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Behavioral Analysis of the Audible Sound with Remedial Action of the Common Acoustical Defects

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Abstract: When the acoustics are applied to any of the buildings, it produces optimum contingencies for producing and listening to vocals, any instrumental sound or recorded song in any cinema. The planning of acoustical design and construction of the building mainly provides to eradicate the noise level below the permissible level. And due to a regular use of these various instruments like frequency modulations, sci-fi movies, heavy machineries, and vehicles that produces noise, it is essential for contemporary era to improve the acoustical conditions of the building by removing the acoustical defects. This paper will explore the typologies of noise and on the other hand it will showcase the behavior of audible sound, factors that affect the same and common acoustical defects with its remedial actions.

A good architectural acoustic design requires an appropriate combination of absorptive, reflective, and diffusive surfaces. Hence, for the better acoustical upshot the construction and implication of sound osmotic and sound reflective materials should be carefully selected and placed. This will lead us to providing a better quality of audio-visual sensations to the viewers and listeners. Optimum planning for acoustics can reduce or completely pulling up by the root defects related to sound which is then so called as

acoustical defects.

Key Word: Acoustics, Acoustical Defects, Remedial Actions, Acoustical Materials.

I. Introduction

Sound is a wave like the ripples on a pond the ocean waves ramming on a beach. It travels through air or water. Sound can be described as an instability in the atmosphere which passes through a physical medium in the form of longitudinal waves from a reference point to a recipient causing a sensation of hearing. The intensity of sound is described as the flux of wave energy passing through per unit time with a unit area taken perpendicular to the direction of generation. This is one of the facts that the human ear's response to sound level is roughly logarithmic and the decibel (dB) scale reflects that fact. The study of sound perception is known as psychoacoustics. For every sound that our ear-brain processes, we get entropy about:

Pitch – [colligated with frequency] – deals with the perception of a high or low sound.
Loudness – [addressed with amplitude] – deals with intensity of sound.
Phase – deals with the gain and loss in the pressure cycle of any vibration.
Direction – [implicates the hearing with both sided ears that creates left or right, high, or low and front or back qualities] – deals with the mindset of first come first heard by one ear or the other.
Distance – [affiliated with reverberation time] – deals with the perception that how much it is or vice versa.
Timbre – [termed as tone color] – deals with the perceived quality of any sound and multiple frequencies changing through time.

II. Behavior of Audible Sound And Common Acoustical Defects

It is reflection of sound, absorption, and transmission. A few of the characteristics of

audible sound are echo, sound foci, dead spots, sound shadows, resonance, insufficient loudness, external noise.

Behavior of audible sound is affected by:

 The speed of sound within the medium depends upon temperature, which in return effect the density and pressure of the medium.

 The propagation is also affected by the motion of the medium.

 The viscosity of the medium.

Behavior of sound in enclosure when the sound waves strike the surface of room on encountering barriers posed by the enclosure, sound waves are likely to behave in different ways:

A] Reflection B] Absorption C] Refraction D] Diffusion E] Diffraction F] Transmission

Reflection – When the wavelength of a sound wave is smaller than the surface of an obstacle, it is referred to as a reflection. The amount of reflection depends on the smoothness, size, and softness of the material.

Absorption – When the sound wave comes to the surface of an obstacle, some of its energy is reflected while others are lost by the transfer to the molecules of the barrier.

Refraction – The bending of sound when it travels from one medium to another medium is said to be refracted.

Diffusion – This is the phenomenon of scattering of waves on a surface.

Diffraction – When the wavelength of a sound wave is smaller or equal to the size of the obstacle, the sound radiation tends to bend the edge of the obstacle thereby turning the edge to a sound source.

Transmission – The sound wave is carried out by molecules of the obstacle through vibration and emitted at the other side irrespective of the medium.

III. Acoustical Design

If you are applying acoustics to the building, it generates the optimum condition for producing and listening to speech, music, actual or recorded music on cinema.

Factors affecting the architectural acoustics or acoustical defects:

A] Reverb Time –

It is the tenacity of sound generated in the enclosed space when the source of sound has stopped. When reverberation time is too high, the sound produced by the speaker will persist for a long period of time, but the reverberation time is low, then the sound dies quickly and becomes inaudible in a short period of time.

