inter•noise 96
25th Anniversary Congress – Liverpool

INCE: 31.1

NOISE REDUCTION OF A MULTIPLE EDGE NOISE BARRIER

H Shima (1), T Watanabe (1), K Mizuno (1), K Iida (1), K Matsumoto (2) & K Nakasaki (2)

(1)BRIDGESTONE Corporation, Tokyo 187, Japan, (2) Japan Highway Public Corporation, Tokyo 194

1. PREFACE

Recently with increase of traffic, road traffic noise is getting louder and reduction of the noise is urgently required. One of the most efficient counter measures to road traffic noise is a noise barrier. But to get better noise reduction the noise barrier should be made higher, which causes other problems, i.e. the rights of sunshine of circumstances, EMI. To get better noise reduction without heightening, multiple edge noise barriers has been applied[1], such as T-shaped barrier or parallel double wall barrier. We developed a new type of multiple edge noise barrier whose noise reduction is much larger than the barriers mentioned above. We show the effect of the new barrier and then discuss about the mechanism of the noise reduction of the barrier.

2. SHAPE OF A NEW NOISE BARRIER

The cross section of a new noise barrier is shown in Fig.1. The top of the barrier is separated into two branches inclining in the different directions like capital-Y, and both branches are separated into two small branches, and the barrier looks like a tree. And sound absorbing linings are applied at the lower side of the branch inclined towards sound source and at the upper side of branches and small branches.

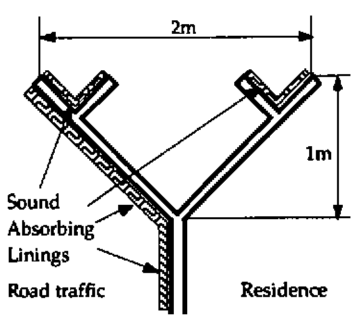


Fig.1 The shape of a new barrier

3. RESULTS OF FIELD TEST

A model test of the barrier at full scale was carried out at the test cite. In the test we measured the noise reduction of the new barrier compared with a straight barrier of the same height. The terrain of the test cite and the positions of a speaker and microphones are shown in Fig. 2. Measured sound pressure level was shown in Table 1. The length of the barrier is 20 meters, which is too short to avoid diffraction from the side ends of the barrier. To remove the effect of it, at the farthest point we also used a ultra directional microphone consist of 75 microphones. Noise reduction measured with the microphone was shown in Fig.3. The noise reduction was as much as 10dB at 1kHz where road traffic noise was dominant.

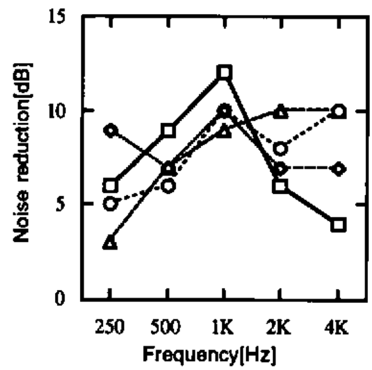


Fig.3 Noise reduction at 20m distance
(□SP at 4.5m,◇7.5m,○14m,△17.5m)

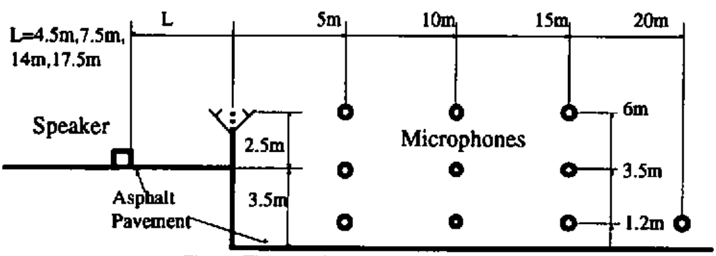


Fig. 2 The terrain of the test cite and the positions of a speaker and microphones

Table1 Noise reduction of the new barrier [dB]

Distance(m)	5			10			15			20
Height(m)	1.2	3.5	6	1.2	3.5	6	1.2	3.5	6	1.2
250Hz	10	10	11	12	9	8	11	8	9	6
500Hz	3	4	2	3	5	2	3	6	2	7
1kHz	7	8	10	9	9	8	11	10	8	8
2kHz	5	5	9	6	6	7	9	8	6	4
4kHz	1	2	6	5	4	4	6	4	6	7

Distance(m)	5			10			15			20
Height(m)	1.2	3.5	6	1.2	3.5	6	1.2	3.5	6	1.2
250Hz	10	7	6	9	8	7	9	10	7	8
500Hz	6	8	9	4	8	8	9	7	5	7
1kHz	5	7	8	8	8	6	6	8	6	8
2kHz	8	7	12	6	8	10	11	10	9	8
4kHz	1	2	9	4	5	6	7	8	8	8

Speaker at 14m

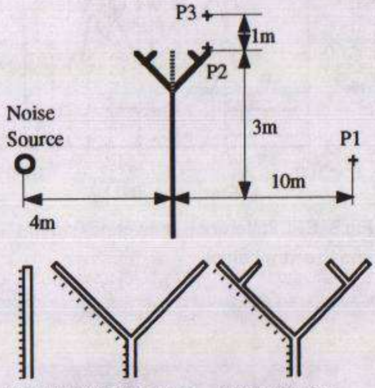
Distance(m)	5			10			15			20
Height(m)	1.2	3.5	6	1.2	3.5	6	1.2	3.5	6	1.2
250Hz	8	7	5	8	7	3	8	6	4	5
500Hz	11	11	7	10	8	6	7	9	6	7
1kHz	13	14	9	12	12	8	13	11	8	9
2kHz	11	12	10	11	11	7	11	11	7	10
4kHz	4	7	11	8	10	10	11	12	10	11

