inter・noise
Miami, Florida, USA
8-10 December 1980
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DEVELOPMENT AND APPLICATION OF SOUND BARRIER FOR THE CONTROL OF TRAFFIC NOISE

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For the control of surface traggic noise, essential procedures would be the reduction of noise at the source. Reduction of noise emission from vehicles and trains has been conducted extensively. However, in many cases, it is rather difficult to obtain quiet environmental situations only through the emission control of the sources.

Most of the practical noise control procedures are aimed at the noise reduction during the propagation of noise from the source to the receiver. The application of sound barrier is the most practical method for the control of traffic noise.

1. BASIC STRUCTURE OF SOUND BARRIER

Now in Japan, two types of sound barrier are being used, that is the sound absorptive type and sound reflective type. These are used by considering several factors, such as the number of traffic lane (width of the road or railway), topography and buildings along the road or railway, the necessary amount of noise reduction and so on.

Several years ago, the Japan Highway Public Corporation developed the standard panel for sound absorptive barrier in cooperation barrier have been amounted to several hundred kilometers for the case of highway.

During the stage of development of this standard panel, several design factors had been taken into considerations. In addition to the sound absorption coefficient and sound transmission loss characteristics, the water proof property and the resistivity against the wind pressure were proof considered carefully in order to be conformed to the outdoor use. The easiness of installation and maintenance of the barrier were also the important factors.

Figure 1 shows the details of this standard panel. Typical sound absorption coefficient and transmission loss characteristics are shown in Fig.

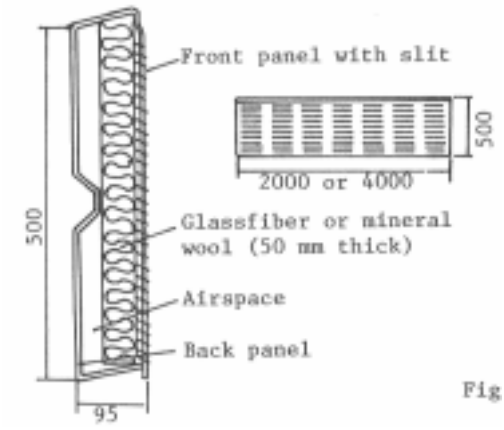

Fig.1 Section and front view of a standard panel

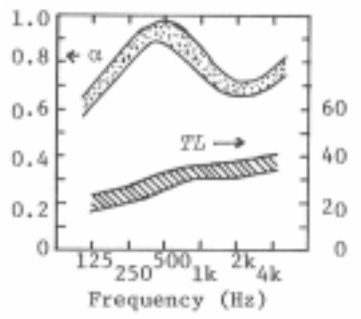

Fig.2 Acoustic characteristics of standard panel

2. FUNDAMENTAL DESIGN OF SOUND BARRIER CONSTRUCTIONS

2.1. Estimation of Noise Reduction by Design Chart. For simple configurations of road or railway constructions and of topography along the road or railway, it is possible to predict the noise reduction to be obtained by the installation of barriers, only through the calculation of diffraction at the top of barriers. A large number of investigations on the diffraction have been carried out theoretically and experimentally. As the practical method of estimation of the noise reduction by barriers, two curves are used for the case of a point source or a line source (Figure 3).

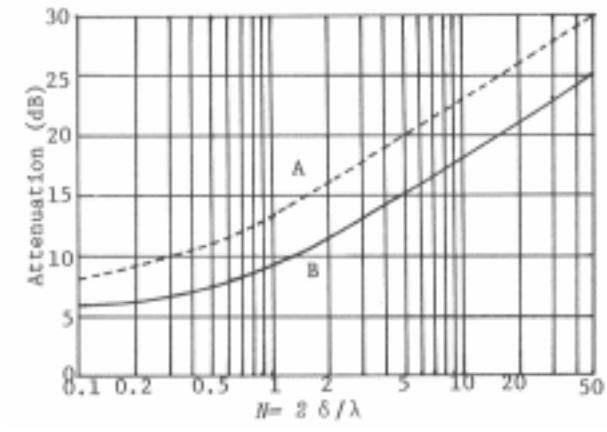

Fig.3 Sound attenuation by acoustic barrier
A: point source
B: line source

2.2. Scale Model Experiments.

Usually, road or railway constructions and the topography or building situations are too complicated to estimate the effect of the barrier only through simple calculations. For these cases, scale model experiments are carried out effectively.

Scales from 1/20 to 1/50 are used according to the extent of the object. Two kinds of jetnoise type sources were developed for these experiments.

