inter.noise 2000
The 29th International Congress and Exhibition on Noise Control Engineering
27-30 August 2000, Nice, FRANCE

I-INCE Classification: 5.6

DISCUSSION ON ACCURACY OF PREDICTION ABOUT SOUND LEVEL OF NOISE FROM THE ROAD TRAFFIC RELATED TO ASJ MODEL 1998

M. Sasaki*, S. Yamaguchi**

* Tohwa University, 1-1-1 Chikushigaoka Minamuku, 815-8510, Fukuoka, Japan

** Yamaguchi University, 2-16-1 Tokiwadai, 755-8611, Ube, Japan

Tel.: 092-541-1511 / Fax: 092-552-2707 / Email: sasaki@tohwa-u.ac.jp

Keywords:
TRAFFIC NOISE, PREDICTION, MODELING, ASJ MODEL 1998

ABSTRACT
In order to maintain an environment as free from noise as possible, it is important to predict probable noise levels before highway construction begins. In this paper the errors between the predictional values, calculated using the ASJ model 1998 as the new prediction method, and the actual values are discussed. Various kinds of predictional errors are considered. The main errors arise from (1) traffic conditions, (2) condition of the road, (3) sound power level of noise from vehicles, (4) computational methods of sound propagation, (5) meteorological conditions, and (6) method of measuring the noise.

1 - INTRODUCTION

In general, various errors are included in the computational values of prediction of noise. There are different factors causing errors in the prediction of noise from road traffic. These errors arise from road condition, the traffic condition, the sound power level of vehicles, the spectrum envelope of noise, the computational method of propagation of noise etc... Further more, the meteorological conditions have a large effect on the outdoor propagation of noise. These factors are classified into the following three items: traffic condition, approximation of computation, the randomness caused by stochastic phenomena of fluctuation of noise, In order to improve the accuracy of predictional values, it is necessary to consider these factors and their characteristics. Consideration of these factors is described in the following.

2 - TRAFFIC CONDITION

The conditions of road traffic which are necessary for the calculation of noise prediction, are the traffic volume and the speed of every kind of vehicle. Therefore, the exact setting of the traffic volume of heavy vehicles which radiate a lot of noise energy and the exact information about the vehicle speed, are much desired, because these conditions are highly related to the noise radiated from vehicles. Another important factor is the classification of vehicles. The vehicle types can be classified into four groups, i.e. large, middle and small sized commercial vehicles, and passenger cars. On the other hand vehicles can be classified into two groups, i.e. large and small sized motor vehicles. However, the classification into two group has an assumption that the proportion of number of large to small sized motor vehicles is 1:1, and that the proportion of small sized motor vehicles and passenger cars is 1:4 according to much previous data. Therefore, the accuracy of prediction will be reduced in the case of a largely different composition of vehicles types.

3 - CONDITION OF ROAD

Virtual setting of vehicle lanes For simplifying the calculation about sound pressure levels, the road having two or more vehicle lanes is often regarded as one lane. However, although the general consideration on the predictional accuracy seems to be difficult, because the accuracy does not only depend on the number of vehicle lanes but also on the traffic volume, proportion of vehicle types, vehicle speed, the distance between vehicle lane and the prediction point of sound level and the acoustic obstacles

