

## English summary

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### Tyre noise emission on different road surfaces

Jarno Kokkonen and Tapio Lahti

**Summary.** The scope of this article is tyre/road noise. Main focus was on the effect of silent pavement on tyre noise. The noise was studied with measurements. Noise measurements were done with Pass-By methods. According to the measurement results, in winter time silent pavements are equally loud compared to the reference surfaces. On summertime silent pavements was from 2 to 3 dB more silent than the reference surfaces. In addition vertical directivity of vehicle noise was studied; result being that there is not much vertical directivity.

*Key words:* road and tyre noise, silent pavement, acoustical measurement, studded tyre

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### Virtual acoustics for better music rehearsal rooms

Jukka Pätynen and Tapio Lokki

**Summary.** In this article the use of an electro-acoustic system to improve the acoustics in music practice spaces is presented. The system uses an active method to create additional reverberation without increasing the sound pressure levels. Performance and acceptance of the system are investigated in three different rooms by reverberation and sound pressure measurements and collecting subjective user feedback. These case studies consist of two small classrooms and a theatre hall converted to a symphony orchestra rehearsal hall. According to the results, the system can provide a potential solution for improving the room acoustics in practice use especially in larger spaces.

*Key words:* electro-acoustics, rehearsal hall, reverberation enhancement, room acoustics, time variance, truncated hall

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## The rendering equation for geometrical room acoustics

Lauri Savioja, Samuel Siltanen and Tapio Lokki

**Summary.** The geometric room acoustic modeling is based on the assumption of ray-like behaviour of sound. In this paper, we recapitulate the derivation of the room acoustic rendering equation that forms a general framework covering all the ray-based room acoustic modelling techniques. In addition, we show the main principles of the room acoustic radiance transfer method. It is an advanced modelling technique enabling use of arbitrary reflection properties at the bounding surfaces. The results are evaluated in one case study in which the simulation results and measurement results are compared.

*Key words:* room acoustic modelling, geometrical room acoustics, acoustic radiosity, rendering equation

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## Teleconference application and directional microphone technique for Directional Audio Coding

Jukka Ahonen and Ville Pulkki

**Summary.** DirAC is a method for spatial sound recording and reproduction with arbitrary sound reproducing system. The simple version of DirAC is presented in this article. In telecommunication, DirAC can be used to deliver spatial sound by transmitting directional data as a side band to monophonic audio with low bit rate. In directional microphone technique, method is used to create arbitrary direction patterns. Method is based on the energetic analysis, in which the arrival of sound and diffuseness are estimated from the microphone signals as a function of time. In synthesis phase, sound is divided into non-diffuse and diffuse parts, which are reproduced with different techniques. Microphone array used in the simple version of DirAC is also presented in this article.

*Key words:* Directional Audio Coding (DirAC), spatial sound, multichannel, teleconference, directional microphone, microphone array, B-format signals

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## Measurement method for controlling the requirement of facade sound insulation in site

Mikko Kylliäinen and Valter Hongisto

**Summary.** In areas affected by traffic noise, a requirement for sound insulation of building facades is given in city plan as the difference of A-weighted equivalent sound levels at facade without reflection from façade and allowable equivalent sound level inside the building. The realisation of the requirement is often controlled by measurement when the building is ready. Because there are no official guidelines of the measurements, there has neither been a commonly used measurement method in Finland. A method for measurement of sound insulation of the facades is presented in this article. It is based on the measurement of weighted normalized level difference  $D_{ls,2m,n,w}$  presented in standards ISO 140-5 and ISO 717-1 and spectrum adaptation terms  $C_{tr}$  and  $C$  presented in ISO 717-1.

*Key words:* traffic noise, sound insulation, sound insulation of facades

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## On vibro-acoustics of periodic-core sandwich panels

Jukka Tanttari, Esa Nousiainen, Samu Aalto and Tomi Lindroos

**Summary.** Lightweight sandwich panels are poor sound insulators. We have studied the use of periodic soft core stripes in improvement of sound insulation. Over 10 dB higher TL:s were achieved using unidirectional or crosswise core stripe designs. The technique leads to many interesting phenomena. These include wavefield disintegration, radiation efficiency changes and lumped behavior at low frequencies.

*Key words:* vibro-acoustics, sound insulation, lightweight structure, core striping technique

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### **Dependence of the absorption coefficient on material parameters**

David Oliva, Henna Häggblom, Jukka Keränen, Petra Virjonen and Valtteri Hongisto

**Summary.** Absorption coefficient measurements of several materials, including multi-layer, have been performed in order to find out about the basics of the absorption process and the capability for accurate prediction of different models. The goal of the project is to create a model able to predict the absorption properties of the wide range of materials applied nowadays in construction.

*Key words:* room acoustics, material, absorption coefficient

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### **Background of problems in measurement method of impact sound insulation**

Mikko Kylliäinen

**Summary.** The formulation of method for evaluation of impact sound insulation of buildings and structures started in the 1930's when an objective sound source, the tapping machine, was developed. In spite of the long history of the method, there is still lack of a correct evaluation method that would correspond to people's subjective rating of floor structures in all conditions. Critique against the present method has been presented since the international standardization of it in the beginning of the 1960's. The aim of this article is to present a literature survey to show how the present method has been developed, what are its problems and what kind of solutions have been tried to solve the problems.

*Key words:* sound insulation, building acoustics, impact sound insulation

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## Measurement and modelling of room acoustics in open offices

Jukka Keränen, Petra Virjonen and Valtteri Hongisto

**Summary.** It has been shown that speech from neighbouring workstations is the most annoying noise source in open offices. Room acoustics in open offices can be controlled by three means: high room absorption, high screens and sufficient masking sound. The interaction of these means is very complicated since the speech privacy should be investigated at different distances from the speaker to evaluate the acoustical conditions of the whole space. In this study, a new measurement method based on speech sound level and speech transmission index measurements is described, recommendations for the measurement results are suggested and a simple internet based prediction model for the design of open office acoustics is presented.

*Key words:* open-plan office, spatial sound distribution, radius of distraction, speech privacy

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## Education of building acoustics in Finland

Heikki Helimäki

**Summary.** Students graduating from Universities in the field of Building and Structural Technologies in Finland are not capable to evaluate needs of acoustical design in building planning. As a consequence, there are plenty of mistakes in building structures. The users of buildings and spaces become aware of mistakes only after the building is readymade. This leads often to high repairing costs. The minimum demand to all students in the respective fields should be the insight, that all buildings and spaces do have acoustical circumstances. After this invention, the students would be able to understand, that the level and quality of these circumstances can and should be defined beforehand, just as structures, electricity and HVAC-systems.

*Key words:* building acoustics, education