OUTDOOR NOISE BARRIER INSERTION LOSS

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Introduction

Barrier walls are used to attenuate sound energy as it propagates from the source to the receiver.

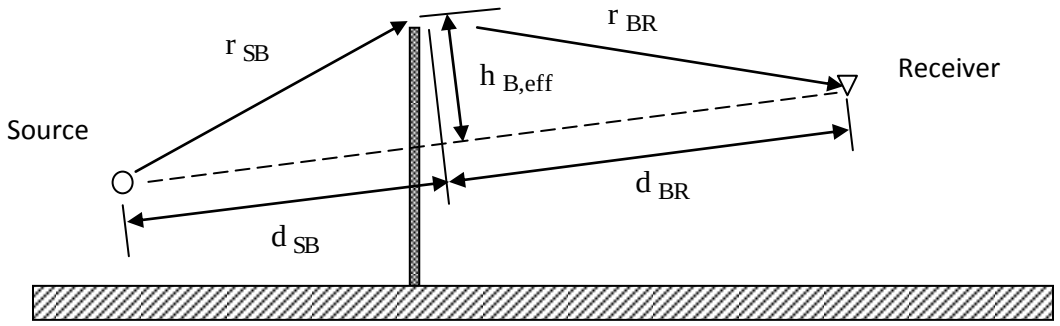


Figure 1. Barrier Diagram

The receiver shown in Figure 1 is in the "shadow zone." The sound waves originating at the source must bend or diffract at the top of the wall in order to reach the receiver.

The following formulas are taken from Reference 1.

The barrier Fresnel number N is

$$N = 2(r_{SB} + r_{BR} - d_{SB} - d_{BR})/\lambda \quad (1)$$

The wavelength λ is

$$\lambda = \frac{c}{f} \tag{2}$$

where

c	Speed of sound
f	Frequency

The barrier insertion loss Δ dB is

$$\Delta \text{dB} = \begin{cases} 20 \log\left[\dfrac{\sqrt{2\pi N}}{\tan\left(\sqrt{2\pi N}\right)}\right] + 5 \geq 0 & \text{outside shadow} \\ 20\ C_1 \log\left[\dfrac{\sqrt{2\pi N}}{\tanh\left(C_2\sqrt{2\pi N}\right)}\right] + 5 \leq 20 & \text{inside shadow} \end{cases} \tag{3}$$

The recommended coefficient values are:

$$C_1 = \begin{cases} 0.75 & \text{line source} \\ 1.0 & \text{point source} \end{cases} \tag{4}$$

$$C_2 = 1.0 \quad \text{for each source type} \tag{5}$$

Reference 1 also states that the "practical limits" for the sources are

Line	15 dB
Point	20 dB

Reference 1 also allows an extra 2 dB for an Earth berm.

References

1. Beranek, L. and Ver, I., editors, Noise and Vibration Control Engineering, Principles and Applications, Wiley, New York, 1992.

