BRITISH ACOUSTICAL SOCIETY: Meeting on "PLANNING TO AVOID NOISE NUISANCE: on 28th October, 1971, at EWELL COUNTY TECHNICAL COLLEGE.

The Physical Aspects of Noise by B. J. Smith

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Sound is an aural sensation caused by pressure variations in the air which are always produced by some source of vibration. They may be from a solid object or from turbulence in a liquid or gas. These pressure fluctuations may take place very slowly, such as those caused by atmospheric changes, or very rapidly and be in the ultrasonic frequency range. The velocity of sound is independent of the rate at which these pressure changes take place and depends solely on the properties of the air in which the sound wave is travelling.

Frequency, measured in Hertz is the number of vibrations or pressure fluctuations per second. The audible range is from approximately 20 Hz to 20 KHz.

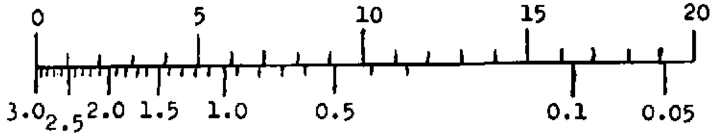
Wavelength is the distance travelled by the sound during the period of one complete vibration. Wavelengths of sound in the audible range vary from about 16.5 m (20 Hz) down to 16.5 mm (20 KHz).

Decibels, magnitudes of sound pressure affecting the ear vary from 2×10^{-5} N/m^2 at the threshold, up to 200 N/m^2 in the region of instantaneous damage. This may be compared with normal atmospheric pressure of 10^5 N/m^2. Because of this inconveniently large order of values involved and also because the ear response is not directly proportional to pressure, a logarithmic scale is used.

$$dB = 10 \log_{10} \frac{I_1}{I_o}$$

Where I_o is the intensity of the sound at the threshold. It can be seen that doubling of the sound intensity (energy) I would increase the sound level by 3 dB.

It can be seen by reference to Figure 1 that if two sounds differ by more than 15 dB the quieter one contributes almost nothing to the total sound.



Sound Level Meters and Weighting Scales

The sound level meter used for the measurement of sound pressure levels consists of a microphone, amplifier and a meter. The microphone converts the sound pressure waves into electrical voltage fluctuations which are amplified and operate the meter. Unfortunately no meter could indicate accurately over such a large range as may be needed from 30 dB to 120 dB or more. To overcome this the amplification is altered as required in steps of 10 dB and the meter only has to read the difference between the amplifier setting and the sound pressure level. Most meters will have connections to which filters can be added to select particular frequencies of the sound. An output is common to allow the sound to be recorded on tape or the levels plotted on a chart.

Besides a linear reading of the sound pressure level most meters have A & B scales where the response varies with frequency. It has been shown that readings on the A scale, dBA, correspond most closely to the response of the ear. For many practical purposes when simple direct readings are needed this is the best scale to use. The response of the ear is dependent on frequency and it is for this reason that weighting scales are originally devised.

Sound Power and Sound Intensity

$$\text{Intensity, } I = \frac{\text{sound power in watts}}{\pi r^2} \text{ for a}$$

point source of sound radiating uniformly into free space.

Reduction of Sound

Distance

It can be seen from above that the intensity from a point source of sound will decrease inversely as the square of the distance or 6 dB each time the distance is doubled. However, this is not the case with a line source of sound, such as that from a busy motorway where the intensity decreases directly as the reciprocal of the distance or 3 dB for each doubling of distance. The use of land to provide space to give sound reduction is uneconomic in the case of urban motorways.

Barriers

A wall or other barrier, provided it is high enough and has no gaps in it, can be a very useful way of providing up to about 15 dB reduction. (Possibly slightly more in a few instances.) They can be light in weight usually of sheet material such as aluminium or plywood and suggest a possible means of reducing sound from urban motorways.

Bushes and Trees

These are virtually useless as a means of providing sound reduction. It appears possible that they may reduce the discomfort caused to people even though there is no actual reduction in sound pressure level, probably because the source of the noise cannot be seen.

Partitions

Reduction of sound by partitions is very commonly used. The normal requirements are:

1. As much mass as possible.

2. That the wall is complete with no air paths through it.

3. Multiple construction where adequate mass is not possible, i.e. windows. The gap should be as large as possible between layers which should be of different superficial mass. Absorbent material in the gap is advisable.

In general it is likely that a brick wall will be the cheapest way of achieving good sound insulation. In some buildings a weight limitation makes it necessary to use lighter constructions.

In every case the amount of sound reduction needed depends not only on the source of sound but on the level that is acceptable at the receiving end. This latter criteria can only be obtained from a knowledge of the subjective effects of noise. Ideally the sound reduction should be achieved at source. In any case careful planning can often reduce the disturbing effects of noise at relatively small cost.