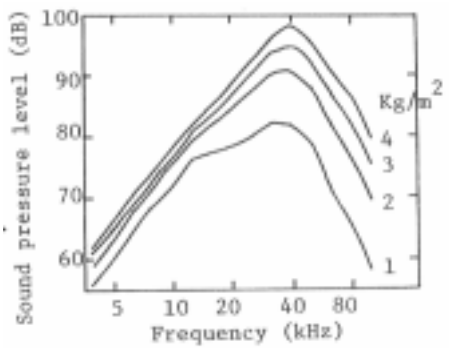

Fig.4 Spectrum of jet noise at 30 cm from the line source.

Figure 4 shows the frequency characteristics of emitted noise from the line source. The output of microphone is fed to the spectrum shaper in order to indicate directly the A-weighted sound pressure level for the average traffic noise or railway noise.

3. PRACTICAL SOUND BARRIER CONSTRUCTIONS

The simplest construction of sound barrier is the plane and vertical one and it has already given god results in manu cases. However, it is often necessary to adopt special barrier constructions in order to obtain the necessary noise reduction or to meet other requirements. For example, in order to make the shadow area for sunlight as small as possible, it is preferable to lower the height of barrier. This will be completely contradictory to the requirements for higher noise reduction.

3.1. Effect of the Bent at the Top of Barrier. Four types of barriers shown in Fig.5 are compared. In these cases, total amount of barrier is constant and only the shapes of top parts are different. The results of experiments are shown in the same

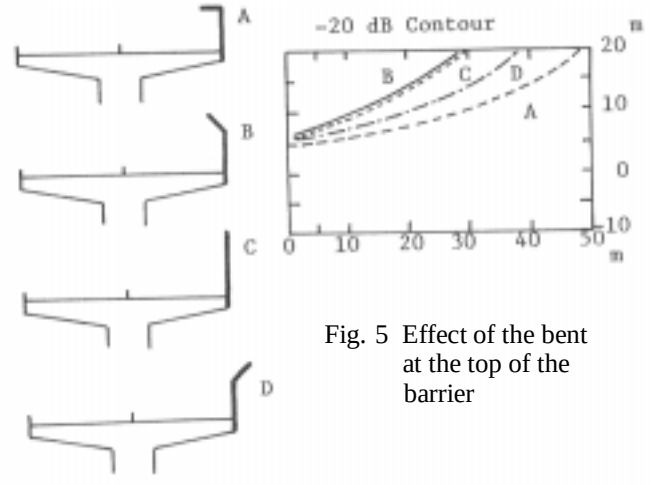

Fig. 5 Effect of the bent at the top of the barrier

figure, by comparing the equal noise reduction contours. Sound pressure level distribution for the road without barrier was chosen as the reference to noise reduction. Flat ant 60 degree inside-bent barriers (B and C) are superior compared with other two cases. Figure 6 shows some practical application.

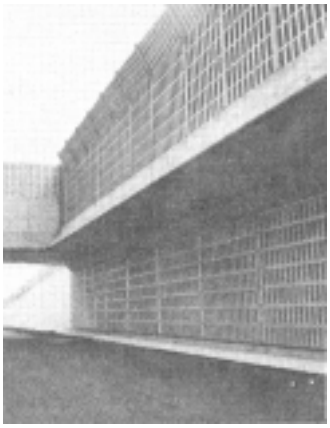

Fig.6 Example of top - bent barrier.

3.2. Inclined Barrier on the Band of Depressed Road. In the case of depressed road, barrier configurations shown in Fig.7 are considered. It was found that the effect of barrier depends on the sound absorption of the surface of the surrounding ground. For sound reflective surface, the most effective barrier configuration is the vertical installation at the top edge of the bank. This is a simple conclusion from the diffraction theory. On the other hand, in the case of absorptive surface, barrier installations would sometimes have negative effects on the noise reduction, especially at the distant areas and near-ground receiving points. This would be due to the decrease of the grazing incidence absorption effect.

