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Need and Construction of Acoustic Halls in Hilly Areas

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Abstract—*Acoustics is a skill which deals with the sound. Also it is a science which deals with the planning, design and construction of building to achieve the proper acoustical conditions within the building and surrounding of the building. Acoustics is also provided for correcting the defects in building units and components of the structure. Mainly the absorption and dissipation of exterior and interior noise (that is outdoor and indoor noise) and their insulation against sound. Acoustics is a science of sound, which deals with origin, propagation and auditory sensation of sound, and also with design & construction of different building units to set optimum conditions for producing & listening speech, music etc. The knowledge of this science is essential for proper functioning of theaters, auditoriums, hospitals, conference halls, etc. also buildings are becoming increasingly mechanized. Use of A.C, work machines, appliances like: vacuum cleaners, typewriters, etc., noise pattern of building has increased, leading to greater need of noise control. The paper discusses the advantages of acoustics in designing of a hall in a building specifically for a construction taking place in hilly areas.*

1. INTRODUCTION

Acoustics is a multidisciplinary science which deals with the vibrations and sound. Hearing is one of the most crucial means of survival in the animal world, and speech is one of the most distinctive characteristics of human development and culture [1, 5]. Accordingly, the science of acoustics spreads across many facets of human society like music, medicine, architecture, industrial production, warfare and many more. The science of acoustics has many applications which are dependent upon the nature of the sound that is to be produced, transmitted or controlled. Acoustics is also provided for correcting the defects in building units and components of the structure. The demand for quiet rooms in hospitals, hotels, and office buildings, the desirability of insulating music studios and other rooms where disturbing sounds are produced, and the necessity for solving other problems for the control of noise have led to repeated requests from architects and builders for reliable information on effective methods for insulating sound[2]. Although present knowledge of the subject is incomplete, nevertheless, on account of the pressing need for guidance in such matters, it is thought desirable to collect and present the available information in a systematic way, giving the methods and results of various investigations relating to the action of materials on sound, describing practical installations of sound proofing, and setting forth in accordance with existing knowledge recommendations that may be applied where sound insulation is wanted.

2. SCOPE OF ACOUSTICS

The broad scope of acoustics as an area of interest and endeavor can be ascribed to a variety of reasons. First, there is the ubiquitous nature of mechanical radiation, generated by natural causes and by human activity. When the acoustic is applied to the building, it produces the optimum conditions for producing and listening to speech, music, actual or recorded music on cinema. The planning, acoustical design and construction of the building mainly provide to minimize the noise level below the permissible level. For this the insulation against the noise is essential. Due to increasing use of the various instruments like radio, motion picture, vehicles like two and four wheelers, machineries which produce the noise, for that purpose it is necessary to improve the acoustical conditions of the building by removing the acoustical defects[5]. A variety of applications, in basic research and in technology, exploit the fact that the transmission of sound is affected by, and consequently gives information concerning, the medium through which it passes and intervening bodies and in homogeneities. The physical effects of sound on substances and bodies with which it interacts present other areas of concern and of technical application.

3. REQUIREMENTS OF ACOUSTICS

The procedure followed by acoustical engineers in designing acoustical treatment is, first, to anticipate the possibilities of noise before a building is started and to make provision to reduce the disturbances. The second procedure is to adjust conditions so that the wanted sound will be loud enough and undistorted. When we provide good acoustical conditions in a building, it promotes comfortable living. It increases the efficiency of the workers. So in modern practices of building design and construction it is necessary to give the due importance to the improvement of acoustical conditions and sound insulation so that there should be minimum disturbance

due to the noise. Few of the points to be kept in mind are given as follows:-

1) The Initial sound should be adequate intensity such that it can be heard throughout the hall.

2) The sound produced should be evenly distributed over the entire area otherwise it will lead to acoustical defects such as formation of echoes, sound foci & dead spots.

3) The design of rooms should include consideration of intelligibility of speech no possibility of distortion & should enhance the tonal quality & total blending of the sound.

4) The sound produced should be clearly heard at all points.

5) There should be no focusing of sound or any dead spots or silence zones in the hall.

6) The sound produced in the auditorium should not persist for long time so as to avoid excessive reverberation.

7) There should not be overlapping of sound waves.

