A Multimedia Software for Evaluation of Traffic Noise Reduction Solutions

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1. INTRODUCTION

The determination of the optimal abatement solution for traffic noise is not easy to carry out. Indeed, sound propagation is a complex phenomenon, and current traffic noise models[1] are still approximate. In fact, most of those models do not consider the multiple reflection effect between two parallel barriers (situation that is often encountered in practice); they neither take into account the type of road surface (very influential factor in practice) nor the spectral content and the absorption properties of the materials as a function of frequency.

Another important deficiency of the existing tools is that they only give a numerical information of the results, that is the sound level and/or the noise reduction in decibels (dB). For most of the people, a level in decibel is however a rather abstract information. What does a reduction of 6, 10 or 12 dB correspond to, in terms of sound perception ? Very few people know it accurately.

The development of *CEEPA* is intended to fill those gaps. CEEPA is a software based on the recent knowledge on sound propagation models and on traffic noise emission. A signal processing algorithm has been integrated to this software in order to provide an audio output to the users. When used with a multimedia functionality computer, this new software thus allows the user to listen to the predicted noise levels. This paper presents the new software developed for a Windows 95 environment.

2. COMPUTATION METHODS

The computation algorithm has for main specificities :

1) Punctual sources model
2) Multiple reflections model
3) Traffic noise emission spectrum
4) Signal processing for audio output

2.1 Punctual Sources Model

Rather than a linear source line model, punctual sources are used to represent the traffic noise. This method allows to use accurate and well known propagation models to evaluate ground effect, diffraction, as well as reflections between barriers. In this model, each punctual source represents a set of vehicles on a unit of road length.

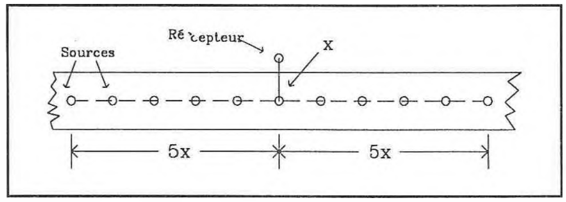

Figure 1 For information on this method, see references 1 to 4.

2.2 Multiple Reflections Model

When there are two parallel barriers, multiple reflections between them occur, which is an aspect that is generally not considered. In the proposed model, this phenomenon is considered using the image source concept (SIM), and the specific reflection coefficient of the material on the barriers is taken into account[1].

2.3 Traffic Noise Emission Spectrum

For a good evaluation of the ground effect, of the absorption effects, and of the diffraction effect, the spectral content of the source sound power should be considered, another aspect generally ignored in common traffic noise models. To overcome this deficiency, the notion of traffic noise emission spectrum[2] has been used. An emission spectrum specifies the contribution of each frequency 1/3 octave band in relation to the spectrum's overall noise level. Since the spectral content and the overall noise level emitted by vehicles depends on the type of road surface, the software offers different particular emission spectra[3]. If required, other particular emission spectra may be evaluated and used[4].

2.4 Signal Processing for Audio Output

The software generates audio files (*.wav)* associated to the receiver locations, for the reference case as well as for the modified case (see below *User Interface and Results* to know the difference between those two cases).

The audio file is carried out by the filtering (in 1/3 octave bands) of pre-recorded traffic noise files (.wav file). The filtering parameters are established following the spectral content of the pre-recorded noise files and of the theoretical spectrum calculated by the software. Figure 2 gives the diagram of this filtering process.

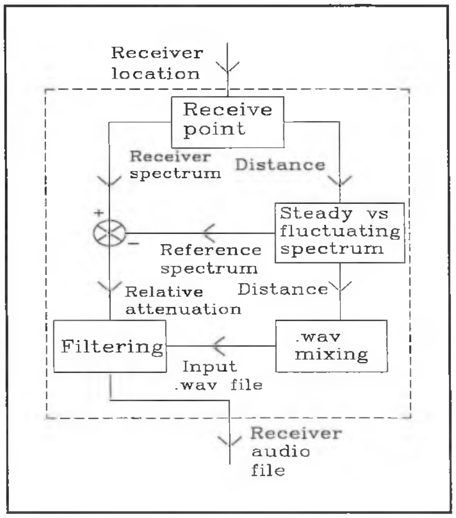

Figure 2 Signal processing of the audio output

3. User interface and results

The interface has been developed following Windows 95 standards.

