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EFFECT OF THE SOUND ABSORBING LININGS ON THE STRUCTURE OF THE ACOUSTIC FIELD IN THE PREMISES

AKMALAYEV K.[1], TUKIBAEVA M. [1], OMAROV C. [1]

[1]The Kazakh national technical university, The Republic of Kazakhstan

Abstract

The influence of absorbent linings in the form of the structure of the acoustic field in the premises. For the study we examined the surfaces of the wings sound absorption on the basis of decorative acoustic blend of cotton waste production. In this paper we propose a rapid method for estimating the sound pressure level sound absorbing facings flat space frame structures.

Thus it is possible to distinguish two moments: pores size in average little bit less millimeter that lays in the field of acoustically effective pores; additives of active substance and PAB serve as the center of crystallizations for hydrating from the grains of plaster double aqueous calcium sulfate knitting crystals dissolved in water. From the sample microstructure it is visible, that crystals of double aqueous calcium sulfate is formed not only in the form of petals and the truncated prisms. Such morphology of crystals assumes higher durability of intercrystal contacts and accordingly forms structure with higher durability of material.

Key words: *acoustic field, sound absorption, the relaxation absorption, decorative and acoustic mix*

1. INTRODUCTION

Acoustic field in a closed volume is the result of addition of direct and reflected sound waves. In connection with this circumstance, the probability distribution function of sound pressure depends on the amount of room reverberation time, the distance between source and detector, orientation, number and location of sound sources, the indoor environment, surface conditions and geometry of the room.

The acoustic environment in this area requires consideration of all these complex physical and geometrical parameters that affect the acoustic field.

Exact calculation of the effect of absorption on the structure of the acoustic field in large production areas is extremely complex. This is due to the fact that in these areas should take into account the absorption in the amount of space in the immediate vicinity of the surfaces and structures protecting the premises. The difficulty lies in the fact that the absorption in the medium of space is masked by the absorption of sound energy near the wall in the acoustic boundary layer thickness δv [1].

2. APPROACHES, TOOLS, DATA, DOMAINS AND NESTING

The work of viscous forces, transforms acoustic energy into heat and per unit volume is proportional to the volume of medium magnitude of the wave number K2, and in the boundary layer, the value of 1 /. The volume in which the absorption occurs - is the amount of space, respectively, the boundary layer and the cladding. By order of the volume of space and the boundary layer are, respectively, L3 δv and L2, where L - the linear size of the room. As a result, the ratio of energy absorbed in the medium and in the boundary layer near the walls, will be equal in order of magnitude [1]:

$$\frac{K^2 L^3}{\frac{1}{\delta_v^2} \cdot \delta_v \cdot L^2} = \delta_v \cdot L \cdot K^2 \qquad (1)$$

Figure 1 shows the approximate calculation of the dependence f / hertz / to air = 0, 0002 m. The calculation was performed for areas with linear dimensions 10, 20 and 40 m (scale logarithmic), whose results show that with increasing frequency ratio increases in the frequency range of 1000Hz viscous losses in the medium and the walls are compared.

In the above calculation does not take into account the relaxation absorption cause by the presence of air, water vapor and carbon dioxide vapors. So in reality, the absorption at the walls and the volume of the medium becomes equal to and at a lower frequency.

The results show that the absorption in the small room in the boundary layer plays an important role in the total energy losses, approximately the same as the viscosity contributes to the loss and thermal conductivity, since the order to continue the relationship and taking into account both mechanisms [2]. Behavior of the sound field in real industrial environments depends on what the contribution of absorption for axial, tangential and oblique waves.

