence) by elastic, thin unwoven fabrics of small meshes (Fig. 4). Sleeves were made in two versions of thickness and diameters.

The obtained results were elaborated in the form of graphs and the cumulative table. Characteristics of sound absorption coefficients for samples of granular materials of a layer thickness 20 mm are presented in Figure 5.

Characteristics of sound absorption coefficients for samples of granular materials of a layer thickness 50 mm are presented in Figure 6. Comparative list of all obtained results is given in Table 1.

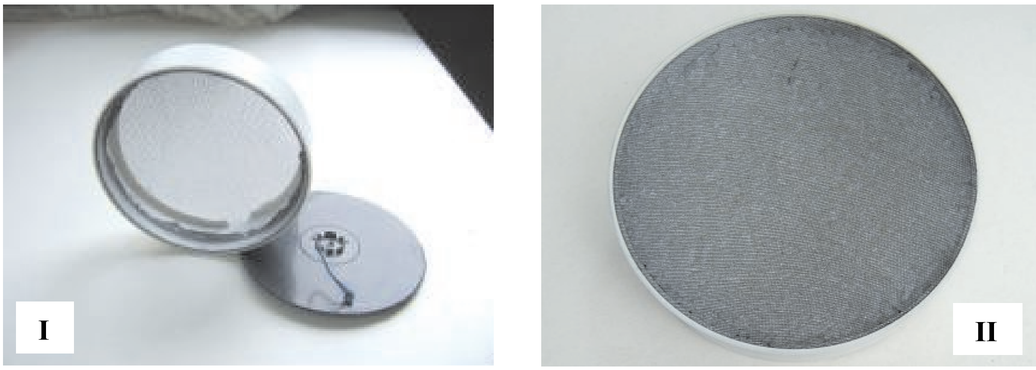

Fig. 4. Example of a sleeve enabling investigating the sound absorption coefficient of granular material: I– sleeve of a diameter 100 mm and thickness 20 mm, II – sleeve filled with granular material (polypropylene)

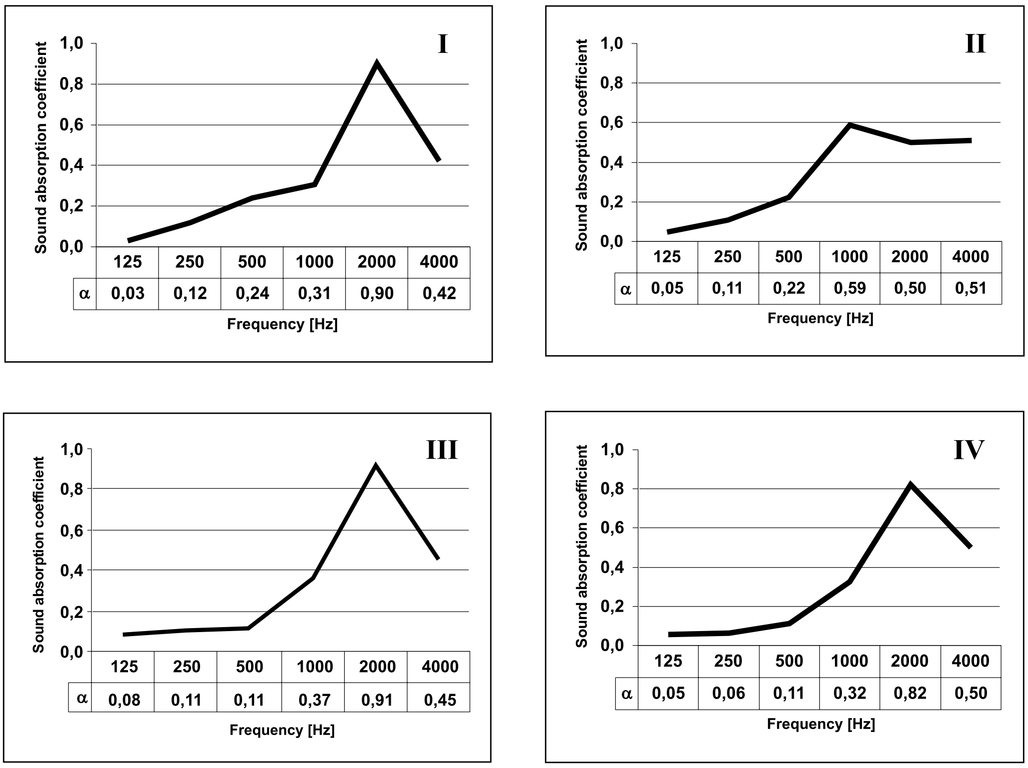

Fig. 5. Characteristics of sound absorption for samples of a layer thickness 20 mm: I – garvelite, II – high-silica sand, III – polystyrene, IV – polypropylene

