THE NEW FRAMEWORK OF EN STANDARDS FOR TRAFFIC NOISE REDUCING DEVICES

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ABSTRACT

In the early 90’s, the European Standardization Committee (CEN) started a working group about “noise reducing devices” under the frame of the Technical Committee TC226 “Road Equipments”. About the acoustic performance standards, three are yet effective and harmonized; they are based on the ISO 354 and ISO 140 for measurements in laboratories. Two new voluntary standards are now drafted: they are defining in situ methods for measuring airborne sound insulation and sound absorption, but also characterizing sound diffraction. The principles of these methods, all the three being based on use of MLS signal and subtraction techniques, are presented. Other standards dealing with products specifications, long term performances, and non-acoustic performances will be briefly presented as they concern how to keep NRD’s performing correctly for many years.
KEYWORDS: Noise Reducing Devices, Standards, Test Methods, CEN

INTRODUCTION

The European qualification system for road traffic noise reducing devices (NRD’s) is based on an advanced framework build on a “product standard”, which specifies the performance requirements for NRD’s in terms of measurable characteristics [1], and "supporting standards", describing the associated test methods.

NRD's have not only to be acoustically performant, but also to be safe and able to keep their performances along time. The CEN working group works thus not only on standards for qualifying acoustic characteristics, either in laboratory [2,3] or in situ [5,6], but also on standards for qualifying non acoustic characteristics, which can affect the safety, and/or indirectly the acoustic performances of NRD's [7,8]. Finally, the standards also consider the long-term durability of all those acoustic and non-acoustic characteristics [9,10].

The whole EN package helps in selecting the most suitable NRD’s for each application, and to keep them performing correctly for many years.

ACOUSTIC CHARACTERISTICS – LABORATORY MEASUREMENTS

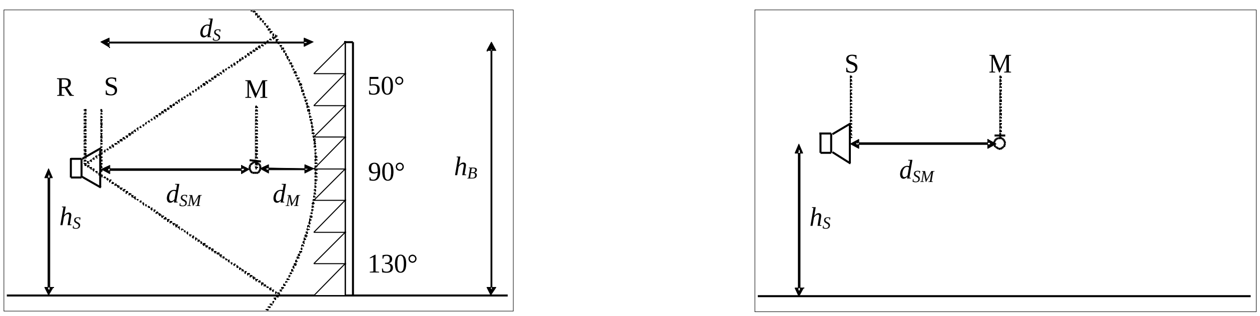
Laboratory qualification of sound absorption and airborne sound insulation. Laboratory measurements, following the principles of the ISO test methods, were the first to be used for characterizing NRD's. EN standards use "tuned" versions of these, and single number ratings following a normalized road traffic noise spectrum [2,3,4].

ACOUSTIC CHARACTERISTICS – IN SITU MEASUREMENTS

The European research project *Adrienne* [11,12] produced innovative methods for testing the sound reflection/absorption and the airborne sound insulation characteristics of noise reducing devices in situ. These methods are now included in the voluntary standard ENV 1793-5 [5].

The *Adrienne* method is based on the recovering of an acoustic impulse response close to the barrier under test [13]. Its principles are used for both sound insulation index and sound reflection index measurements.