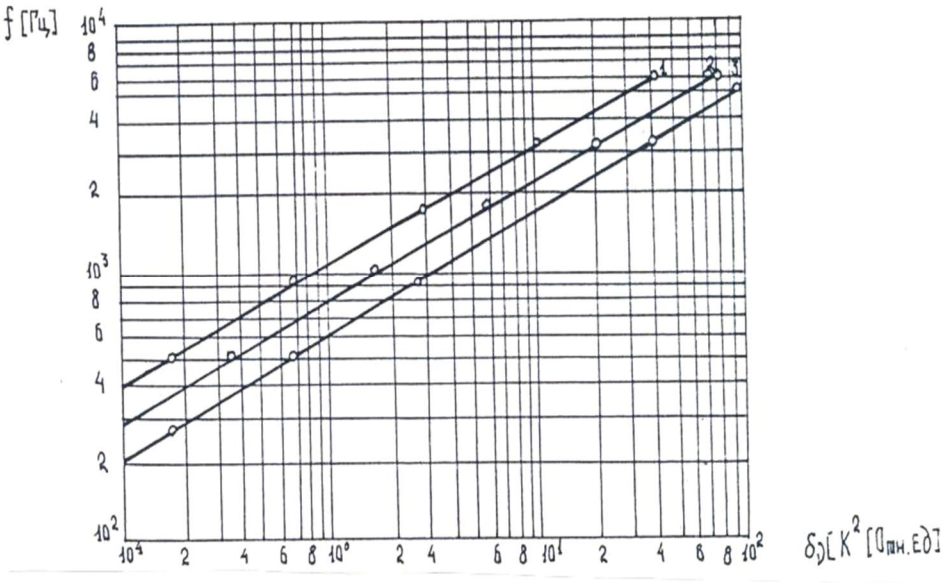


Fig. 1. From a calculation of the frequency dependence of f / Hz / airfor c = 0, 0002m. Linear dimensions of the room 10, 20 and 40m

For axial waves each wall space contributes to the absorption coefficient, but the wall on which the sliding surface of the wave, causing less absorption at equal conductivity. On the other hand, the absorption efficiency of the tangential wave surfaces of a rectangular area selected depends on the

orientation relative to the surface of the wall. For the surface, where the wave vector makes an angle with the normal 900, the efficiency of absorption half.

3. APPLICATION VALIDATION

The greatest contribution of the surface absorption can be observed when using the speaker "wings" where there are all kinds and directions of the incident surface wave absorbers.

Sound-absorbing element is a rocker-type body length and the width is much greater than the thickness.

The combined in a certain way in the space of the premises separate elements form a space lattice, which can be regarded as a sound-absorbing system with distributed elements of the system smaller quantities, providing the conditions for their independent work.

At all frequencies of acoustic scenes provide a higher absorption of sound at the same flow rate of absorbent material. Save sound-absorbing materials in short supply in this case is obvious.

Reduction of sound pressure level in the area of the reflected sound can be determined by the formula:

$$\Delta L = 10 \lg \frac{B_1}{B} \qquad (2)$$

Where B is a constant to the acoustic treatment, B1 - permanent premises after the acoustic treatment.

To calculate the absorption wings, designed by the author's using the formula [2]:

$$\Delta L = 10 \lg \frac{\frac{S}{1/B + 1/S} + \Delta A^1 \cdot S \cdot S_{КУЛ}}{\frac{S}{1/B + 1/S} + \Delta A^1 \cdot B \cdot S_{КУЛ}} \qquad (3)$$

Where the S-total area of building envelope surface, m^2.

SKUL - surface area of the wings; ΔA1 - additional sound absorption surface of the wings, divided by the area of 1 m^2 of ceiling on which the wings.

Developed by the authors behind the scenes, a sound system of the double plate made of decorative and acoustic mix of waste cotton plants [2] is shown in figure 2 and figure 3. Proposed in this paper, the scenes, as shown, has the highest efficiency in manufacturing plants with high levels of sound pressure.

In some cases, the practice of design and construction of buildings with high sound absorption requires rapid assessment of the approximate number of sound-absorbing lining for the premises. This should be taken into account not only the total area of the lining, but the dominant frequency of the level of the intended sound. In this paper we propose a method for calculating the rapid - assessment

of reduction of sound pressure level inside the building depending on the area facing absorbers and frequency of the incident sound wave. For the calculation were chosen the most popular in the construction of the former CIS materials, including materials developed by the authors of this paper.

Table 1. Shows a comparison of acoustic absorption wings and flat sound absorbing paneling of the room.