2. George Diehl, Machinery Acoustics, Wiley-Interscience, New York, 1973.

3. U.S. Department of Transportation, Federal Highway Administration, High Traffic Noise, Noise Barrier Design.

APPENDIX A

Sound Wave Diffraction

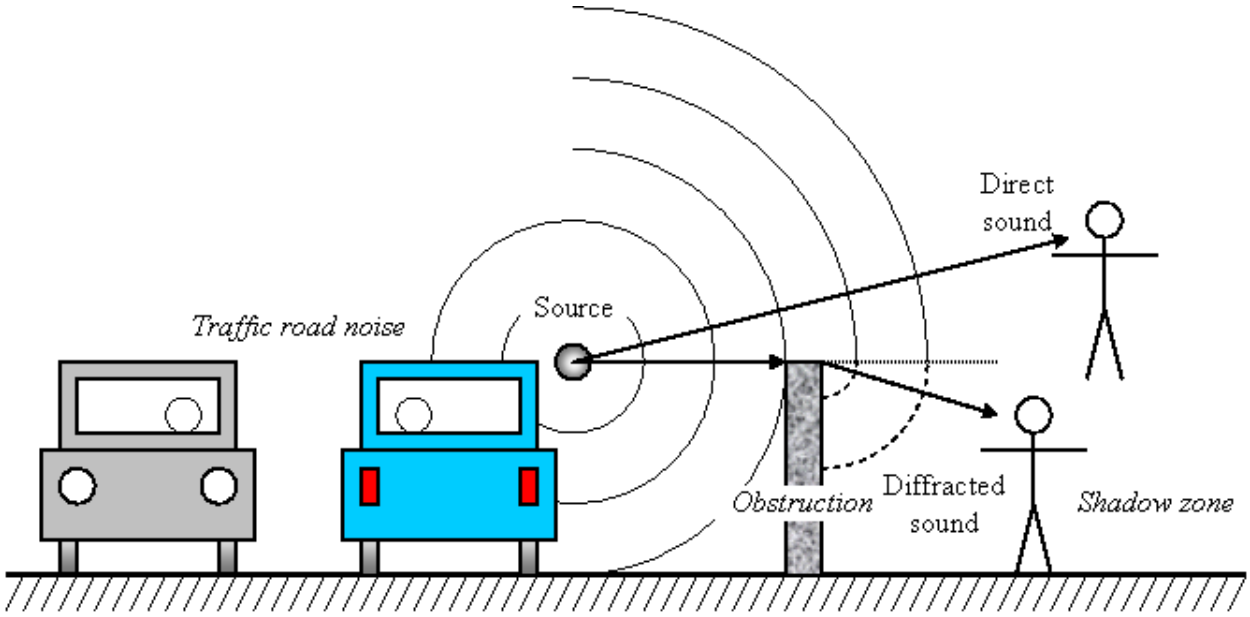


Figure A-1.

Image Courtesy of Tore Skogberg.

APPENDIX B

Simple Method

The acoustic attenuation provided by a barrier or wall can be estimated using the method in Reference 2. Consider the barrier in Figure B-1.

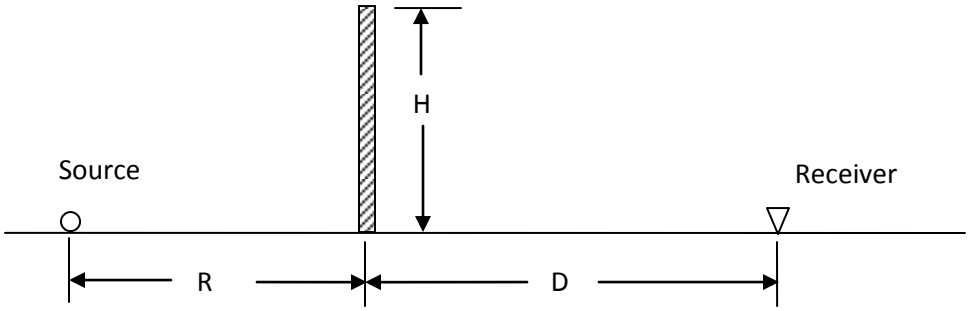


Figure B-1.

Note that the Receiver is in the "shadow zone." The sound waves from the Source must diffract or change direction past the top of the barrier in order to reach the Receiver.

Assume

1. The distance from the receiver to the wall is greater than the distance from the source to the wall, D > R.
2. The distance from the wall to the source is greater than the height of the wall, R>H.
3. The distance from the source to the ends of the wall is at least twice the distance R.

The attenuation $\Delta\,\mathrm{dB}$ is

$$\Delta\,\mathrm{dB} = 10\,\log\frac{20\,\mathrm{H}^2}{\lambda\,\mathrm{R}} \qquad \text{(B-1)}$$