As per Prof. W. C. Sabin's reverberation time 't' is given by the formula t = 0.16V/A [where, V = volume of room in cubic meters and A = total absorbing power of all the surfaces of room].

Curatives –

 The total absorption coefficient of the wall needs to be decreased.

 A sound reflection board must be installed inside that hall.

 Check the limits of reverberation time as per IS codes: 2526-1963.

Sr. No.

Recommended Time in Seconds

Acoustics

1

0.50 To 1.50

Excellent

2

1.50 To 2.00

Good

3

2.00 To 3.00

Fairly Good

4

3.00 To 5.00

Bad

5

Above 5.0 Seconds

Very Bad

Table 1: Limits of Reverberation Time

B] Reflections –

It is a phenomenon of propagating sound waves being thrown back from the surface. A plain surface reflects the sound uniformly, but a curved surface doesn't. So, the reflection of sound from a curved surface produces a harmful effect.

Curatives –

 The height of the building should be lessened by two times the radius of curvature of ceiling.

 The distribution of sound waves from a concave surface should be made uniform.

C] Sonority within a building –

Sound waves get amplified when the frequency of vibration of air particles matches with the hall's natural frequency of vibration. Thus, it results in an unwanted sound effect inside the hall.

Curatives –

 Hall or auditorium should be kept inside a vessel which contains water.

 The water-wave particle movements are used for the construction of halls or auditoriums.

D] Resound –

It is the repetition of a sound resulting from reflection of the sound waves. If the time limit is less than that then the sound arrives later and will cause confusion. Sound bounces off the solid matter the way a tennis ball bounces off a wall.

Curatives –

 Selection of the correct shape of the hall must be helpful.

 The energy of echoes can be dispersed by providing rough and porous interior surfaces.

E] Sound Nucleus –

Sometimes the shape of the hall makes sound waves to concentrate in some specific areas of the hall creating a sound of better quality.

Curatives –

 Shapes of different geometries can be used in the interiors of the spaces.

 Absorbent spaces such as curved spaces can be designed.

F] Lamented Spot –

This is the result of the sound foci. The deficiency of sound can be seen because of the high concentration of reflected sound at foci. And therefore, these areas are termed as dead spots where the sound intensity is too low for hearing.

Curatives –

 Reflectors and diffusers can be installed properly so that it can be eradicated.

 Use of geometrical patterns in the roof design may help in proper distribution of sound.

G] Brashness –

Loudness is directly proportional to the reverberation time.

Curatives –

 Sounding absorbing and reflecting boards can be installed to reduce and increase the loudness respectively.

H] Echelon Effect –

Due to bad finishing of the floor surface and structural effects, undesirable sounds are produced while climbing the staircase.

Curatives –

 Cover the whole floor and staircase with the help of carpet.

I] Structure Borne Sound –

Sound waves generated due to seeming motion of benches & footsteps & propagated through walls and floors.

Curatives –

 Design rigid structures.

 Use of sound absorbing and anti-vibration materials in the floor and ceiling.

J] Extraneous Noise –

When the fenestrations and other structural elements designed with improper sound insulations then noises from external sources may enter.

Curatives –

 Consider proper sound insulation for external walls and any of the fenestrations.

 Planning against the outdoor noise by interposing the buffer zones and protection with the help of green belts, public garden.

 The principle of shading or screening.

 Avoid narrow and hard paved courts between adjacent tall buildings.

 Within the residential zones especially, the road needs to be kept to a minimum in both width and length to discourage speed.

IV. Types Of Acoustical Materials

For Absorbers –

Open cell polyurethane foam, Cellular melamine, Fiberglass, Fluffy fabrics, and porous materials.

For Diffusers –

It reduces the intensity of sound by scattering it over and expanding area rather eliminating the sound reflections as an absorber.

For Barriers –

It can be used to reduce the transmission of airborne sound and impact noise.

For Reflectors –

Panels of wood, Plywood with some gel.

V. Conclusion

Rationale for selecting the site as the site must be away from noisy places, like railway

track, roads, airports, or any of the industries. Mass of the Hall leads to ill-mannered distribution of sound because of formation of waves. And big halls may also generate weaker intensity. While designing the halls, shape must be taken care of, so that it cannot generate echo. Reflection of sound from rear side wall is of no use, so it must be covered with absorbents and the ceiling should be covered to solve the acoustics issues effectively.

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