Frequency, Gz		125	250	500	1000	2000
ΔA^1	Wings	0,6	0,9	1,2	1,55	1,55
	Flat lining	0,2	0,5	1,1	1,25	1,25

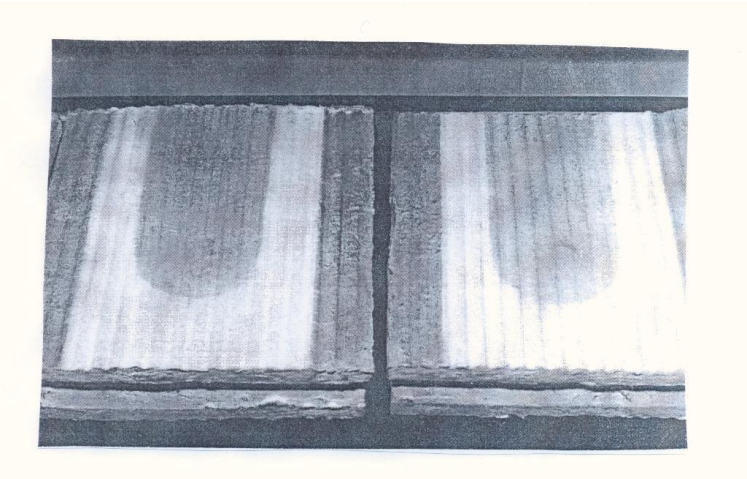


Fig. 2. Placing speakers behind the scenes

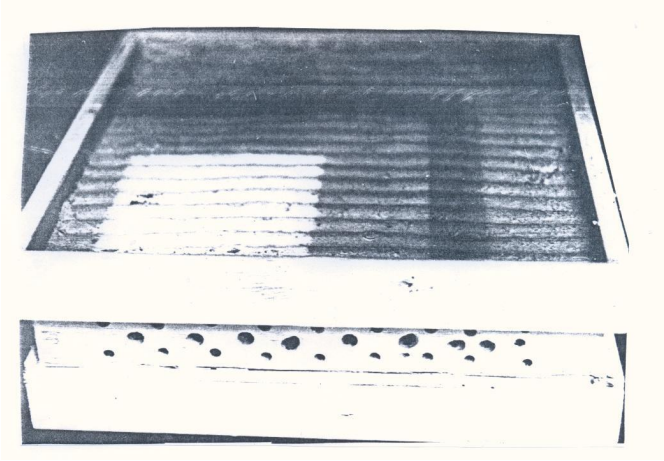


Fig. 3. Akusticheskaya rocker with a "trap"

Calculation of reduction of sound pressure level depending on the amount of space, sound-absorbing surface area depending on the frequency of sound performed by the formula [1]:

$$\Delta l = \frac{\frac{S}{1/B + 1/S} + \Delta A^1 \cdot S \cdot S_{3B}}{\frac{S}{1/B + 1/S} - \Delta A^1 \cdot B \cdot S_{3B}} \qquad (4)$$

Where the total area of S-walling the room, m^2;

B - constant area, m^2;

A^1 - a parameter depending on the size of sound-absorbing panels and distance between them.

The area of sound-absorbing panels sound

$$S_{sound} = \frac{S\left(10^{0,1\cdot\Delta L} - 1\right)}{\Delta A^1 \left(\frac{1}{B} + \frac{1}{S}\right)\left(B \cdot 10^{0,1\cdot\Delta L} + S\right)} \qquad (5)$$

In this condition must be satisfied:

$$\Delta A = \frac{S\left(10^{0,1\cdot\Delta L} - 1\right)}{S_{OII} \left(\frac{1}{B} + \frac{1}{S}\right)\left(B \cdot 10^{0,1\cdot\Delta L} + S\right)} \qquad (6)$$

This paper has been determined the dependence of for rooms with volume: 1800 m^3 protecting the surface = 1120 m^2, 600 m^3 protecting the surface = 2780 m^2, lined with acoustic tiles "silakpor" for premises with a volume of 1800 m^3 acoustic tiles "akmigran" and facilities for up to 2000 m3 penogipsovymi acoustic tiles, designed by the authors of this paper.

Penogipsovye plates authors [2] is a single-layer flat products, mostly square.

Technical characteristics:

Dimensions:	300x300x20
Weight of 1 m^2	12,9 kg
The average density, kg/m^3	500-600
Flexural strength, MPa	0,8 – 1,2

Sound absorption coefficient on the frequencies, Hertz

	500	0,35-0,45
	1000	0, 65 – 0,75
	2000	0,7 – 0,8
Hygroscopicity, %	3	

We calculated decrease in sound pressure level depending on the amount of space, sound-absorbing surface area, lined with acoustic tiles "silakpor" and "akmigran" and constructed a graph of the indicative reduction of sound pressure level of the proportion of the area facing "silakporom" in relation to the total area surfaces enclosing the room for all frequencies of octave bands.

