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COMPARISON OF SIMPLE PREDICTION METHODS FOR NOISE REDUCTION BY DOUBLE BARRIERS

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INTRODUCTION

Noise barriers are widely applied to the traffic facilities such as highways for the noise mitigation at residential areas. They are generally installed at the road side edges. In a special case, however, an additional second barrier is erected at the middle of highway construction. This is to obtain double diffraction effect and to get more noise reduction than that of a single noise barrier. The attenuation of sound is estimated by the treatment of double diffraction theory. There are practical methods of calculation proposed by several authors, however, results of trial calculation showed that the deviation of around 10 dB in maximum existed between these methods.

In this paper, four simple methods are selected and compared to examine the validity of noise attenuation by double barrier diffraction. They are Maekawa's method, Kurze's method, ISO's method and the present author's method. Scale model experiments were carried out for sound attenuation due to double barriers of several types, where the barriers were composed of semi-infinite screens. The experimental results were used for the check of the validity.

PRACTICAL METHODS FOR THE NOISE ATTENUATION DUE TO DOUBLE DIFFRACTION

In the noise control engineering, two of the practical methods have been often employed to the calculation of double edge diffraction. One is Maekawa's method[1)] and the other is Kurze's method[2)]. Maekawa's method is a simple one where a single effective barrier is specified between the two barrier edges and the calculation is made to the single diffraction (see Fig.1. Path:S-O-P). Kurze's method is also a simple one where two diffraction paths are considered (see Fig.1 Path:S-X-P' and S'-Y-P). The determination of the sound attenuation is made by the combination of the attenuations due to single barrier with a distance correction term and a constant. Recently, International Standard Organization has proposed[3] a calculation method for sound propagation outdoors. In the proposal, a calculation method of double diffraction is described. Path difference for double edges diffraction is newly defined and the attenuation is calculated with a aid of specific expression (see Fig.1. Path:S-X-Y-P).

One of the present authors proposed[4] another simple model for the calculation of double barrier diffraction. The attenuation is expressed in a single diffraction term and the correction of the shielding effect due to the width of the barriers (see Fig.1 Path:S-Y-P and S-X-Y). In the application, the next conditional expression is used in this paper for the shadow zones shown in Fig. 2 .

$$[ATT] = \begin{cases} [ATT]_{SXP} & \text{for Zone I \& II} \\ [ATT]_{SYP} + ([ATT]_{SXY} - 5) & \text{for Zone III} \end{cases} \quad (1),$$

where [ATT] denotes the sound attenuation and the suffix shows the sound path in Fig.1. The value of [ATT] is calculated by Maekawa's chart[1].

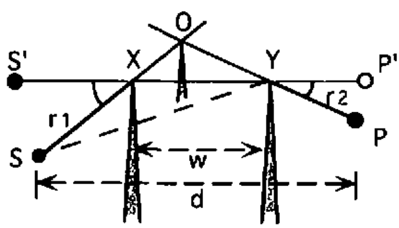

Fig.1 Parameters in calculation of the attenuation due to double edges.

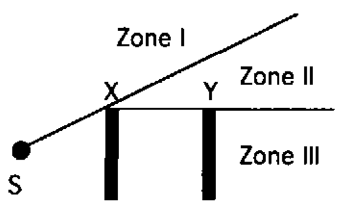

Fig.2 Shadow zones in Eq. (1).

COMPARISON WITH EXPERIMENTAL DATA

Scale model experiments were carried out to examine the validity of the selected calculation methods. The scale factor was 1/20 and the vehicle noise was simulated by adjusting the spectrum of a point source to that of representative spectrum of vehicle noise[5]. Figure 3 shows the schematic geometry showing the barriers, the source and the receivers. The point source and the receivers were fixed at the locations in Fig. 3, while the distance between the barriers was changed from 5 m to 15 m. Sound pressure levels were measured and attenuations were determined from the difference of sound pressure levels in free field.

