

MODULE :03

ACOUSTICS

**By: Mr. Birajit Basumatary
Assistant Professor (C)
Department Of Physics
BBEC, Kokrajhar**

Outlines:

- Sabine's Formula for Reverberation-time
- Optimum Reverberation-time

13.17 SABINE'S FORMULA FOR REVERBERATION TIME

Wallace C. Sabine (1868-1919) conducted some experiments and calculated the reverberation times of empty and furnished halls of different sizes.

According to his studies the reverberation time depends on:

- (i) the reflecting properties of the surfaces such as walls, floor and ceiling of the hall. When these surfaces are good reflectors of sound, it would take longer time for the sound to die away and the reverberation time of the hall would be longer.
- (ii) directly on the physical volume V of the enclosure.
- (iii) the absorption coefficient of different surfaces such as carpets, cushions, curtains etc existing in the enclosure (hall, room etc).
- (iv) the frequency of the sound waves. Absorption coefficient of the materials increases with frequency and high absorption coefficient at high frequency would lead to shorter reverberation time.

Prof. Sabine summed up his results in the following form.

$$\text{Reverberation Time, } T \propto \frac{\text{Volume of the Hall, } V}{\text{Absorption, } A}$$

or
$$T = k \frac{V}{A}$$

where k is a proportionality constant. It is found to have a value of 0.161 when the dimensions are measured in metric units. Thus,

$$T = \frac{0.161 V}{A} \quad \dots(13.24)$$

where A is the absorption coefficient is given by Eq. (3.16) as

$$A = \alpha_1 S_1 + \alpha_2 S_2 + \alpha_3 S_3 + \dots = \sum_1^n \alpha_n S_n$$

$$\text{Reverberation time, } T = \frac{0.161 V}{A} = \frac{0.161 V}{\sum_1^n \alpha_n S_n} \quad \dots(13.25)$$



Fig. 13.19:
Reverberation Time.

or Reverberation time,
$$T = \frac{0.161V}{\alpha_1 S_1 + \alpha_2 S_2 + \alpha_3 S_3 + \dots + \alpha_n S_n} \quad \dots(13.26)$$

Eq. (13.26) is known as Sabine's formula and works well for large enclosures.

13.17.1 Optimum Reverberation Time

Sabine determined the time of reverberation for halls of various sizes. In these measurements, he used an organ pipe as the source, which was blown at a definite frequency and under a constant pressure. The instant of cutting off of the sound and the instant at which the observer ceased to hear the sound were recorded. And from the results, he deduced the reverberation time that is likely to be most satisfactory for the purpose for which a hall is built. Such satisfactory value is known as the *optimum reverberation time*. The optimum reverberation time for music or speech lies between 0.6 to 0.75 s whereas it lies between 0.8 to 1.00 s for orchestra. The reverberation time of a hall can be adjusted to a desired value by arranging absorbent materials for the various surfaces of the hall.

Thanks