inter•noise 96
25th Anniversary Congress – Liverpool

INCE:
76.1.1.1

URBAN NOISE PREDICTION IN PAMPLONA (SPAIN)

M Arana

Dept of Physics, Public University of Navarra, Spain

1. INTRODUCTION

The sources of environmental noise in the urban areas in developed countries are related to the wheeled traffic : cars, trucks, motorcycles, etc. As a result of numerous studies on the acoustic pollution, it is known that the noise level produced by the traffic depends fundamentally on the intensity and composition of the traffic, on the slope on the road and on the conditions of the asphalt .

Prediction models of the urban noise should also take into account the characteristics of that way, such as the width of the streets, the height of the buildings or the existence of crossings and traffic lights.

In this communication different prediction formulas for the urban noise are presented with regard to a great number of measures carried out in Pamplona (Spain), which all the data of the influential variables have been obtained [1]. The provided formulas are a result of a statistic analysis, not from theoretical models.

2. DATA BASE

A data base has been obtained with 703 measures. Each measure took 15 minutes. The measured noise levels were the Leq and the statistics L10, L50 and L90, all in dBA. The microphone was located to 1-1.5 meters of height, inclined 45º with the horizontal. The values the following variables were taken into account :

. - Traffic density (cars, heavy vehicles and motorcycles)
. - Shape of the street (U/L)
. - Width of the street
. - Number of tracks
. - Buildings height along both sides
. - Distance to the two near crossways
. - Density of the traffic in both crossings

. - Distance to the two nearest traffic lights
. - Slope of the road

3. STATISTIC ANALYSIS

For the statistic analysis we have used the SPSS/PC+ program [2]. We have used the program with "enter" and "stepwise" methods, depending on the number of independent variables that was introduced in the equation. When we use all the cited independent variables above, the stepwise method selects that variable whose correlation with the dependent variable is the greatest of all. Accomplished and shown all the calculations with this variable, the program chooses the following variable more influential; this selection is made with regard to two criteria: the partial correlation coefficient and the tolerance of the variable. The process is repeated with the following variables. The variables are introduced in the equation when the probability associated with statistic F (or the equivalent T of each parameter) is smaller or the same as the value that previously we may have assigned. In our case, we have considered a value of 0.05. The method concludes when all the variables have been included; the remainders have not surpassed the cited condition.

4. SOUND LEVELS - TRAFFIC DENSITY CORRELATION

In a first approach, we use the density (Q) of the total traffic, calculating previously the logarithm of this magnitude (Log Q). The obtained results were the following :

	B	SE
Leq = 56.4 + 4.45 Log Q	0.65	4.66
L10 = 57.6 + 4.95 Log Q	0.67	4.94
L50 = 51.3 + 4.50 Log Q	0.63	5.02
L90 = 48.5 + 3.30 Log Q	0.52	4.88

Being all the dependencies totally meaningful, both constant and slopes.

The reliability of the prediction provided by these simple formulas is not very accurate; this situation was foreseeable, since all the cases have been considered, very different, that are given in the whole city : from very close streets to large avenues, from traffic moving quite freely to heavy traffic, etc., etc.

The reverberation effect produced by the buildings is an important consideration. Separating the records with buildings along both sides of the street (U-shaped streets, 75% of the data) from the records with buildings on an only side (L-shaped streets , 25% of the data) we obtain the following expressions :

U-shaped streets

	B	SE
Leq = 56.1 + 4.79 Log Q	0.68	3.67
L10 = 56.9 + 5.45 Log Q	0.70	3.94
L50 = 49.2 + 5.55 Log Q	0.70	4.11
L90 = 45.6 + 4.65 Log Q	0.62	4.20

L-shaped streets

	B	SE
Leq = 55.1 + 5.05 Log Q	0.65	4.68
L10 = 55.2 + 5.98 Log Q	0.68	5.11
L50 = 47.9 + 5.84 Log Q	0.68	5.01
L90 = 45.6 + 4.22 Log Q	0.57	4.85

Being all the dependencies totally meaningful, both constants and slopes. It is noted that the slopes of the straight line regression increase, respect to the corresponding ones to U-shaped streets for the indices Leq, L10 and L50 and decrease for the L90. The reverberation effect can be quantified between 0.5 and 1 dBA for small traffic densities. For high traffic densities (≥ 2000 veh/h) the effect is negligible.

Other of the effects that contribute to the complexity in the prediction of the sound level in urban situations is the existence of crossings and traffic lights. We have analyzed this effect by selecting the records where the distance to crossings or traffic lights was greater than 100 meters. The results are the following :

U-shaped streets

	B	SE
Leq = 47.5 + 8.00 Log Q	0.82	4.40
L10 = 49.0 + 8.48 Log Q	0.83	4.46
L50 = 44.9 + 7.51 Log Q	0.81	4.38
L90 = 44.2 + 5.55 Log Q	0.72	4.29

L-shaped streets

	B	SE
Leq = 41.2 + 9.53 Log Q	0.85	2.78
L10 = 40.4 +10.69 Log Q	0.92	2.26
L50 = 33.5 +10.55 Log Q	0.94	1.87
L90 = 33.8 + 8.06 Log Q	0.85	2.43

Being all the dependencies totally meaningful, both constants and slopes. For L-shaped streets, the correlation coefficients are high and the standard error of the estimate is reasonably small.

5. SOUND LEVELS -TRAFFIC CHARACTERISTIC CORRELATION

So far, we have considered as the only variable the total density of the traffic. The characteristics of the traffic, such as the average speed or the percentage of heavy vehicles have to influence the sound level. Now, we include these variables.Likewise, we include the distance between the microphone and the center of the road; this distance is, in fact, the halfwidth of the street. Previously, we calculate the field Log d as the logarithm of the halfwidth of the street.

The variables that the stepwise method of the SPSS program includes in the multiple regression equation (that is to say, the variables that surpass the tolerance test) are the following : traffic density (Log Q), halfwidth of the street (Log d), average speed (V, in km/h) and the percentage of heavy vehicles (P, in %). It is timely to note that the city of Pamplona is very flat, with very few streets with slope. The obtained results (for the Leq) are the following :

	R	SE
$L_{eq} = 53.0 + 6.81 \log Q - 8.49 \log d + 0.09 V + 0.08 P$ **(Eq 1)**	0.83	3.1

Separating again the U-shaped and L-shaped street records, we obtain the following expressions :

U-shaped streets

	R	SE
$L_{eq} = 53.5 + 6.03 \log Q - 6.31 \log d + 0.09 V + 0.08 P$	0.80	3.0

L-shaped streets

	R	SE
$L_{eq} = 51.3 + 7.05 \log Q - 8.85 \log d + 0.11 V + 0.11 P$	0.89	2.7

6. DISCUSSION

The multiple regression analysis accomplished on the experimental data in the urban area of Pamplona (Spain) has permitted us to deduce a semiempiric formulation capable of predicting with reasonable precision the value of the sound levels with regard to a reduced number of variables. The obtained results are practically identical to the obtained by similar projects in other Spanish urban areas [3]. The sound levels predicted for Eq 1 are being used as tool for the urban planning in the city of Pamplona (Spain)

References

[1] M.Arana, Estudio del ruido ambiental en Pamplona (Spain). Tesis Doctoral. Univ. de Valencia (Spain). 1989.

[2] Nie, Hull, Statistical Package for the Social Sciences (McGraw-Hill,New York, 1975)

[3] A. García, Predicción de niveles de ruido ambiental producidos por el tráfico rodado en zonas urbanas. Tecniacústica 95. Proceedings pp 175-178. La Coruña (Spain). 1995