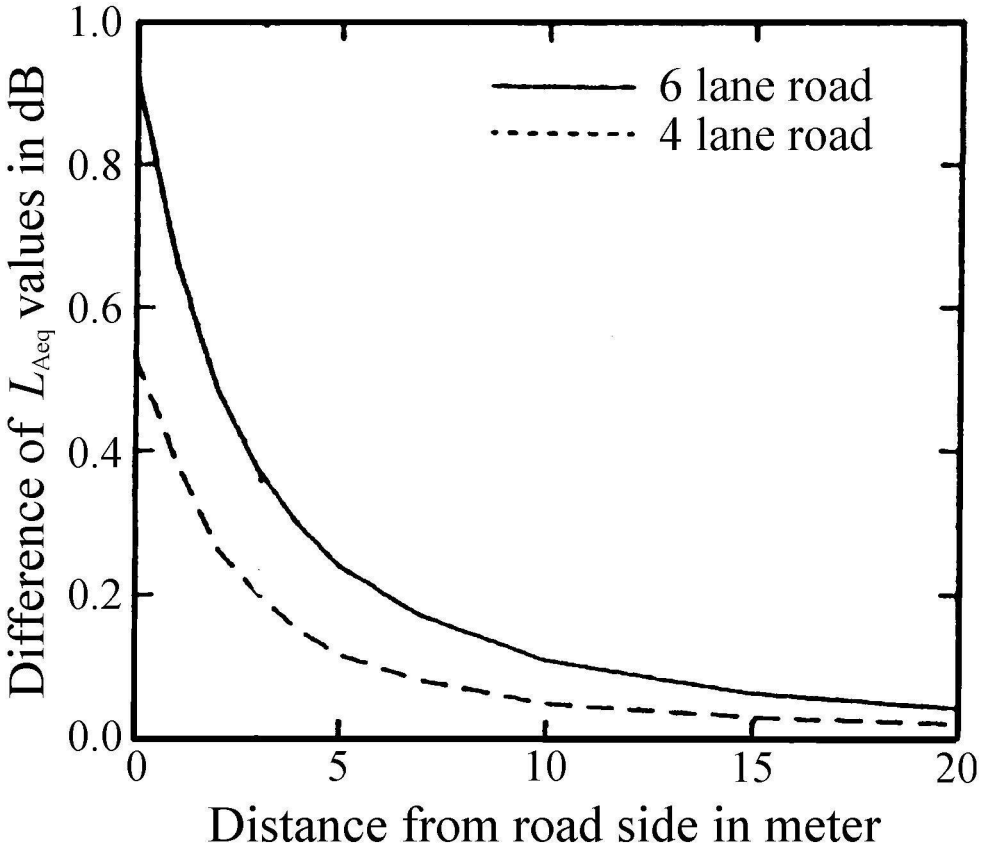

Figure 1: Difference of L_{Aeq} values by virtual setting of vehicle lanes.

such as the sound barrier. The Figure 1 shows that, the solid line shows the level difference of noise between from the six lanes and from two lanes, and the dotted line shows the level difference of noise between from four lanes and from two lanes. In both of two cases the level difference of noise is less than 0.5 dB. This shows that the errors of predictional computation is small enough.

Condition of the road surface The running noise which is radiated by the interaction between the tire and the road surface changes according to the condition of the road surface. The results of observation are shown in figures 2a and 2b. These figures show the yearly change of sound power level of vehicle noise at the same site during 1991 − 1998. The following results were obtained. (1) One year after re-pavement, the sound power levels of noise seem to become smaller, but after two years no change is observed. (2) The tendencies marked in (1) are almost equally observed for all kinds of vehicles.

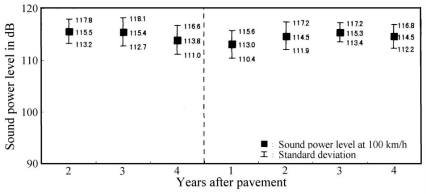

Figure 2(a): Every year change of sound power level of noise from heavy vehicles.

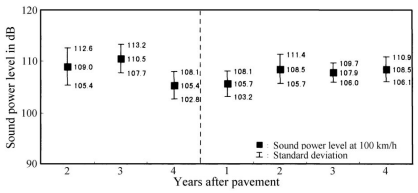

Figure 2(b): Every year change of sound power level of noise from small typed vehicles.

