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ZARAGOZA'89 ENVIRONMENTAL ACOUSTICS

8º SYMPOSIUM FASE'89
«ACUSTICA AMBIENTAL»
Zaragoza, Abril 1989

THE PROPAGATION OF STRUCTURE-BORNE NOISE THROUGH MODELS OF MODERN BUILDINGS

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The problem of structure-borne noise propagation in modern large-sized acoustically homogenous construction buildings is of great practical importance - most of city residents are aware of this fact. Various engineering equipment or nearby underground lines can be the sources of structure-borne noise. Mechanical oscillations of walls or floors, appearing in one point, are large distance propagated almost without any damping and irradiated into the air, resulted in discomfortable conditions in living accomodations and industrial premises.

The influence of building constructive parameters on structure-borne noise propagation was estimated by calculations, made with statistical energy analysis (1) and by experimental modelling the fragments of panel and framework buildings. The models were made from plexiglass in the scale 1:7. The oscillations were induced by a stationary vibrator 4810 in the range of 125÷8000 Hz. The root mean square values of acceleration level were measured on each element of the model in 25 points with further statistical processing the results of these measurement, using on-line analyzer with graphical registrator 2313. The dependence of structure-borne noise attenuation upon the distance from the source of oscillations was estimated by the following formula:

$$\Delta L_a = 10\lg\left(\frac{1}{n}\sum_{i=1}^{n} 10^{0,1L_{a1}}\right) - 10\lg\left(\frac{1}{n}\sum_{i=1}^{n} 10^{0,1L_{am}}\right),$$

where ΔL_a - acceleration level attenuation; n - number of measurement points at each element of the model; L_{a1} , L_{am} - root mean square value of the acceleration level on the floor with a source and on the m - element of the model respectively.

According to statistical energy analysis, frameless panel buildings can be considered as a dynamical system, consisting of plates, fightly connected with each other. The calculated model of framework buildings become more complicated because of blocking masses (bars, columns) in junctions of building plates. The calculation assumes, that the great part of sound energy is transferred by bending waves. The longitudinal waves were not taken into account because of the complication of mathematical apparatus. The equations system of energy balance for each model, consisting of 42 elements, is the following

$$\omega K E = P$$

where ω - circular frequency ; K -loss matrix; E - matrix-columns of unknown energies; P - external energy matrix.

The necessary values of transmission coefficients of sound energy through the junctions of framework building constructions were determined on the face of (2).

The theoretical regularities of oscillation energy distribution through floors, partitions and walls of framework and frameless buildings dependently on the distance from the source of oscillation were got and experimentally confirmed.

It was found strong attenuation of structure-borne noise in more than 800 Hz frequency in framework buildings in comparison with frameless buildings. While in middle range ($315 \div 630$ Hz) there was found the contrary effect, i.e. the attenuation in frameless buildings is 1-2 dB more, than in framework buildings, but in the range of 125-250 Hz the damping values were just similar (Fig. 1).

The final aim of structure-borne noise isolation is decreasing the sound pressure level in accomodations (air noise), appearing because of irradiation of oscillating bounding constructions. There were considered the problems of predicting the efficiency of different measures in structure-borne noise isolation. Since the structure-borne noise is the spreading of elastic waves through hard bodies (plates, bulbs, columns), its decreasing is possible by influencing on physico-mechanical properties of concrete construction, on size relationship of floors and wall intersections, on using elastic paddings and blocking masses in junctions and on enlarging construction masses. The equations system of energy balance includes all the above mentioned parametres and that is why their variation could determine by numerical calculation the ways and measures of decreasing the oscillations of bounding constructions and air noise in accomodations.

The decreasing of sound pressure level (ΔL_p) in accomodations was determined as

$$\Delta L_{p} = 10 \lg \frac{\sum_i S_i \langle V_i^2 \rangle}{\sum_i S_i \langle V_i'^2 \rangle},$$

