ABSORPTION COEFFICIENT
We know that all the sound waves when pass through as open window passes through it. Thus, we can say that the open window behaves as a perfect absorber of sound and hence the absorption coefficient can be defined as the rate of sound energy absorbed by a certain area of the surface to that of an open window of same area.
Definition: The absorption coefficient of a surface is defined as the reciprocal of its area which absorbs the same amount of sound energy as absorbed by a unit of an open window.
For example if 2m² of a carpet absorbs the same amount of sound energy as absorbed by 1 m² of an open window, then the absorption coefficient of the carpet is 1.2=0.5. The absorption coefficient is measured in open window unit (O.W.U) or Sabines.

1 Average absorption coefficient
The average absorption coefficient is defined as the ratio between the total absorption in the hall to the total surface area of the hall.

\[ a = \frac{A}{S} = \sum \frac{a_s}{s} \]

2 Measurement of sound absorption coefficient
Let us consider a sample for which the absorption coefficient \( (a_m) \) is to be measured. Initially without this material the reverberation time in a room and again the reverberation time is measured and let it be \( T_2 \).
Then from Sabine's formula
For Case (1) i.e. without the sample
Her, by knowing the terms on the right hand side the absorption coefficient of the given sample can be determined.

**3 ACTORS AFFECTING THE ACOUSTICS OF BUILDING**

We know, when sound waves are produced in a hall, it reaches the observer directly as well as after reflections from walls, floors, ceilings, etc. Thus there is a possibility for causing interference between these waves, which in turn affects the originality of the sound produced.

The actors affecting the acoustics (sound) of building are as follows.

i. Unoptimised reverberation time

ii. Very low or very high loudness

iii. Improper focusing of sound to a particular area, which may cause interference

iv. Echoes or echelon effects produced inside the buildings

v. Resonance caused due to matching of sound waves.
vi. Unwanted sound from outside or inside the building, so called noise may also affect the acoustics o buildings.

3.1 OPTIMUM REVERBERATION TIME AND ITS REMEDY
We know Reverberation time is the taken for the sound to fall to one millionth of its original sound intensity, when the source of sound is switched off. This reverberation time is high then it produces, echoes in the hall and if the reverberation time is very low, the sound will not be clearly heard by the audience. Therefore, for clear audibility, we should maintain optimum reverberation.

The optimum reverberation time can be achieved by the following steps
1. By having the full capacity of audience in the auditorium.
2. By choosing absorbents like felt, fiber, board, glass etc inside the auditorium and even at the back of chairs.
3. Reverberation time can be optimized by providing windows and ventilators at the places wherever necessary and using curtains with folds or the windows.
4. The reverberation time can also be optimized by decorating the walls with beautiful pictures.

The optimum reverberation time will not be constant for all types of building; it varies from one building to another as follows.

i. For concert halls, the speech should have the optimum reverberation time of 0.5 seconds and music should have the optimum values of 1 or 2 seconds
ii. For auditorium, or theatres, the optimum reverberation time should be between 1.1 to 1.5 seconds for smaller area and between 1.5 to 3 seconds for larger area.

3.2 Loudness and its remedy:
We know loudness is the degree of sensation produced on the ear; it varies from observer to observer. But, it is found that for a single observer the loudness varies from one place to another in the same auditorium. This defect is caused due to the bad acoustical construction of buildings.

The loudness will be very low in some area and will be very high in some areas. It can be optimized by the following remedies.

Remedies
i. Loudspeakers should be placed at the places where we have low loudness.
ii. The loudness can also be increased by making reflecting surfaces, wherever necessary
iii. Loudness can be increased by constructing low ceilings
iv. Absorbents are placed at the places where we have high loudness.
Thus, the loudness should be made even, all over the auditorium, so that the observer can hear the sound at a constant loudness at all the places.
3.3 FOCUSING AND INTERFERENCE EFFECTS

In some places of a hall, the sound will not be heard properly and that place is said to be a dead space, which is due to presence of convex or concave surfaces in the hall as shown in the figure. Sometimes the sound waves will have interference pattern because of ceiling surfaces which will create maximum intensity of sound (due to constructive interference) in some places and minimum intensity of sound (due to destructive interference) at some places and hence causing uneven distribution of sound intensity in the hall and hence causing uneven distribution of sound intensity in the hall.