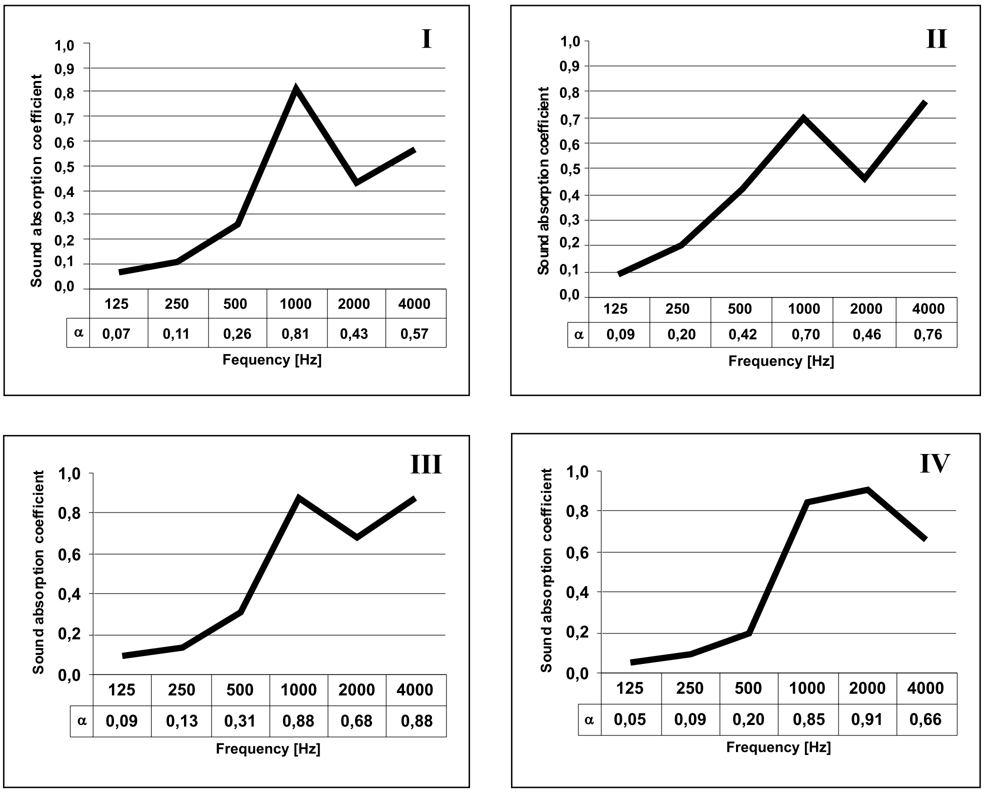

Fig. 6. Characteristics of sound absorption for samples of a layer thickness 50 mm:
I – garvelite, II – high-silica sand, III – polystyrene, IV – polypropylene

Table 1

Sound absorbing properties of selected granular materials

No	Kind of material	Thickness of layer [mm]	Mass density [kg/m^3]	Sound absorption coefficient α_f						
				Frequency [Hz]						Mean value $\alpha_{f\,śr}$
				125	250	500	1000	2000	4000	
1	Polypropylene	20	626	0,05	0,06	0,11	0,32	0,82	0,50	0,31
2	Polypropylene	50	626	0,05	0,09	0,20	0,85	0,91	0,66	0,46
3	Polystyrene	20	667	0,08	0,11	0,11	0,37	0,91	0,45	0,34
4	Polystyrene	50	667	0,09	0,13	0,31	0,88	0,68	0,88	0,50
5	Gravelite	20	333	0,03	0,12	0,24	0,31	0,90	0,42	0,34
6	Gravelite	50	333	0,07	0,11	0,26	0,81	0,43	0,57	0,38
7	High-silica sand	20	1600	0,05	0,11	0,22	0,59	0,50	0,51	0,33
8	High-silica sand	50	1600	0,09	0,20	0,42	0,70	0,46	0,76	0,44

3. CONCLUSIONS

Preliminary investigations of sound absorbing properties of the selected granular materials have showed that they can be considered as sound absorbing materials. Thus, sound absorbing materials and products used in industrial vibroacoustics (fibrous materials – mineral and glass wools, different kinds of unwoven fabrics, porous materials – polyurethane foams, foam glass, foam rubber, materials of a 'honey comb' structure) can be successfully supplemented by granular materials.

The tests have shown that the characteristics of sound absorption of granular materials are similar to the classic sound absorbing materials.

Granular materials are mainly applied as sound absorbing cores in double-wall partitions. Partitions filled with those materials are characterised by a very good acoustic insulation at small thickness (10 to 30 mm). It is caused by much higher volumetric mass of granular materials as compared to fibrous materials. Volumetric masses of mineral wools are not exceeding 200 kg/m^3.

The obtained promising results prompted the authors to broaden the research programme by including new granular materials (especially rubber granulates). The investigations should provide also the answer concerning the influence of a shape and grain fraction of granular materials on their sound absorption properties.

The presented study was performed within the statutory research of the Dept. of Mechanics and Vibroacoustics, AGH in years 2006–2009. Investigation Task No 3: "Methods of measuring and reduction of vibroacoustics hazards".

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