PROCEEDINGS

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MEASUREMENT AND PREDICTION OF HIGHWAY NOISE WITH REGARI THE ITALIAN SITUATION: ANALYSIS OF A REAL CASE

W. Bowlby (1), G. Cerrato (2) and G. Elia (2)

(1) VANDERBILT University, Nashville, TN 37235; (2) MODULO UNO Acou: Engineers, 90, corso Vittorio Emanuele - 10121 TORINO (ITALY)

INTRODUCTION

According to recent Italian legislation, industrial and transportation sources assess their Environmental Impact, with the help of procedures and techniques that been enhanced significantly in the last few years. Still, no government models are avail so the noise engineer must define the most suitable approach to a problem for bot measurement procedure and the theoretical model.

The U.S. Federal Highway Administration traffic noise prediction computer pro STAMINA 2.0 [1] has been chosen by the authors because of its widespread use in the and other countries as well as its ease of use. However, the U.S. model needs adjustn in order to fit the Italian situation because: a) Italian vehicles have different noise emi characteristics from American ones; b) operating speeds of Italian vehicles are comparat higher (despite recent, more severe speed limits); c) unlike in the U.S., where the impact of the highway generally has to be assessed near the ground (receiver height = m), in Europe common cases include higher receivers (frequent multistory reside buildings) that are often nearer to the highway.

This paper presents the first results of a joint research project undertaken wit aim of providing an analysis tool of the noise impact of highways in Italy.

EVALUATION OF EMISSION LEVELS OF ITALIAN VEHICLES

Measurements were taken alongside two highways in northern Italy during Jan and February 1989 to gather a database of maximum passby levels (L_O) for three class vehicles (automobiles, medium and heavy trucks) and of L_{EQ} values at typical sites. levels were measured according to the procedure in [2], under neutral conditions of and temperature. The STAMINA 2.0 database of "reference energy mean emission le was then modified using the measured L_O data. The Italian version of the model calibrated on the basis of the L_{EQ} data collected at locations nearest to the highway.

For the statistical analysis of the data collected, five kinds of regression considered. The first three were regressions on the individual data points, for maxi passby levels as linear, polynomial and logarithmic functions of speed. The data were grouped into 10-km/h speed bands and logarithmic regressions of average level (by s band) and energy-average level (by speed band) as functions of average speed were t

While the linear regression on all data points seemed to overestimate and polynomial expression seemed to underestimate the sound levels at higher speeds, logarithmic relation fit the data better. Also, as the number of samples for the "average speed" classes was different, the regression analysis of individual samples was preferred to that of average speed classes of data. The few highest speed readings (175-220 km/h) for automobiles were neglected as being non-typical.

The resulting sound level vs. speed relationships in the 70-165 km/h speed range for automobiles and 55-105 km/h for trucks are:

$$\textit{Automobiles:}\quad L_o = 33.6 + 20.1 \log(V) \tag{1}$$

$$\textit{Medium Trucks:}\quad L_o = 45.0 + 17.8 \log(V) \tag{2}$$

$$\textit{Heavy Trucks:}\quad L_o = 48.9 + 17.7 \log(V) \tag{3}$$

Fig. 1, 2 3 show, for each class, the distribution of samples around the regression curve. The upper curve gives the related energy-averaged $(L_o)_E$ values. $(L_o)_E$ is related to L_o by 0.115 times the square of the standard error of the regression. The standard errors for automobiles, medium trucks and heavy trucks were, respectively, 2.4 dB, 2.0 dB and 2.0 dB. Fig. 4 reports the graphical representation of the three energy-averaged emission level expressions.

A combined truck relationship was also derived [$L_o = 41.7 + 21.0 \log(V)$]. However, as shown in Fig. 4, with a 4 dB difference between equations (2) and (3), we decided to maintain the U.S. classification of trucks for the time being. More L_o data will be collected so as to be able to compare the two sets of samples and improve the regression analysis results.

