ENGLISH SUMMARY

Rakenteiden Mekaniikka, Vol. 24 No 1, 1991

ON THE EFFECT OF NOISE AND VIBRATION TO MAN

Antero Honkasalo

The development of technology, urbanization and increase of traffic has lead us to the curret situation where noise is one of major pollution problems. Noise can cause stress, sleep-disturbances and increase risk of cardiovascular diseases and accidents. Noise is however a complex and many-sided risk-factor. Even high noise levels are not often considered as a "real" risk to one!s health or well being; people seems to accept noise levels that are above acceptable risk levels expressed in international standards. The studies of risk perception and assessment have shown that people stand greater risk if they think that these are under their own control than in the situation where the risk is involuntary and out of control. Noise can in some extent be handled with ones' own cognitive activities and by using personal safety equipment. However even more important influence to the risk perception in the case of noise seems to be that it can carry different kind of meanings. It can be a sign refering to danger and power or it can even be an symbolic sign of whole life style.

REQUIREMENTS FOR SOUND INSULATION IN BUILDINGS

Laila Hosia

Harmful noise and needed noise insulation in urbanized environmental and inside buildings are regulated by legislation for ex. health, labour protection, building and protection against noise.

Acceptable noise levels and the methods to measure noise levels are given and explained in the circular of the National Board of Health. Planning and building in the noise polluted areas is avoided.

The national building code of Finland includes also regulations of noise insulation (C1). They consist desibel values of noise insulation inside buildings, and maximal noise levels of fixed apparates in the building. The obligatory level of noise insulation and protection are about the same as in other Nordic Countries and in the middle Europe.

HOW TO EXPRESS THE SOUND INSULATION AS A SINGLE NUMBER?

Juhani Parmanen

Basic concepts of airborne and impact sound insulation are discussed. Generally speaking, the terms do mean transmission loss of structural parts like windows, doors and partition walls (in dB) or floors' ability to modify and weaken impact sounds. They are frequency dependent, which is taken into account in the Finish building code by measuring at 16 third-octave bands between 100...3150 Hz and giving the result as a series of 16 insulation values. In practical applications, however, a one-value measure is necessary. The inherent dependence on frequency shall then be chosen so as to be consistent with the sound spectra, which are most common, and taking into account also the frequency dependence of human perception. So, the definition of insulation will include a definition of the sound spectrum (or an approximation for it). Possibilities for such definitions and some development trends are discussed.

COMMON SOUND INSULATION FAILURES IN BUILDINGS

Reijo Heinonen and Pauli Sysiö

A comprehensive study concerning sound insulation in long-slab houses and habitants' residential comfort was conducted (by VTT) in years 1976-1978. About one-third of the 1182 replied families did experience a poor sound insulation. The situation has been tried to be improved in the recent buildings by using, e.g., acoustically better structures and low-noise HVAC-facilities, but still it can be estimated that in over 20 % of houses there are failures affecting the residential comfort. Some most common factors lowering sound insulation, like the coincidence and resonance effects, flanking transmission and sound leaks, are discussed in the treatise, as well as means to avoid or correct failures of sound insulation.

SPECIAL REQUIREMENTS OF THE FUTURE STRUCTURES

Asko Sarja

The flexibility of the buildings in design and operation as well as the controlled service life rise needs for new structural systems having a strong and stiff bearing frame and light partition and envelop structures.

The sound insulation can be ensured together with the installation assembly using separate installation floors, hollow structure or multi-layer structures. The partition walls are classified based on functional requirements e.g. regarding to the sound insulation. The choises of products is then made case by case. Because of the light weight of the structures, the exact control of sound insulation is important. The envelop

consists of different combination of materials. Because of the light weight of the composite structures, the insulation of the building against the external noise and the insulation between internal spaces is a challenge for structural engineering.

PROPAGATION OF VIBRATION IN STRUCTURES

Jukka Linjama

The paper presents some basic consepts of the transmission of vibration (structure-borne sound) in structures. Different wave types propagation at low frequencies in homogeneos beam- and platelike structural members, as well as the concept of impedance, are rewieved. In addition a short description of new measurement techniques for determination of the vibrational energy flow in situ (vibrational intensity measurements) is given.

VIBRATION BEHAVIOUR OF STRUCTURES AND MATERIALS

Tuomo Kärnä

Some aspects of noise control are briefly described using the concepts of the dynamics of structures. Basic features of sound transmission through a simple panel are compared with the response of a single degree of freedom oscillator. The effects of acoustical leaks are not treated. The comparison shows that the transmission loss through a panel depends on the conventional dynamically parameters of the structure and material: mass, stiffness and damping. The transmission loss of massive walls increases by the rate of 6 dB per octave increase in frewuency. The transmission loss will increase by the same amount also if the panel thickness is doubled. However, this mass law does not apply at higher frequencies due to a coincidence effect. A panel has a tendency to support bending wave motion. Therefore, the wall may become acoustically transparent at a critical frequency.

NEW ANALYSIS METHODS FOR SOUND INSULATION

Tapio Lahti

The paper describes several new methods of measuring and simulating sound insulation which considerably enhance the analysis possibilities provided by standard methods. The measurement methods are based on the sound intensity techniques and the fast Fourier transform (FFT), and the 2-dimensional FFT is used also in the simulations. Among the methods are the direct measurement of the incident and transmitted sound intensity, the acoustic modal analysis of the air spaces inside structures, and the reconstruction of the entire radiated sound field using nearfield acoustic holography. In the calculations, the sound field radiated by a vibrating panel, and the vibration response of the panel when excited by an incident sound field, were used as simulation examples. The measurement methods were applied to the analysis of the sound transmission through a two-plane window.

DAMPING LAYERS IN SANDWICH PLATES

Mats Backholm

Air and structure borne sound insulation of plate constructions can be improved by using a damping layer. A test method was developed and used to measure loss factors of varying sandwich-type plywood specimens with damping layers.

ISOLATION OF STRUCTURE BORNE SOUND IN HELSINKI METRO

Mats Backholm

Underground trains induce small vibrations in the tunnel rock. This can lead to annoying noise in nearby dwelling houses. The most common method to reduce this structure borne sound is to lay a flexible isolation mat between the ballast and the tunnel bottom (a so called ballast mat). A test and calculation procedure was developed and used to evaluate the performance of ballast mat materials proposed by different manufacturers to be used in the Helsinki metro.

SEA-MODELS (STATISTICAL ENERGY ANALYSIS)

Pertti Hynnä

Basic principles of the Statistical Energy Analysis (SEA) are shortly discussed. Power balance equations for two element SEA-model and for general case are presented. The meaning of SEA-parameters, energy and input power are discussed. SEA-models found in literature for sound insulation of single panel and double panel are discussed. A general way to model a structure using nodes and attached elements is presented to reduce the amount of modelling work. Applications of SEA to sound insulation problems in building structures are shortly discussed.

ON THE APPLICATION OF THE FINITE ELEMENT METHOD IN ACOUSTICS

Matti Hakala

Application possibilities of the finite element method to some acoustic problems are treated. The finite element formulations for the solution of the wave equation in air with various boundary conditions, for the sound propagation in structures, and for the structural-acoustic interaction are briefly presented. Some practical applications found in the literature are described.