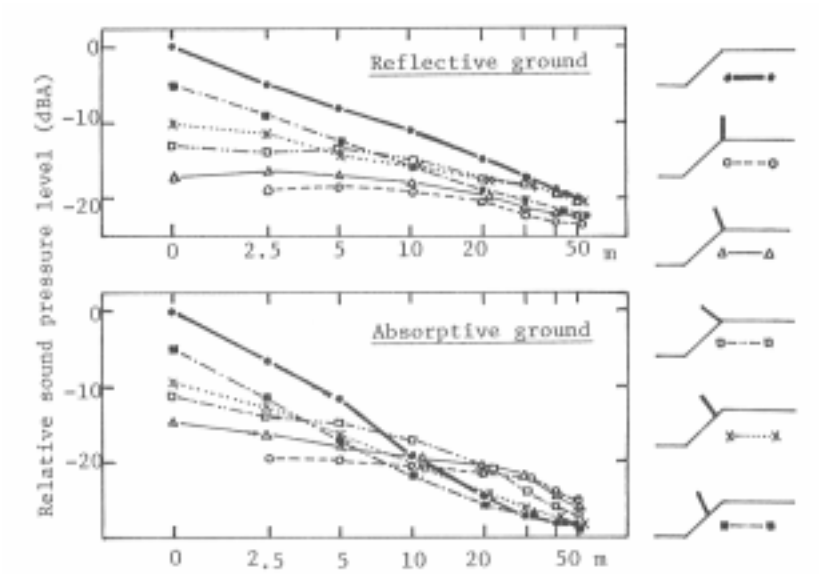

Fig.7 Effect of the barrier configurations on the propagation of noise from depressed road

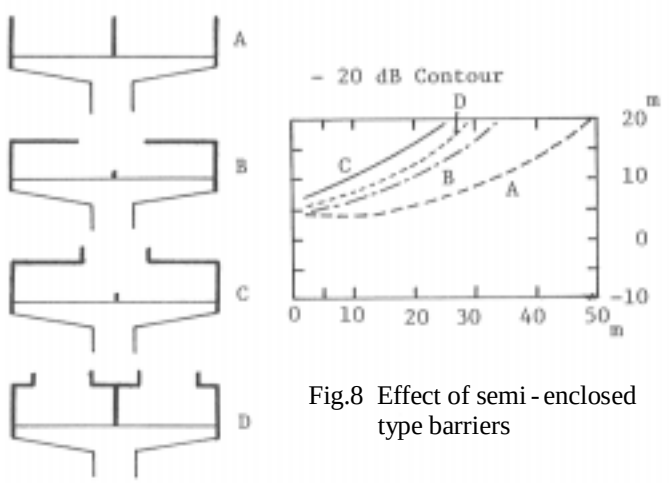

Fig.8 Effect of semi-enclosed type barriers

3.3 Semi-enclosed Type Barrier. Sound barriers mentioned above have a little effect of noise reduction, if there are high-rise buildings along the road.

In these cases, semi-enclosed type barrier shown in Fig.8 are used. Sometimes, the vertical barrier is installed along the edge of upper openings. In the same figure, the noise reduction of these types of barriers are shown by the equal noise reduction contours from the case of no barrier. Figure 9 shows some practical example of semi-enclosed construction.

Fig. 9 Example of semi-enclosed barrier construction.

4. PRACTICAL APPLICATION OF SOUND BARRIER

4.1. Special Application. Figure 10 shows the special application of sound barrier for the noise reduction in toll gate areas. In this area, the width of the road is very wide and on both sides of this area there are a large number of multi-storied residential buildings. So, at the top of band, special curved barriers were installed. The height of the top of barrier from the road surface is about 11 m. The surface of barrier faced to the road has a highly sound absorptive treatment. In this case, sound barrier was also installed on the median.

Fig. 10 Sectional view of specially shaped barrier

4.2. Effects of Wind on Noise Reduction by Barriers. In general, meteorological conditions have important effects on the propagation of noise. The effects of wind on the noise reduction by barriers have been studied by a large number of investigators theoretically and experimentally. Figure 11 shows some examples of the effect of wind on the traffic noise reduction by barriers obtained in our field measurements. In this figure, an ordinate shows the difference between measured and calculated equivalent point about 150 m apart from the road. Calculated values have not any correction on the effect of wind.

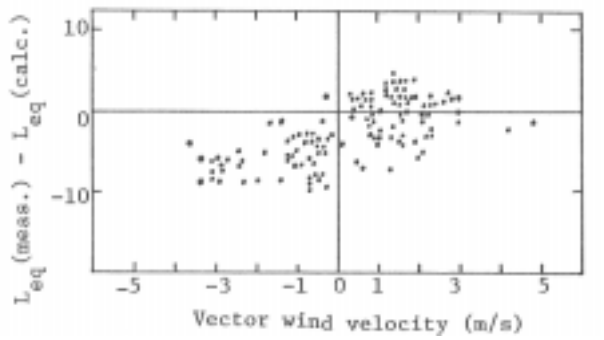

Fig. 11 Effect of wind on the propagation of road traffic noise
Distance : 150 m

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