Italian and U.S. energy-mean emissions levels are compared in Fig. 5. It can be easily seen that, unlike the trucks, Italian automobiles produce higher sound levels than American ones, the difference between the two sets of data decreasing as the speed increases. As the distribution of automobiles samples covered a wide variety of cars, it suggests that Italian automobiles should probably be divided into two classes (small and large cars). Finally, other vehicle classes should be considered, such as busses and motorcycles, both being quite common on Italian highways.

CALIBRATION OF THE MODEL

Measurements were made with sound level meters and magnetic tape recorders alongside three highways at sites chosen for their typical topographical characteristics: flat, elevated and depressed highways and viaducts running through flat grassland, shrubbery, woods, marshes. At each site, for each sample period, the noise signal was recorded simultaneously at 4 microphone locations for 30-min time intervals. Distances from the highway varied from 10 to 200 m, with heights above ground of 1.5 and 5 m, so as to assess the noise impact at both differently affected site and multistory buildings. The recorded signals were analyzed by third octave frequency bands for information on frequency dependent phenomena related to the sound propagation over the ground. The traffic flow parameters (number of vehicles and average speeds) were derived by camera recording.

We are now investigating whether the model, as it is, can be successfully applied to the Italian situation or needs further adjustments in order to better describe the noise impact on multistory buildings (i.e., contour levels at different heights), as will be required by E.I.A. regulations. Major items under investigation are: 1) the approximation given by the model at shorter distances: we are getting positive results from first tests, so we think that relationships (1), (2) and (3) are at the moment satisfactory; 2) the classification scheme for vehicles: the L_o data measured up to now seem to point out that Italian vehicles are to be classified in a different way in order to get a better degree of approximation even at shorter distances. For this purpose more data are being collected; 3) the model's approach to the outdoor sound propagation phenomena: its actual use of

alpha and shielding factors may not fit the variety of cases occurring in practice. Pr measurements [3], aiming to identify a correct theoretical approach for evaluating the attenuation of sound waves due to their interference with the ground, put into eviden these phenomena can affect to a great extent the sound level at the receiver and, strongly frequency dependent, they are not correctly evaluated by using A-weighted level.

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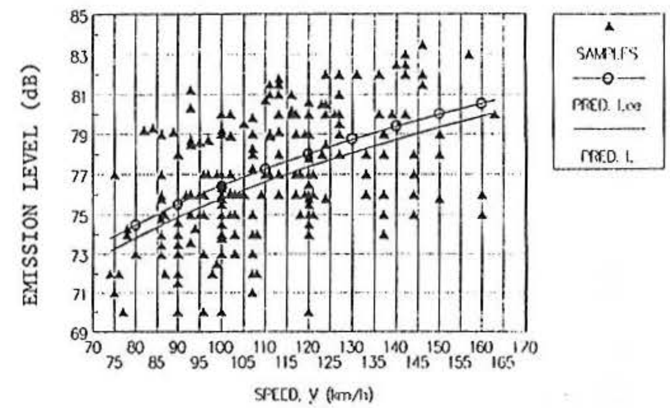