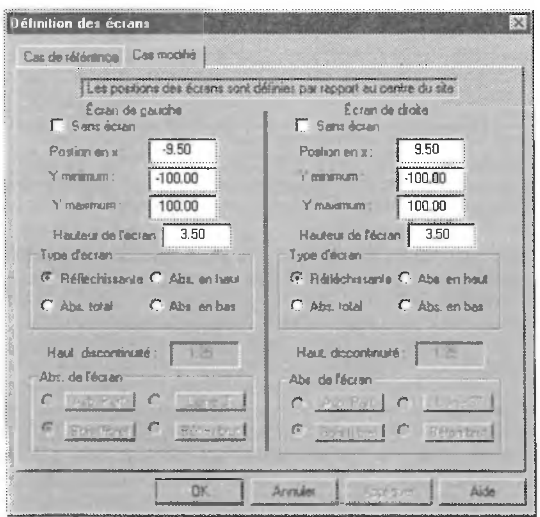

Figure 3 Example of dialog box.

Each analysis is made of two cases called *reference case* and *modified case*. The *reference case* corresponds to the road as it exists before the modifications. The *modified case* is a second configuration where the user gives the various changes desired: addition of barriers, addition of absorbents on the barriers, change of surface, change of traffic parameters, etc.

The noise level computation is done for every 1/3 octave frequency. The computation is automatically done for the reference case and the modified case. This computation is done for a given receiver grid (for example 25x25) distributed uniformly on the studied site (see Figure 4).

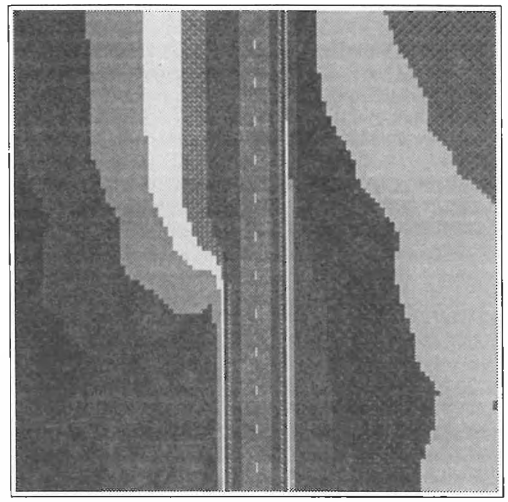

Figure 4 Example of graphical results given by CEEPA.

Using a computer with a sound blaster card, an audio evaluation of the noise abatement strategies can be done. To get this evaluation, the user has to establish the receivers where he wants the analysis done, and CEEPA will generate some audio files (*.wav)* for the reference case and for the modified case. One can thus have a representative impression of the effect of noise abatement strategies for any given location.

4. CONCLUSION

CEEPA is a user-friendly evaluation tool for the traffic noise. Compared to common methods, this software allows to consider ground effect, multiple reflections between barriers and emission spectra of different road surfaces. Besides its user-friendliness and the functionalities of its user interface, CEEPA can generate an audio output, which facilitates the analysis and optimization of the planned acoustical abatement strategies.

References

1-STAMINA model, developed by the FHWA (Federal Highway Administration).

[2] Panneton et al. *Development and validation of a model predicting the performance of hard or absorbent parallel noise barriers* , J. Acoust. Soc. Jpn. (E) 14, 4 (1993).

3-Watts, G., *Normalized Traffic Noise Spectra*, Proceeding Inter-Noise 92, Toronto p. 823-827

[4] L'Esperance et al. *Méthode d'évaluation de l'efficacité acoustique des revêtements routiers* », Rapport d'étude réalisée pour le ministère des Transports du Québec, Juin 1993, pp. 30.