4 - SOUND POWER LEVEL OF NOISE FROM VEHICLES

The predictional calculation of the sound level seemed to be successful in the case of classification of vehicles into four groups. However, the sound power levels of all vehicles are given as the functions of vehicle speed, and further more, these functions are determined by the results from regression analysis of much actually measured data. Therefore, these functions have stochastic properties, where the measured

data are widely distributed around the true values. Therefore, the accuracy of predicted values is influenced by the distribution of measured data. If the property of the traffic flow, the condition of the road and vehicle speed are widely different from ordinary conditions, large and systematic errors are probably included in the predictional values.

5 - CALCULATION METHOD OF SOUND PROPAGATION

The temporal pattern of the sound level of one passing vehicle is called the "unit pattern". The shape of the unit pattern is characterized by the calculation method of noise propagation. There are two methods of calculation of noise propagation. One is the theoretical method (called A-method) and another is the empirical method (called B-method). The A-method is suitable for the precise calculation of unit pattern on account of setting the acoustical propagation properties exactly, i.e. the boundary condition in the noise propagation path, the frequency characteristics of noise etc... The B-method is suitable for the approximate or practical calculation of the unit pattern without details of boundary condition. The difference of sound levels between the calculated values derived from A-method and B-method hardly exists, because the sound energy included in the predictional calculation is only in the region of 10 dB lower than the maximum values of sound level. For example, Figure 3 shows the comparison between L_{Aeq} values in dB calculated by both of A-method and B-method in the case of bank road. Both values are highly correlated and the correlation coefficient is 0.99.