Figure 1. Italian Automobile Emission Levels at 15 m

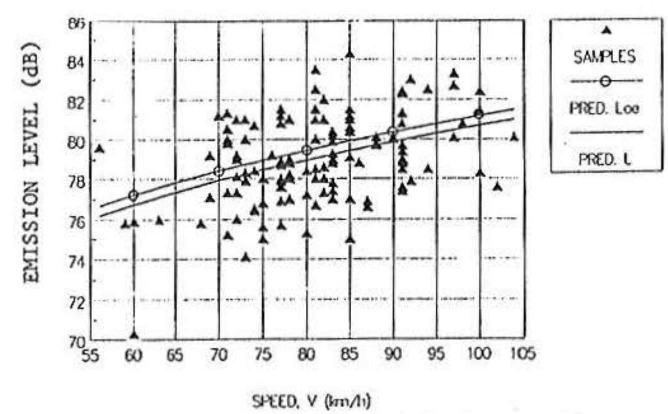

Figure 2. Italian Medium Truck Emission Levels at 15 m

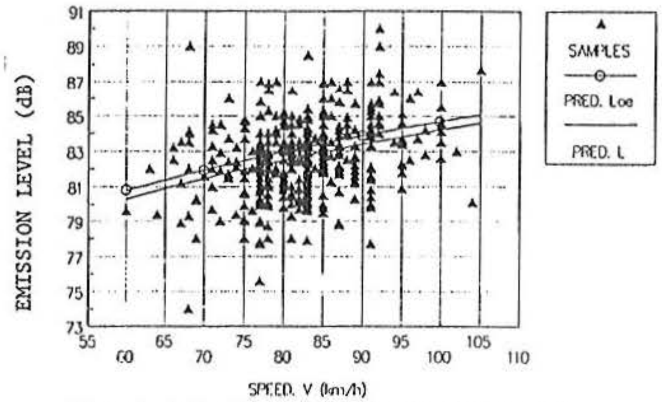

Figure 3. Italian Heavy Truck Emission Levels at 15 m

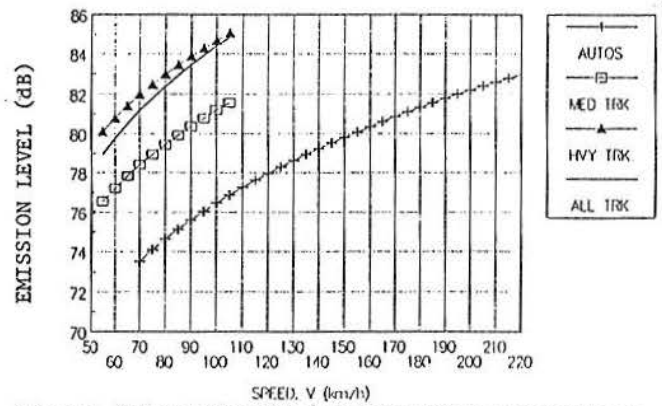

Figure 4. Italian Vehicle Reference Energy-Mean Emission Levels

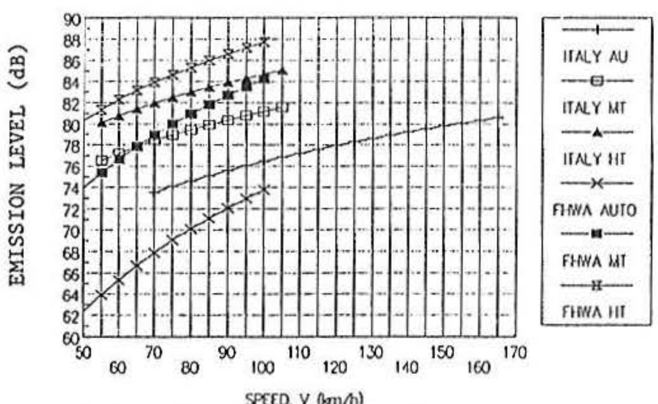

Figure 5. Comparison of U.S. and Italian Vehicle Emission Levels

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AIRCRAFT NOISE ANNOYANCE

Truls Gjestland

Research Scientist

ELAB-RUNIT
The Norwegian Institute of Technology
N-7034 Trondheim, Norway

In 1978 Schultz [1] published an extensive re on social surveys on noise annoyance. These survey included both noise from road traffic and aircraft According to the conclusions in the review there s to be a "universal" relationship between annoyance noise exposure regardless of what kind of communit noise sources that were present. A plot showing "percentage highly annoyed" versus noise level is smooth curve as shown in figure 1.

A more recent study from Canada [2] indicate there may be a difference in community reaction depending on the type of noise source. According t these results the aircraft noise becomes exceeding more annoying than road traffic noise as the leve increases. For any given noise level twice as many people will be annoyed by aircraft noise than road traffic noise, see figure 2.

Similar results have been reported by by a B team [3]. Their results indicate that the annoyan to aircraft noise is much higher than what should expected from earlier studies.

Several countries including Norway have adop noise codes based on earlier reports. In view of newly reported results, serious questions have be asked about the validity of the present recommend

The Civil Aviation Administration of Norway commissioned ELAB-RUNIT to perform an extensive s community reaction to aircraft noise around Oslo Fornebu. The results will be used to establish a