**Environmental Engineering**

**Lec.7 Noise Pollution 4th year**

**Real Noise Sources**

Real noise sources such as machines with vibrating surfaces differ from the simple point source in two important ways, firstly, the source has a definite size and is not a point, and secondly, it may radiate different amounts of sound energy in different directions. However, provided the distance from the source is great enough, real noise sources do behave like simple sources inasmuch as the SPL in any direction (in the open) will decrease at a rate of 6dB per doubling of distance away from the source.

Each portion of a vibrating machine surface radiates sound. Near to machine the contribution of the various portions combine in a complex way and it is difficult to predict local variations in sound pressure near to machine. This region close to the machine is called the **near sound field** or simply by the **near field**. The near field is limited to a distance from the source equal to about a wavelength of sound or equal to three times the largest dimension of the sound source (whichever is the larger).

Further away from the machine the noise contributions from the various parts of the machine coalesce smoothly, individual can think of the machine radiating as a whole. This region is called the **far sound field** or simply the **far field**. It is in this far field region that the sound pressure distribution varies moothly with distance according to the inverse square law. The far field of a source begins where the near field ends and extends to infinity. Note that the transition from near to far field is gradual in the transition region. In the far field, the direct field radiated by most machinery sources will decay at the rate of 6 dB each time the distance from the source is doubled. For line sources such as traffic noise, the decay rate varies between 3 and 4 dB.

**7.1 Directionality of noise source**

The dirctivity factor Q is a ratio, which may be greater than one ( in directions where more than average power is radaied) or less than one.

The directivity index D, in dB, may be positive (for directions in which more than average power is radiated), or negative (for directions of less than average radiation).

D= SPL - SPLav

where SPL is the sound pressure level in the direction of interest, dB

SPLav is the true, logarithmic average of the levels measured at the same

distance in various directions around the source.

Directivity factor Q and directivity index D are simply related:

D=10 log Q

Table 1 shows the directivity of an omnidirectional source when postioned at various points in a room.

|  |  |  |  |
| --- | --- | --- | --- |
| Position of source | Part of sphere into which source can radiate | Directivity factor Q | Directivity index D, dB |
| Center of room | Whole sphere | 1 | 0 |
| Center of wall, floor or ceiling | Half | 2 | +3 |
| Junction of two planes,e.g. wall and ceiling, wall and floor | Quareter | 4 | +6 |
| Corner ( junction of three planes) | Eight | 8 | +9 |

The SPL at a given distance r from a source can be related to the SWL of the source and its directivity factor D as follows:

SPL=SWL-20 log r-8 +D

**7.2 Sound distribution in rooms, direct and reverberant fields**

The sound which arrives at a point in a room from a noise source in that room may be considered to consist of two parts; first there is the direct sound which arrives from source to receiver without having been reflected from any of the room surfaces. This is followed by first reflections from the walls, ceiling and floor and any other prominent reflectors in the room, and by innumerable further reflections. The sum total of all these reflections is called the reverberant sound. If the noise is transient, the direct and reverberant sound arrives at the receiver at different times, and the reverberant sound decays with a reverberation time given by Sabine’s formula.

So, The direct field of a sound source is defined as that part of the sound field which has not suffered any reflection from any room surfaces or obstacles. The reverberant field of a source is defined as that part of the sound field radiated by a source which has experienced at least one reflection from a boundary of the room or enclosure containing the source.

If the noise source is continuous the total SPL is the combination of the direct SPL and the reverberant SPL.

The direct SPL from a source depends on the distance from the source and the sound power level and directivity of the source.

The reverberant componenet of the sound builds up to a level at which the rate of supply of sound energy to the room from the source is equal to the rate at which it is being absorbed by the room surfaces. A simple theory assumes that the reverberant sound is distributed uniformly throughtout the room. The reverberant SPL depends on the SWL of the source and the amount of acoustic absorption in the room, expressed as a room constant Rc, according to the following equation

The room constant

where S= the surface are of the room, m2

α = the average absorption coefficient in the room

Rc=room constant, m2

The average absorption coefficient may be calculated from the areas of different types of absorbing surfaces in the room.

The total SPL is found by adding up the two componenets logarithmically, the following formula made by used:

where Q= is the dirctivity factor of the noise source in the direction of the receiver

r = is the distance between source and receiver

**7.3 Transmission of sound between two adjacent rooms**

For a given amount of sound energy transmitted through the partition, the level of reverberant sound created in the receiving room will depend upon the amount of absorption in the receiving room. The level difference between the two rooms is given by:

*SPL1-SPL2= R- 10 logS + 10 logA*

where SPL1= sound level in the source room, dB

SPL2= sound level in the receiving room, dB

R= sound reduction index, dB

S= area of partition, m2

A= absorption in receiving room, m2

**7.4 Transmission of sound from indoors to outside**

In this case the sound energy transmitted though the partition is radiated into open space, where there is no reverberant field. The sound pressure level close to the partition on the outside is given by:

*SPL2= SPL1 - R- 6*

where SPL1= sound level on the source side of the partition, dB

‎ SPL2= sound level close to the partition on the outside, dB

‎ R= sound reduction index, dB‎

**7.5 The sound power levels of surfaces and facades**

SWL = SPL+10 log S