The graph (Figure 1) allows tentative, without lengthy calculations to evaluate rapid method of reducing sound pressure plates, for example, "silakpor" if we know the possible area of cladding.

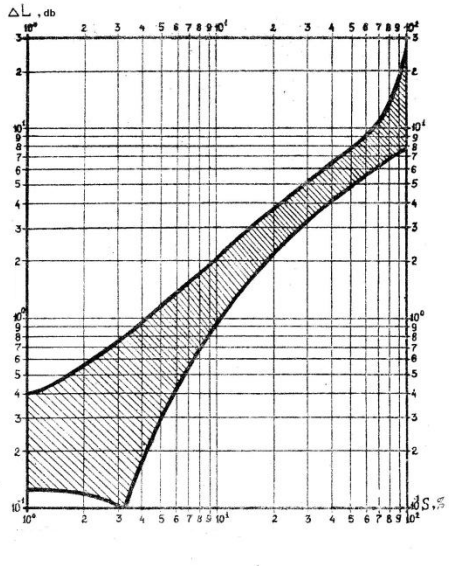


Fig. 4. Dependence reducing sound pressure on the share of the area facing the surface of the enclosing area (% of total area of building envelope)

Preliminary calculations show that the use of this type of flat lining is on the (60-70)% of total surface area in the design or renovation of facilities will eliminate the excess of the sound pressure level of the normative values.

4. SOME EXAMPLES FROM THE NUMERICAL EXPERIMENTS

Thus, knowing the exact range of the sound in any room, you can choose sound-absorbing lining to the relevant maximum absorption coefficient in this frequency range.

Authors of this work had been developed the technological scheme including following basic operations: separate preparation of suspension of fibre and foam gypsum mass, obtain of foam gypsum mass, pressing and thermal processing.

Foam gypsum mass is received by foaming solution of PAB up to the settlement frequency rate and the subsequent mineralization foam by dry plaster knitting. Wastes of cotton fibers are expanded in a water solution of poly-vinyl -acetate dispersions.

Forming mix is received by mixing the foam gypsum mass with suspension of cotton fibers. Preparations of a forming mix were carried out by means of a mixer of compulsory action at duration of hashing of components within 2-3 minutes.

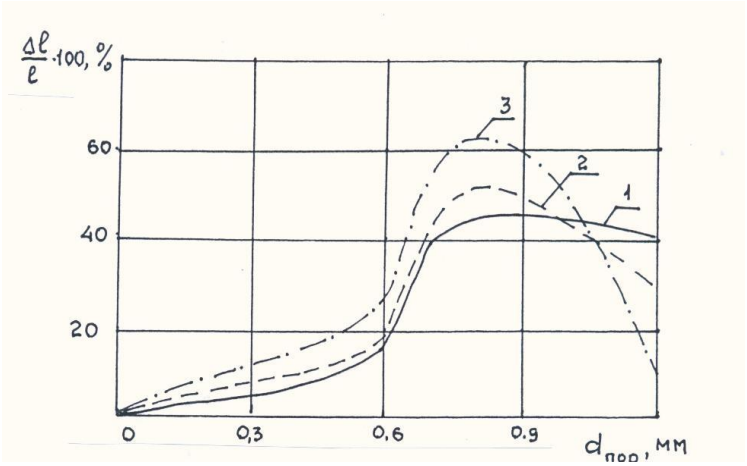


Fig.5a. Influence of pressure on the pores distribution in the sizes of foam gypsum materials with average density 250 kg/m^3

Formation of a plate is carried out by pressing foam gypsum mixes in a compression mould at pressure 10 MPa within 3-4 minutes, with simultaneous compression and mixes during pressing surplus of water gauging. Rise of pressure up to the set size was carried out with a speed 0,05-0,08 MPa/s.