Speaker at 17.5m

Distance(m)	5			10			15			20
Height(m)	1.2	3.5	6	1.2	3.5	6	1.2	3.5	6	1.2
250Hz	7	7	5	7	8	3	7	8	4	3
500Hz	10	11	7	10	9	6	7	8	6	6
1kHz	13	14	9	11	11	8	12	11	8	9
2kHz	13	12	9	10	11	6	11	10	7	10
4kHz	5	7	11	8	10	8	11	11	10	9

4. MECHANISM OF THE NOISE REDUCTION

To find out the mechanism of the noise reduction, we calculated sound field near the barrier with BEM. Models of the calculation is shown in Fig. 4. Three types of barrier of the same height was calculated: (a)straight wall, (b)Y-shaped and (c)the new barrier. The noise reduction of (b) and (c) compared with (a) was shown in Fig. 5. Y-shaped barrier has good noise reduction with its double diffraction, and the new barrier shows much better noise reduction. The mechanism of the new barrier can be explained in two points as follows.



(a)Straight (b)Y-shape (c)new barrier

Fig.4 Models of the BEM calculation (Dot lines are absorbing boundary conditions where Z= $\rho 0 C 0$)

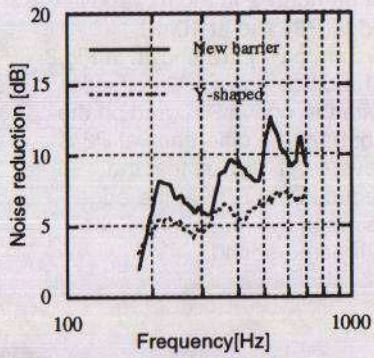
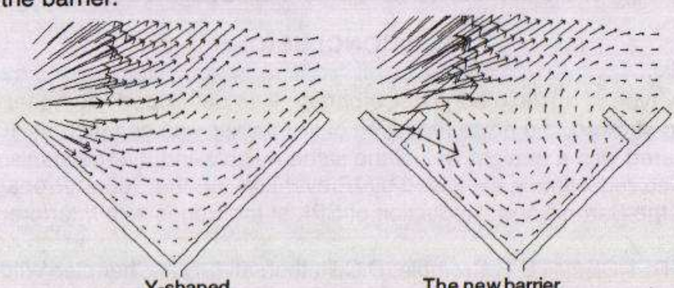


Fig.5 Noise reduction of the new barrier and Y-shaped barrier compared with straight wall

Prevention of the Sound Propagation along the Barrier

Sound intensity vector map of (b) and (c) at 250Hz octave band is shown in Fig.6. In Y-shape barrier the sound propagates along the barrier, but in the new barrier the two small branches prevent the sound propagation along the barrier.



Y-shaped The new barrier

Fig.6 Sound intensity vectors around Y-shaped barrier and the new barrier

Reduction of SPL at the Edges with Interference

In Fig. 5 at 215Hz and 380Hz the new barrier shows better noise reduction. The sound pressure level contours at 215Hz and 380Hz are shown in Fig.7. It is found that at these frequencies sound pressure level was quite low at the edges of small branches as the result of interference between direct sound wave and reflected sound wave. Sound pressure level difference between the new barrier and Y-shaped at the edge of branch(P2 in Fig.4), above the edge(P3) and at 10m distance(P1) are shown in Fig.8. The difference at P2 coincides with the one at P1, and on the contrary the difference at P3 is reverse. It proves that the reduction of SPL at the edge leads to the reduction of the diffracted sound.

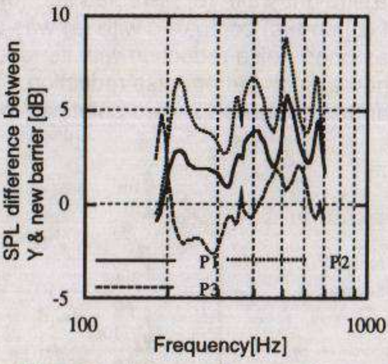


Fig.8 SPL difference between Y-shape and the new barrier

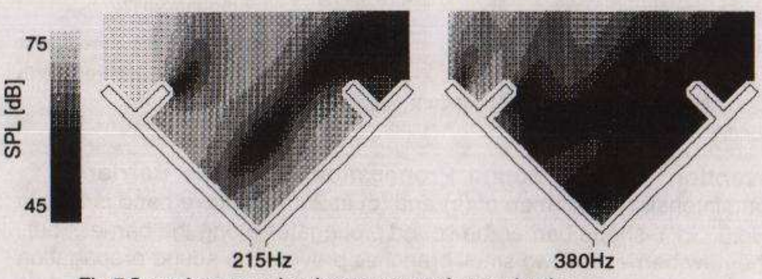


Fig.7 Sound pressure level contour near the new barrier

5. CONCLUSIONS

A new type of multiple edge noise barrier was developed. A model testing showed the noise reduction of the barrier was as much as 10dB compared with a straight wall of the same height. And the mechanism of its noise reduction is explained by "Prevention of the Sound Propagation along the Barrier" and "Reduction of SPL at the Edges with Interference ".

REFERENCE [1] D.H.Crombie, D.C.Hothersall & S.N.Chandler-Wilde, "Multiple-Edge Noise Barriers",Applied Acoustics 44(1995),pp.353-367