A Subjective Related Measure of Airborne Sound Insulation

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In many practical cases, the objective measures of airborne sound insulation using standard procedures do not agree with subjective assessments. This paper describes a calculation scheme based on the loudness level linked to the specific fluctuation strength and yields a weighted normalized loudness level difference. Evidence has been presented through a subjective evaluation that the model can be considered to be a link between an objective and subjective evaluation. The stimuli offered in the experiment were electronically filtered sound samples representing the sound insulation of interest. Steady-state and non-steady state signals are used as stimuli. To differentiate the signal in terms of psychoacoustic measures, investigations of music type signals were focused on specific fluctuation strength. An assessment of identical airborne sound insulation experimental results has shown that steady-state signals were assessed to be significantly quieter than non-steady-state signals, which also yield greater specific fluctuation strength. As expected, sound insulation was judged differently for different sound samples. A simple level difference is shown not to exhibit the effects of a given signal to the frequency-dependent airborne sound insulation curve. This study supports findings in the literature that airborne sound insulation performance is significantly dependent on what type of sound signal is used.

1. INTRODUCTION

The quality of sound insulation in buildings is generally described using a single number rating of the sound insulation and has an important bearing on the comfort, health, and general amenity of the residents. In many cases, however, single-number ratings do not correlate well with subjective expectations. Comparing single number quantities of airborne sound insulation with subjectively estimated airborne sound insulation frequently yields significant differences. Therefore, it is necessary to establish a better understanding of airborne sound insulation through the use of psychoacoustics. Neubauer and Kang introduced a concept describing a frequency-dependent weighted normalized loudness level difference. This concept is intended to be a connection between the objective measure of airborne sound insulation and the psychoacoustic measures of the loudness level and fluctuation strength.

This study investigates the previously introduced calculation scheme describing the airborne sound insulation in terms of a probability of the insulation’s “best fit.” This means that if a certain airborne sound insulation is compared with its “unbiased” airborne sound insulation, as e.g. calculated, the airborne sound insulation of the real construction is biased by means of resonances, leakages or other effects, which can influence the airborne sound insulation.

This paper first describes the inapplicability of standards to rate airborne sound insulation in terms of a subjective assessment, and second discusses the new model of a weighted normalized loudness level difference. Finally, it validates the model by comparing subjective test results and clarifies the discrepancies among sound insulation and the weighted normalized loudness level difference.

2. EXPERIMENT ON THE SUBJECTIVE EVALUATION ON SOUND SIGNALS

To determine the subjective assessment of different test signals for different sound insulation values, hearing tests were conducted. The main goal for this investigation is to find evidence that the perceived sound is judged differently if the signal is changed and if the spectrum of the airborne sound insulation is different. It is, therefore, vital to know how the model depicts differences in sound signals and spectra and how the differences are related to subjective assessments.

2.1. Excitation Signals

From the literature, it is known that music is reported as one of the most frequently detected noises even in dwellings that fulfill sound insulation requirements. Therefore, the influence of using different signals is investigated by using two categories of signals: steady-state and non-steady-state signals. The steady-state signals are broadband noise signals: “pink noise” (PN) and “white noise” (WN). These signals are selected because they are recommended in standards for measuring airborne sound insulation. The non-steady-state signals, i.e., the transient signals, were music samples, namely rap (Eminem: “Lose Yourself”) (E) and classic music (Beethoven’s Symphony No. 9: Poco Allegro, Stringendo Il Tempo, Sempre Piu Allegro-Prestissimo) (B). This type of music was also investigated earlier.