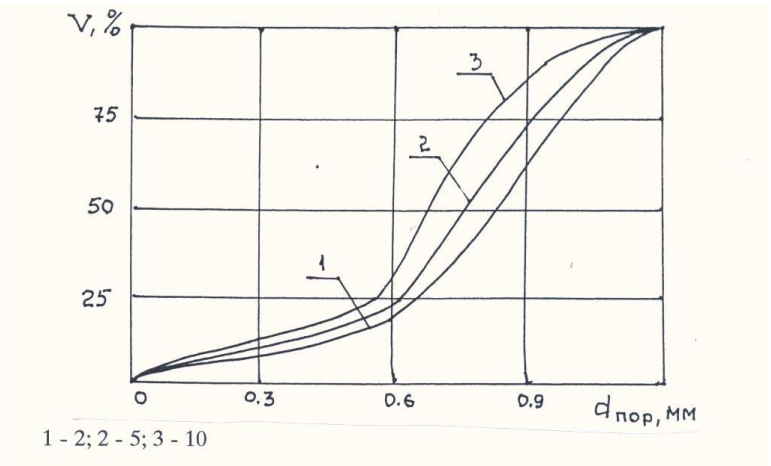


Fig. 5b. Integrated porosity of foam gypsum materials with average density 250 kg/m^3

The slabs taken from press were dried by blowing through a material of the heat-carrier in temperature 80 °C. Duration of drying thus makes 2,5 hours.

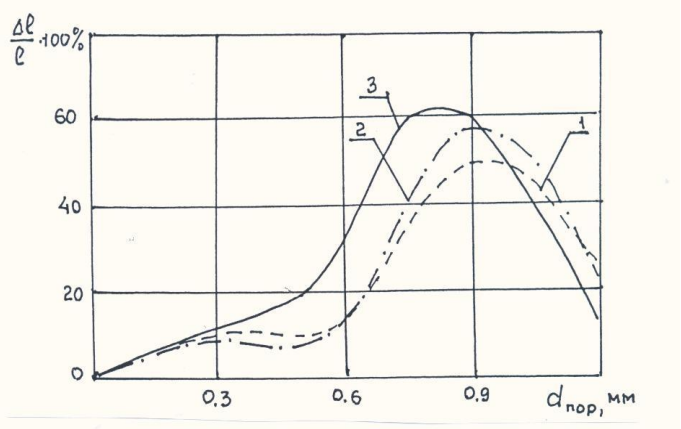


Fig. 6a. Dependence between average density and pores distribution in the sizes of foam gypsum materials

5. CONCLUSIONS

The feature of the acoustic materials structure is the high percentage porosity in it. Research of distribution of times depending on specific pressure of pressing (fig. 5 a,b) has shown, that the pressure of pressing equal 10МПа is optimum not only for reception of material with high strong parameters, but also with favorable for the purposes of sound absorption in the pore sizes. At the material formation under pressure 2 and 5 MPa the significant volume in it borrow the huge pores (accordingly 40 % and 30%) in which the sound absorption is complicated because of reduction of viscous friction forces of air waves in material pores.

ACKNOWLEDGEMENTS:

At reduction of average density of foam gypsum slabs the maximum of curve is displaced aside increases in the pore size (fig.6a), but as a whole the general character of durability of samples approximately identical, which testify the data on the average pore size (fig. 6b).

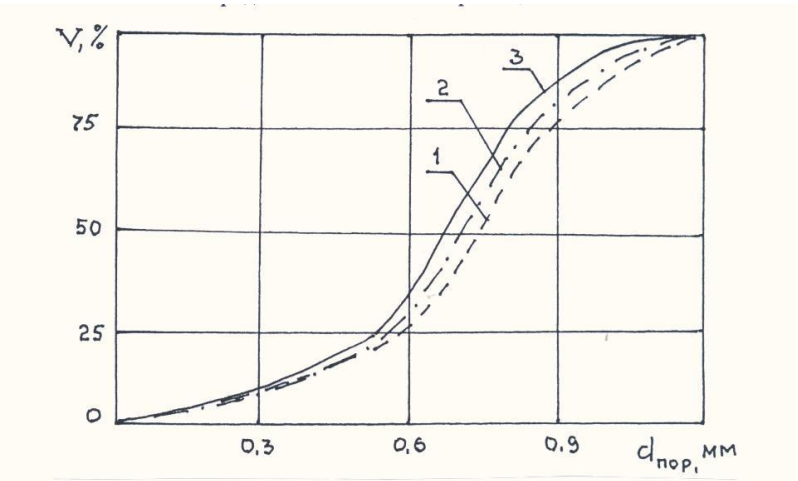


Fig. 6b. Dependence of foam gypsum materials by integrated porosity .Here: 1-170; 2 -200; 3-250

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