8) The external undesired sound should not enter the hall or auditorium.

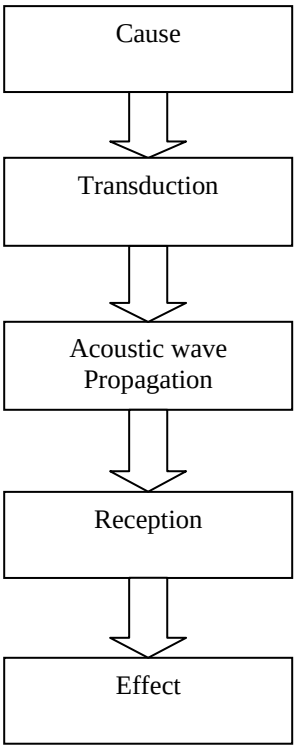
When the detailed study of acoustics of building in hilly areas is done, following important aspects must be required to be studied in details:-

3.1 Characteristics of audible sound

Sound is basically series of alternate compressions and refractions which are generated by a vibrating body which travels in the form of waves in all directions through a media. This media can be solid, liquid or gaseous. The average speed of sound is 340 m/sec. The velocity of sound depends upon the temperature and nature of the media through which the sound travels. The velocity of sound in water is 15 times in steel, 12 times in bricks, 10 times in wood. For transmission of sound in vacuum form one place to other, media is required. Frequency or pitch are also the important factor and is defined as the number of cycles per second. More the number of cycles, higher will be the pitch [3]. The highest audible sound has a frequency of 2000 cps and the lowest sound has the frequency of 20 cps. Another important aspect is the intensity of loudness of sound which is flow of sound energy per second through unit area. The loudest and almost painful sound is about 1013 times the intensity of sound which is just audible by the human ear. The unit used to compare the two sound levels is 'Bel 'which is logarithm (base 10) of the ratio of two intensity levels. Tone or tone structure: It is the quality of sound which various sounds can be distinguished from one another. Sometimes the two sounds may have the same frequency and intensity, but even they can be distinguished by virtue of their different tones.

3.2 Principles of Acoustics

The study of acoustics revolves around the generation, propagation and reception of mechanical waves and vibrations.



The nature and characteristics of the sound plays an important role in acoustical design of the buildings and rooms or in sound insulation. When sound originates from its source, the source may be speech or music. It is transmitted from the source in all directions. When it travels, it strikes on some surface such as wall, ceiling, floor or any other barrier. Some part of the sound may be reflected back , a part of the sound may be absorbed by the surface i. e. the sound may die out in the material or transmitted in part to another side of the barrier when the sound is reflected back and it is not properly controlled . It may create some acoustical defects like reverberation and echoes. The reflected sound, which remains in the room, is represented by Reflection Coefficient and it is most important in acoustical design of the building. The part of the sound may absorbed is represented by Absorption Coefficient. Absorption Coefficient for open window is unity. When the sound waves strikes against the resilient and porous surface, the considerable heat is dissipated and hence absorption is relatively high.

3.3 Acoustical Defects

Acoustical conditions in a big room, ball, auditorium or building can be developed when there is clarity of sound in every part of occupied space. For this, the sound should rise to suitable intensity everywhere with no echoes or distortion of the original sound with correct reverberation time. Some of the common defects are:

Reverberation - It is persistence of sound in the enclosed space, after the source of sound has stopped. Reverberant sound is the reflected sound as a result of improper absorption.

Excessive reverberation is one of the most common defects, with the result that sound once created longs for a longer duration resulting in confusion with the sound created next. However, some reverberation is essential for improving quality of sound. Thus, optimum clarity depends upon correct reverberation time which can be controlled by suitably installing the absorbent materials.

Reverberation Time - The time gap between the initial direct note & the reflected note up to a minimum audibility level is called as reverberation time. The intensity of sound as received by the listener as shown gradually. When the source emits sound, the waves spread out and the listener is aware of the commencement of sound. When the direct waves reach his ears subsequently the listener receives sound energy due to reflected waves also. If the note is continuously sounded, the intensity of sound at the listener's ear gradually increases. After some time, a balance is reached between the energy emitted per sound by the source and energy lost or dissipated by walls or other materials. The Value of reverberation time depends on the volume and area of room.