Sound reflection. A loudspeaker is placed facing the traffic side of the noise reducing device and a microphone is placed between the sound source and the NRD (Figure 1).



a) Reflected sound measurements

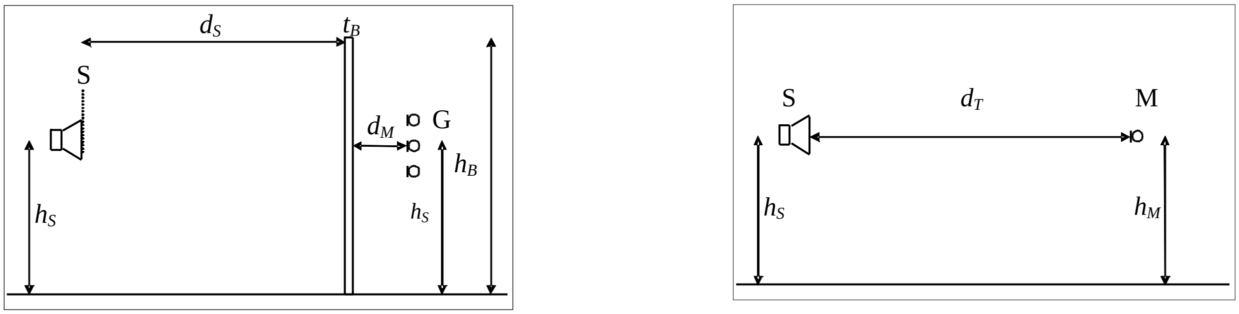
b) Reference "free-field" sound measurements

Fig. 1. Reflection index measurement set-up in front of a non flat noise reducing device.

With the loudspeaker emitting a transient sound , the microphone receives both the direct sound pressure wave traveling from the sound source to the device under test and the sound pressure wave reflected (including scattering) by the device under test. The power spectra of the direct and the reflected components, corrected to take into account the path length difference of the two components, gives the basis for calculating a quantity called *sound reflection index* [5]. The *sound reflection index* is calculated using the signal subtraction technique [14] that requires an exact reproduction of the time signals for both the direct and (direct + reflected) components. Measurements must be repeated at nine incidence angles for a flat sample; for non-flat or non homogeneous samples, the number of measurements to average is increased [5].

The low frequency limit is inversely proportional to the width of the analysis window and depends also on its shape; for an *Adrienne* window 7.4 ms wide this limit is about 160 Hz [15]. The angle averaging influences this limit: it is the reason why, in ENV 1793-5, it is limited to 90° ± 0° below 200 Hz, ± 10° at 250 Hz, ± 30° at 315 and 400Hz, and ± 40° over 400Hz.

Airborne sound insulation. A loudspeaker is placed facing the traffic side of the noise reducing device, a microphone is placed on the opposite side. The loudspeaker emits a transient sound wave that is partly reflected, partly transmitted and partly diffracted by the NRD (see Fig. 2). The microphone receives: the transmitted sound pressure wave, traveling from the sound source through the NRD to the microphone and the sound pressure waves diffracted by the edges of the account the path length difference of the two components, gives the basis for calculating the outdoor transmission loss, which has been called *sound insulation index* [5]. The measurement in front of the NRD is repeated at nine points placed on an ideal grid (scanning points).



a) Transmitted components measurements   b) Free-field (incident) component measurement