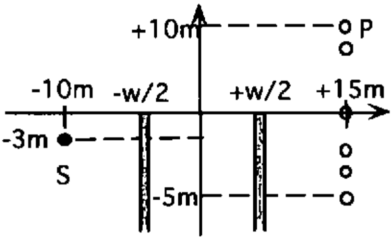

Fig. 3 Geometry of the barriers, the point source and the receivers. (w=5m, 10m and 15m. Units in full size scale.)

w=	5m	10m	15m
Zone I	■	■	□
Zone II	▲	▲	△
Zone III	●	●	○

Table 1 Symbols in the experimental results.

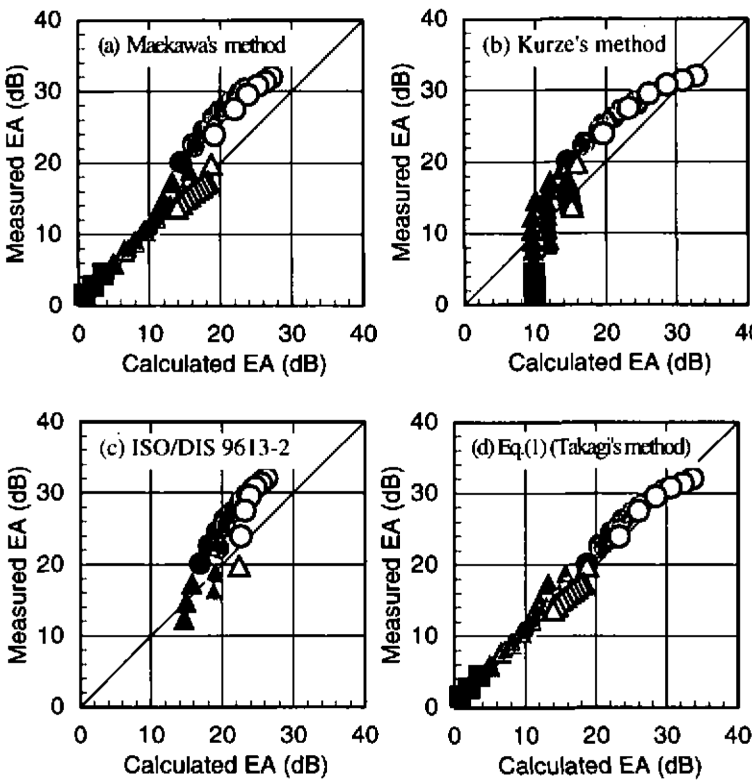

Fig.4 Comparison of experimental data with the calculated values. (a): Maekawa's method, (b) : Kurze's method, (c) : ISO/DIS 9613-2, (d) : Eq.(1) (Takagi's method).

Figures 4 (a)-(d) show the comparison of the experimental data with the calculated values. The symbols in the figure are listed in Table 1. It is shown that the attenuation estimated from Maekawa's method gives conservative values of 5 dB (under-estimated in attenuation) for Zone III where the sound ray comes into over two barrier edges. However, good agreement is obtained for Zone I and II (see Fig.4 (a)).

Kurze's method also gives lower attenuation in comparison with the measured for Zone II and III. The attenuation in Zone I shows disagreement with different tendency (see Fig.4 (b)). As for the method of ISO/DIS 9613-2, lower attenuations of around 5 dB are given for Zone III and close values to the measured are seen with a slight deviation for Zone II (see Fig. 4 (c)). Calculation was unable in Zone I due to the negative value in the logarithm function.

In the selected methods, the last one of Eq.(1) gives good agreement with the experimental data. Although the calculated values give lower attenuation of 2 dB in Zone III, Eq. (1) is almost valid for all the zones (see Fig. 4 (d)). However, care must be taken to use Eq.(1) in the case that the calculation is close to the boundary between zones of II and III. Since the calculation results may give a discontinuity of the value on the boundary, it is preferable to take into account of an acoustical boundary with [ATT(Zone II)]=[ATT(Zone III)] for smooth contour map of sound pressure level.

CONCLUDING REMARKS

Validity of the practical methods for sound attenuation due to double barriers has been examined with a aid of scale model experiments. It is shown that reasonable agreement is obtained between the experimental results and the calculated value by Eq. (1). This method may apply to the design of double barriers of highways located close to the residential area with serious noise problems.

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