$t = 0.166\ V/as$

Where,

t = Reverberation time in seconds

V = Volume of the room in m2 as = Total absorption of various absorption units in m2 sabins.

Formation of echoes - Echoes mainly produced due to the reflection of sound waves (mainly from the surface of walls , roofs , ceilings etc.) coming from the some sources , reaches to the ear , just when direct sound wave is already heard and thus there is a repetitions that is nothing but echoes. Normally the formation of echoes (happens when the time lag between the two voices or sounds is about 1/17 of a second. And the reflecting surfaces are situated at a distance more than 15 meter. If the reflected surface is curved with smooth surface this problem usually occurs. To minimizes this problem select ion of proper geometry of auditorium and surface and also use the rough and porous material for the interior surface.

Sound foci - In case of concave shaped reflecting interior surface or domed ceiling or an enclosure, depending upon the curvature of these surfaces, there is possibility of meeting the sound rays at appoint called as sound foci and thus it creates the sound of large intensity . These spots of unusual loudness are called sound foci. This defect can be minimized by providing proper geometrical design. Shape of the interior faces including ceiling and also by providing absorbent materials on focusing areas.

3.4 Sound Absorbing Materials

On striking any surface, sound is either absorbed or reflected. The sound energy absorbed by an absorbing layer is partially converted into heat but mostly transmitted to the other side, unless such transmission is restrained by a backing of an impervious, heavy, barrier. In other words, good sound absorber is an efficient sound transmitter and consequently an inefficient sound insulator. Sound absorbing materials and constructions used in the acoustical design of building or the sound control of noisy rooms can be classified as:

1. Porous materials
2. Panel or membrane absorbers
3. Cavity resonators
4. Gypsum Boards
5. Blue boards
6. Sound boards
7. Glass fiber insulations
8. Board insulation
9. Duct Boards

4. GUIDELINES FOR DESIGN ACOUSTICS

These are the some basic guidelines depending upon specific requirements.

1) Selection of the site - As far as possible the site is away from the noisy place, like railway track, roads, with heavy traffic, airports, industrial vicinity.

2) Volume - Size of the hall / auditorium should be such that if remains optimum. Small halls lead to irregular distribution of sound because of formation of standing waves. Too big halls may also create a weaker intensity and larger reverberation time which may be a very serious issue.

3) Shape - It is one of the most important parameter to be considered for acoustically correct hall. The reflections are created due to side walls & roof so while designing the halls care should be taken that no formation of echoes in the hall. In phase of parallel walls, splayed side walls are preferred. Curved surface on walls, ceilings or floors produce concentration of sound into particular region & absence of sound in other regions.

4) Use of absorbents – When the construction of hall is completed. Certain errors are found or the hall requires further corrections as far as acoustics are concerned. Hence use of absorbents is essential & it is very common. Reflection of sound from rear wall is of no use. Hence it must be covered with absorbents; also ceiling is covered with absorbents. If the hall height is more than false ceiling is provided in the hall to solve the problem effectively.

5) Reverberation – Reverberation time must be maintained in such a that it does not to short or too long i.e. 0.5 sec. for hall 1.2 sec. for concerts hall & 2 sec. for cinema hall. Proper use of absorbent material, capacity of the audience, presence of open windows furniture, these are the important components which affects the Reverberation time. So before designing any hall the calculated use of such components will be helpful to either increase of decrease the Reverberation time.

6) Echelon Effect –[4] If in the auditorium set of railings, staircase or any regular spacing of reflected surface may produce a musical note due to regular succession of echoes of the original sound to listener. This makes the original sound to appear confused. So to avoid this problem either avoids use of such surface or keep them covered with thick carpets.

5. CONCLUSIONS

The main aim of the paper is to show the importance of the acoustics and acoustical treatments at the time of designing the building. The architects or the designers must be well known with the guidelines before designing any building and this produces the useful results. Also to control the noise, the windows and doors of the various rooms should be kept away from the main traffic. Instead of increasing the thickness of the brick wall for sound reduction, the cost of structure may increases, to overcome that problem the porous and flexible material if used it will reduce the thickness of the wall. The double glazing windows improve the sound insulation to a considerable degree.

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