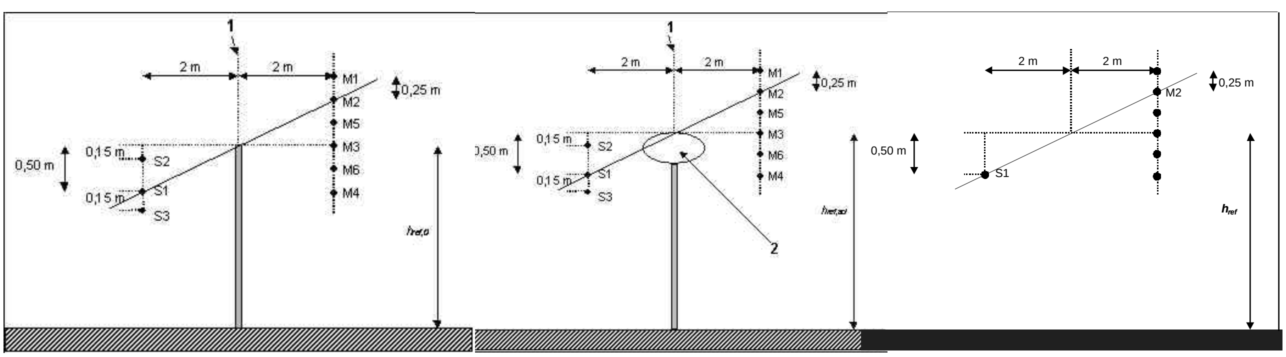
Fig. 2. Airborne sound insulation index measurement set-up in front of a flat noise reducing device.

The final sound insulation index is the logarithmic average of the results in these nine positions. A set of nine measurements must be repeated in front of the acoustic elements and in front of a post.

Comparison between field and laboratory results shows a quite acceptable correlation for sound reflection (r = 0.89) and a very good correlation for sound insulation (r = 0.97 for acoustic elements; r = 0.93 for posts):existing differences can be explained with the different sound fields, averaging techniques and mounting conditions between the outdoor and laboratory tests [15,16].

Sound diffraction. Part of the market of traffic noise reducing devices is constituted of products designed to be added on the top of noise reducing devices and intended to contribute to sound attenuation, acting primarily on the diffracted sound field. Calling these products “added devices”, a new EN standard has been logically drafted in order to qualify them [6]. The *Adrienne* method have been again considered. It is used to characterize a *diffraction index* for a NRD, with and without the added device.

A loudspeaker emits a transient sound wave that travels toward the noise reducing device under test and is partly reflected, partly transmitted and partly diffracted by it (see Fig.3).



a) without added device   b) with added device   c) free-field measurement

Fig. 3. Sound diffraction index measurement: loudspeaker (S) and microphone (M) locations

The microphone placed on the other side of the noise reducing device receives both the transmitted sound pressure wave travelling from the sound source through the noise reducing device and the sound pressure wave diffracted by the top edge of the noise reducing device under test. If the measurement is repeated without anything between the loudspeaker and the microphone, the direct free-field wave can be acquired. The power spectra of the direct and the top-edge diffracted components, corrected to take into account the path length difference of the two components, give the basis for calculating the *diffraction index*.

The measurement procedure and diffraction index calculation shall be carried out twice: one with, and one without the added device placed on the test construction. The *diffraction index difference* is then calculated: this is regarded as a relevant characteristic of the added device under test.

NON-ACOUSTIC CHARACTERISTICS

Non-acoustic characteristics are also very important for qualifying NRD's. Apart safety concerns, the mechanical characteristics and the ageing process can also drastically influence the acoustic performance of NRD's: they have to be considered by the acousticians as being at least as important as acoustics when defining new NRD's to install along roads [7, 8].

LONG TERM DURABILITY

Durability of NRD's is a very sensitive one, as NRD's can be made from different combinations of different materials, each one possibly reacting in different manners to ageing. Specific drafts are progressing acoustic [9], and non-acoustic characteristics [10]. This last one is still in progress: the increasing use of ENV1793-5 [5] could be of great help in order to understand how ageing influences the actual in-situ acoustic performances.

CONCLUSIONS

The *Adrienne* method led to the final draft of ENV 1793-5, characterizing in situ values of sound reflection and airborne sound insulation. Until now, its numerous results are consistent with the laboratory ones. ENV 1793-4 is now submitted for sound diffraction of "added" devices.

By characterizing the acoustic (either in laboratory or in situ) and non acoustic characteristics of NRD's, the whole EN package helps in selecting the most suitable NRD's for each application and to keep them performing correctly for years.

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