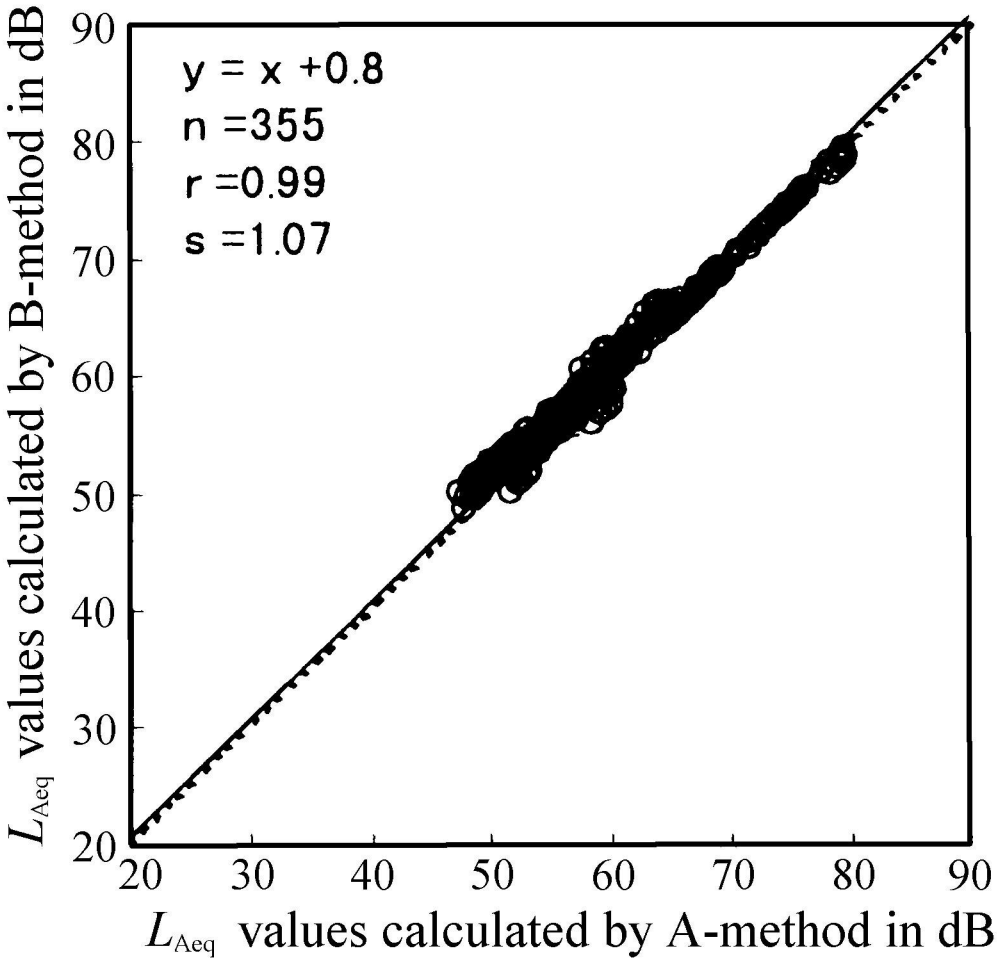

Figure 3: Comparison between L_{Aeq} values calculated by A-method and B-method at the bank road.

6 - METEOROLOGICAL CONDITION

The influence of meteorological conditions on sound propagation are caused by sound absorption in air, the refraction effect due to the inclination of atmospheric temperature and wind speed. The sound attenuation caused by absorption in air can be calculated precisely on the assumption that the temperature

and humidity are almost uniform. However, the prediction is very complicated if we assume that the inclination of temperature and wind speed are not uniform. The method of predictional calculation is not yet constructed in such complicated case. Further more, in the case when the influence of the wind can not be ignored, the range of sound fluctuation is estimated by considering of the vector of wind speed and distance of sound propagation. The prediction of influence on the sound propagation caused by non-uniformity of distribution of atmospheric temperature is very complicated. The relationship between the accuracy of prediction and non-uniformity of wind direction are further problems.

7 - METHOD OF MEASURING THE NOISE

The factors related to errors of prediction are the characteristics of time fluctuation of sound levels, the sampling intervals in seconds of noise measurement, the duration required for noise measurement, the existence of reflected sound or background noise, and errors due to approximate calculations. These error factors which are included in the results of predictional calculation must be further discussed as problems in the method of noise measurement. Further more, it is especially important that noise from other sound sources must be removed by techniques of the noise measurement.

8 - THE COMPARISON BETWEEN PREDICTED VALUES AND MEASURED VALUES

The accuracy of prediction is naturally evaluated through the comparison between the predicted values and measured values. Figures 4a and 4b show the comparison between the predicted values and measured ones for flat and cut roads respectively. The letters **s** are the standard deviation in dB which is derived from all the data. The marks + shown in figure 4b show the influence of background noise, these values must be avoided when the stochastic quantities are calculated. The results from the observation of these figures show good agreement except for the influence of background noise in figure 4b.

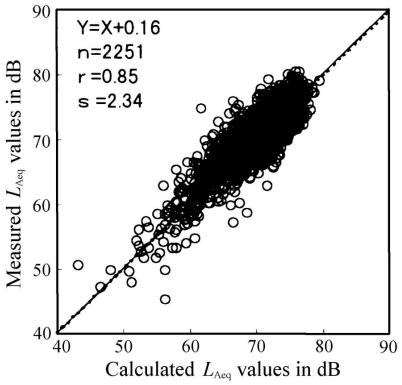

Figure 4(a): Comparison between L_{Aeq} values calculated and actually measured calculated and actually measured at the plane road.

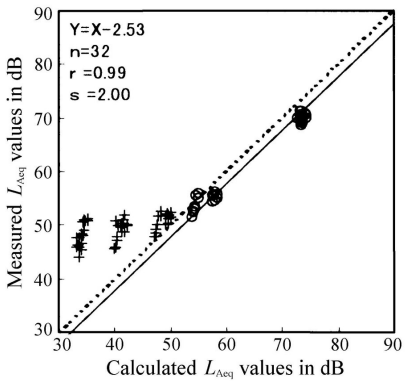

Figure 4(b): Comparison between L_{Aeq} values calculated and actually measured at the cut road.

ACKNOWLEDGEMENTS

The authors would like express the thanks for co-operation of Mr. T. Tamesue and Mr. T. Saeki in our laboratory.