where

H	Barrier height
R	Distance from source to wall
λ	Wavelength of sound

The wavelength formula is

$$\lambda = \frac{c}{f} \tag{B-2}$$

where

c	Speed of sound
f	Frequency

By substitution,

$$\Delta \text{dB} = 10 \log \frac{20 H^2 f}{c R} \tag{B-3}$$

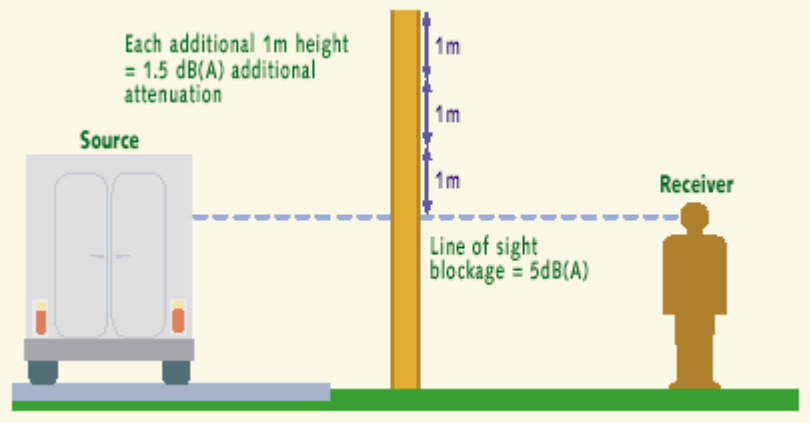
The amount of attenuation increases with frequency at the rate of 3 dB/octave.

APPENDIX C

U.S. Department of Transportation, Noise Barriers

Excerpt from Reference 3.

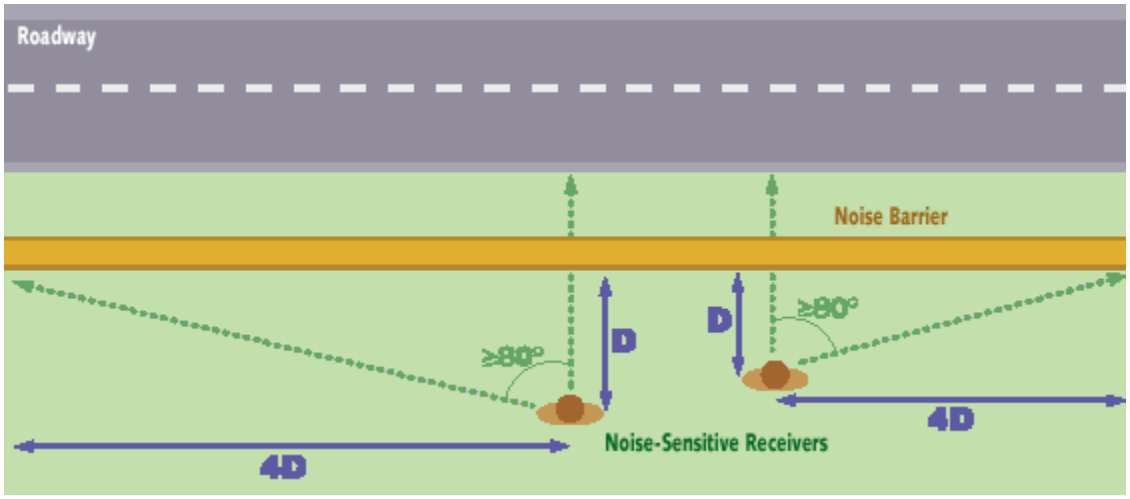
How Does a Noise Barrier Work?



Noise barriers reduce the sound which enters a community from a busy highway by either absorbing the sound, transmitting it, reflecting it back across the highway, or forcing it to take a longer path over and around the barrier. A noise barrier must be tall enough and long enough to block the view of a highway from the area that is to be protected, the "receiver."

Noise barriers provide very little benefit for homes on a hillside overlooking a highway or for buildings which rise above the barrier. A noise barrier can achieve a 5 dB noise level reduction, when it is tall enough to break the line-of-sight from the highway to the home or receiver. After it breaks the line-of-sight, it can achieve approximately 1.5dB of additional noise level reduction for each meter of barrier height.

To effectively reduce the noise coming around its ends, a barrier should be at least eight times as long as the distance from the home or receiver to the barrier.



Openings in noise barriers for driveway connections or intersecting streets destroy their effectiveness. In some areas, homes are scattered too far apart to permit noise barriers to be built at a reasonable cost. Noise barriers are normally most effective in reducing noise for areas that are within approximately 61meters (200 feet) of a highway (usually the first row of homes).