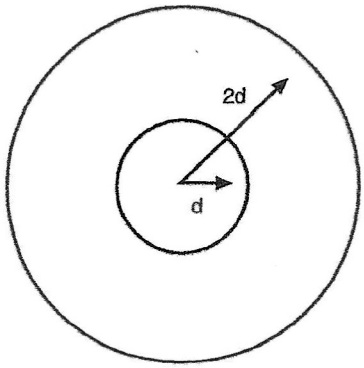

Geometrical spreading of sound from a point source

Hand Calculations of Insertion Loss

Insertion loss can be estimated by using the model proposed by Kurze and Anderson (Kurze 1971). It is the result of compiling data of many researchers onto a single plot and developing a curve fit for a point source. The equation is below and the plot is shown in Figure 2.4.

$$IL = 5dB + 20\log\left(\frac{\sqrt{2\pi N}}{\tanh\sqrt{2\pi N}}\right) dB \qquad \text{up to } N = 12.5$$

$$IL = 20\ dB \qquad \text{for } N > 12.5$$

N is defined as the Fresnel number, a nondimensional measure of how much farther the sound must travel as a result of the barrier. It is calculated with the following equation:

$$N = \frac{(a + b - \ell) f}{c_o}$$

ℓ is the original length of the direct path from source to receiver

a and b are the lengths of the two straight-line segments comprising the path as modified by the noise barrier

f is the sound frequency in Hz

c_o is the speed of sound propagation in air (approximately 1100 ft/sec)

The illustration below is used in an example calculation. The noise wall is 12 ft from the nearest tire, and is 12 ft tall. A house is 15 ft beyond the barrier and has a window at a height of 4 ft.

The length of the original direct path is :

$$\ell = 27^2 + 4^2 = 27.3\,feet$$

The lengths of the segments comprising the modified path are :

$$a = 12^2 + 12^2 = 17 \text{ feet}$$

$$b = 15^2 + 8^2 = 17 \text{ feet}$$

Hence :

$$a + b - \ell = 34 - 27.3 = 6.7\,feet$$

at f = 100 Hz, the Fresnel number is

$$N = \frac{6.7 * 100}{1100} = 0.61$$

and the insertion loss calculated from the equation is

$$IL = 5 + 20\log\frac{\sqrt{2\pi * 0.61}}{\tanh\sqrt{2\pi * 0.61}} \approx 10\,dB$$

The calculated insertion loss can be compared with the predicted value in the graph below (referred to as Eqn 19). The calculated insertion loss is close to the measured value from experimental data.

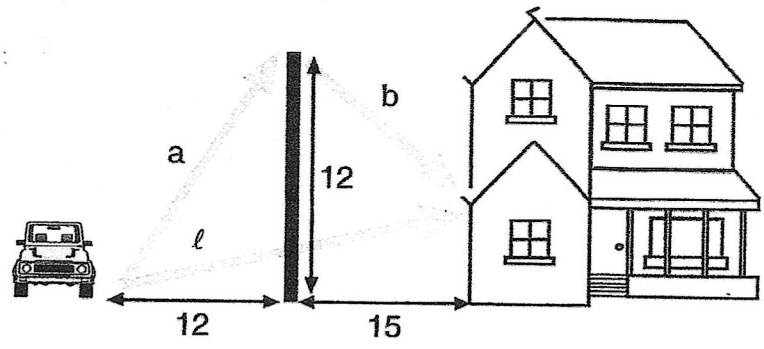

Figure 2.3 Illustration of lengthened sound path due to noise barrier