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Perceptual evaluation of metamaterials as insulation partitions: A listening test within the COST action DENORMS (CA15125).

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Abstract

The need for improving indoor and outdoor acoustic comfort constantly drives the development of novel sound insulation and sound absorption solutions through the use of new materials. Optimising their performance becomes reachable today by designing "metamaterials". Besides their acoustic performance in terms of absorption and/or insulation, these materials are also challengers for the cost and volume/weight reduction of passive acoustic solutions. However, due to their locally-resonant behaviour, these responses often vary significantly with frequency. A pending question in this respect is whether the strongly non-uniform spectral characteristics of meta-materials is detrimental to the subjective appreciation of their sound insulation capabilities.

By means of a headphone listening test, the present study aims at perceptually comparing the pleasantness from sounds transmitted through five office-like partitions. These included homogeneous solid screens, sonic crystals and tuned metamaterials. Four stimuli were used: broadband signals such as pink noise and traffic noise, and complex or tonal signals such as voices and phone ringing. The transmitted sounds were synthesised from partition models and replayed to jurors by pairs for each stimulus, following the so-called "A-B comparison" method. For each test pair, the single criterion consisted in selecting the most annoying among the two sounds in an office context. This resulted in a ranking of the test sounds - and thus of the partitions – by order of annoyance. In order to assess the subjective appreciation of the spectral content of the transmitted sounds independently from the perceived loudness, an additional comparison was performed, in which all the sound samples were equalised to the same loudness.

During the DENORMS workshop "Dedicated manufacturing and experimental techniques for acoustic metamaterials and acoustic treatments", Leuven, Feb 6-7 2018, 35 jurors volunteered for the test. These represented 17 countries, a large age range and 20% were women.

The quality of each test was quantified by intra- and inter-subject indicators, such as consistency and concordance. The preference ranking was additionally interpreted in the light of the physics governing the responses of the selected partitions. Furthermore, insights are given towards a definition of a quantitative sound quality metric for acoustic material design.

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