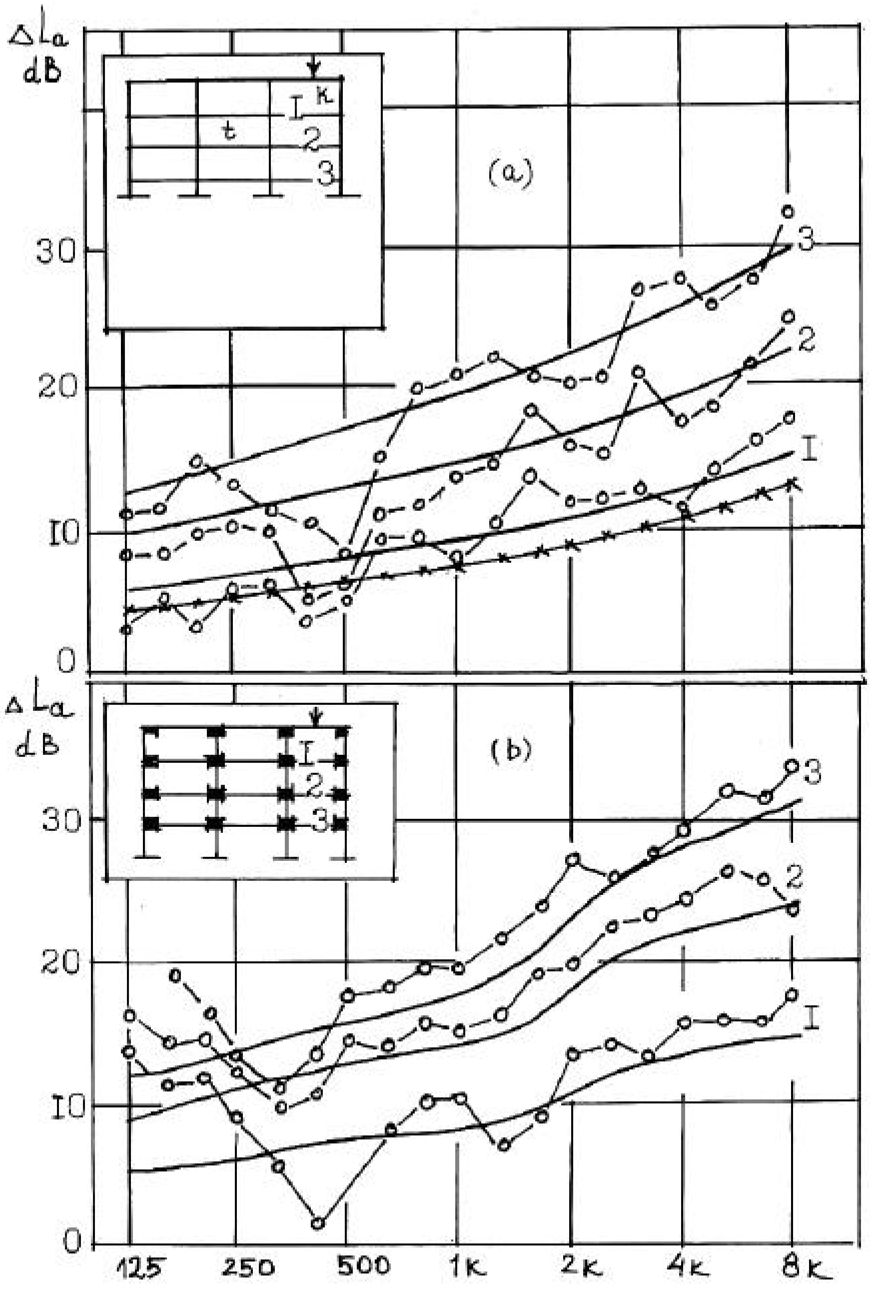
where $\langle V_i^2 \rangle, \langle V_i'^2 \rangle$ - root mean square of oscillation velocity before and after measures of structure-borne noise isolation respectively.

It was shown, that the decreasing of air noise in accomodations is largely influenced by construction damping. When the loss factor is increasing twice, than in accomodation k the sound pressure level is decreased by 2-3 dB and in accomodation t - by 5-7 dB.

References

1. R.H.Lyon, 1975, Statistical Energy Analysis of Dynamical System: Theory and Application; Cambridge, Massachusets: MIT Press.

2. Krishov S.I., Osipov A.G., Romanov V.G. The transmission of bending and longitudinal waves energy through the junction of building constructions - 26th acoustic conference, Bratislava, 1987.



Frequency, Hz

Fig. 1. The attenuation of structure-borne sound in panel (a) and framework (b) models of buildings: —, ** - SEA calculation (normal, and diffusive transmission coefficients); o—o - experiment.