Remedies
i. By avoiding curved surfaces (or) covering the curved surfaces by suitable absorbents the focusing can be avoided.
ii. By evenly polishing and decorating with absorbents the interference effects can be avoided.

3.4 ECHOES AND ECHELON EFFECT

In some halls, the walls of the halls will scatter the sound waves rather than reflecting it, thus way create nuisance effect due to echoes. The echoes are formed when the time interval between the direct and reflected sound waves are about 1/15th of a second. This effect occurs due to the reason that the reflected sound waves reaches the observer later than the direct sound.

If there is a greater repetition of echoes of the original sound to the observer then the effect is called as Echelon effect.

Remedies
The echo can be avoided by lining the surfaces with suitable sound absorbing materials and by providing enough number of doors and windows.

3.5 RESONANCE

Resonance occurs when a new sound note of frequency matches with standard audio frequency. Sometimes, the window panel, sections of the wooden portion is thrown into vibrations to produce new sounds, which results in interference between original sound and created sound. This will create disturbance to the audience.

Remedies
i. The resonance effect can be avoided by providing proper ventilation and by adjusting the reverberation time to the optimum level.

ii. Nowadays the resonance is completely eliminated by air conditioning the halls.

### 3.6 NOISE
Noise is an unwanted sound produced due to heavy traffic outside the hall which leads to displeasing effect on the ear. There are three types of noises.

i. Air Borne noise

ii. Structure Born Noise

iii. Inside Noise

All these three noises pollute the area at which it has been produced and create harmful effects to the human beings. Fortunately human beings have the capability to reject the sound within certain limits with conscious efforts and to carry on his normal work. But sometimes the noises are strong which results in the following effects.

### 3.7 EFFECTS PRODUCED DUE TO NOISE POLLUTION

- It produces mental fatigue and irritation.
- It diverts the concentration on work and hence reduces the efficiency of the work.
- It sometimes affects the nervous system and lowers the restorative quality of sleep.
- Some strong noises leads to damage the eardrum and make the worker hearing impaired.
- The noises which are produced regularly will even retard the normal growth of infants and young children.

### a. AIR BORNE NOISE

The noise which reaches the hall through open windows, doors, and ventilations are called as air borne noise. This type of noise is produced both in rural areas [natural sound of wind and animals] and in urban areas [noise that arises from factories, aircrafts, automobile, trains, Flights etc.]

**REMEDIES**

i. By making the hall air conditioned, this noise may be eliminated

ii. By allotting proper places or doors and windows, this noise can be reduced.

iii. It can be further by using double doors and windows with separate rames and by pacing the absorbents in-between them

### b. STRUCTURE BORNE NOISE
The noise that reaches the hall through the structure of the building is termed as Structure Borne noise. Those types of noise produced inside the building, which may be due to the machinery operation, movement of furniture’s footsteps etc and these sounds will produce structural vibration giving rise to the Structure Borne Noise.

**REMEDIES**

i. By properly breaking the continuity of the interposing layers by some acoustical insulators this type of noise can be avoided.

ii. By providing carpets, resilient, antivibration mounts etc., this type of noise can be reduced.

**c. INSIDE NOISE**

The noises that are produced inside the halls is known as inside noise. For example in some offices the sound produced by machinery, type writers etc produces this type of noise.

**REMEDIES**

i. By placing the machineries and type writers over the absorbing materials or pads this type of noise can be reduced.

ii. It can be reduced by covering the floors with carpet.

iii. By fitting the engine on the floor with a layer of wood or elt between them this type of noise can be avoided.

**4 FACTORS TO BE FOLLOWED FOR GOOD ACOUSTICS OF BUILDING**

To have a clear audibility of sound have an optimum level

i. The reverberation time should have an optimum level

ii. The sound must be evenly distributed to each and every part of the building.

iii. There should not be any focusing of sound to any particular area.

iv. Each and every syllable of sound must be herd clearly and distinctly, without any interference.

v. There should not be any echoes, echelon effects and resonance inside the buildings.

vi. The building should be made as sound proof building, so that external noises may be avoided.

vii. Generally to say the total quality of sound should be maintained all over the building to all the audience.