Use of Sound Absorbing Screens in CBRI Open Plan Office

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The latest trend of open plan office space is to eliminate segregating walls and design the space with or without low flexible screens. The technique serves as a means of accommodating more number of people in a given space; maintaining thereby, a better relationship between space and function. Such spaces, are usually highly reverberant and require acoustical treatment for achieving satisfactory acoustical conditions. However, a system of partial acoustical screens has been found very useful in controlling the acoustical conditions within such spaces. The present paper describes a case study of the use of partial acoustical screens in the second floor of the main building of CBRI, Roorkee and the overall improvement achieved in the speech privacy conditions of the space.

Introduction

The current trend in construction of open plan offices is to eliminate the segregating walls and design the space without partitions or with low flexible partitions. The technique not only serves as a means to accommodate more number of persons in a given space but also improves the overall working conditions within the space, maintaining thereby, a better relationship between space and function. These segregated partial enclosures are expected to have such acoustical conditions that the people working within them must not be disturbed by the unwanted sounds of other people. Achieving complete privacy is impossible in such open type of spaces, yet a system of partial acoustical screens has been found to be quite useful in controlling the undesired sounds from different groups of workers. Further improvement in the acoustical conditions has been achieved by using absorptive type of acoustical screens. These screens are more beneficial than the hard reflective type of screens for the reason that they reduce the reverberation of the space besides acting as a noise barrier. The present paper describes the method of layout of these partitions in the second floor of the Central Building Research Institute,

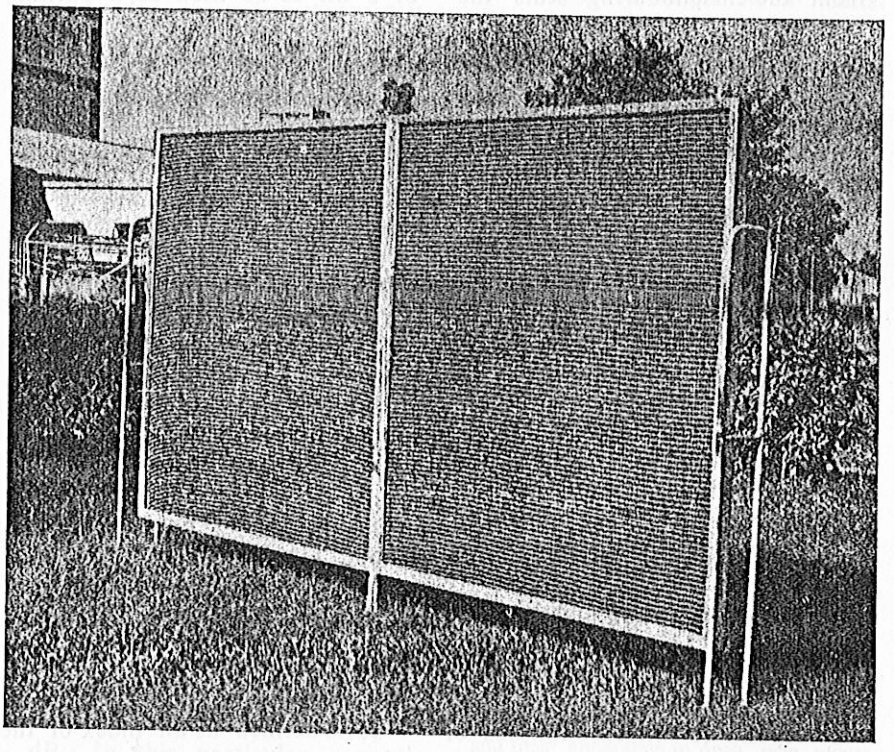

Fig. 1 : Sound Absorbing Partial Partition.

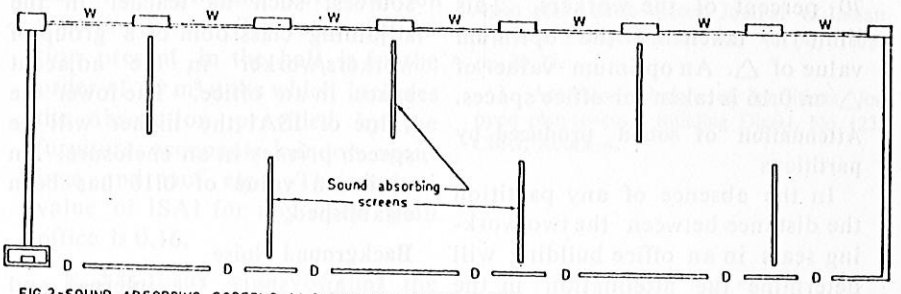

FIG.2-SOUND ABSORBING SCREENS IN ONE OF THE HALLS AT THE MAIN BUILDING OF CBRI ROORKEE.

Roorkee and its effective usefulness in controlling the acoustical conditions of the space under consideration.

2. Theoretical consideration

Speech privacy It is well established that the main source of disturbance in large office buildings is the speech sounds generated by neighbours, and not the continuous types of noises such as those from exhaust fans and air conditioners etc. The more intelligible the speech sounds from the neighbouring seats the more will be the acoustical disturbance. Thus a speech sound of 60 dB may be more disturbing and annoying in a quiet environment than the speech sounds of the same intensity in a noisy surroundings. It is therefore clear that the intelligibility of a speech sound does not only depend upon the intensity of a speech sound but on the background noise also. It is found that the intelligibility of intruding speech sound depends on the rates of the intruding speech sound (ISL) and the background noise level (NL). Intruding speech articulation index (ISAI) is a function of the difference of ISL and NL and determines the ability of the workers to recognise the speech components in the unwanted sounds of the neighbouring workers reaching him. The lower values of $\triangle$ correspond to better conditions of speech privacy yet there is lower limit of $\triangle$ which satisfies at least 70 percent of the workers. This limit is taken as the optimum value of $\triangle$. An optimum value of $\triangle$ on 0.16 is taken for office spaces.

Attenuation of sound produced by partitions

In the absence of any partition the distance between the two working seats in an office building will determine the attenuation in the intensity of speech sounds between two working spaces. In general, this is not sufficient to produce the desired effects of speech sound reduction. A screen placed between the two has the effect of reducing direct soundwaves. Thus the noise reduction property of the screen is utilised in reducing the intensity depending upon the geometry and location of the partition. A partition, irrespective of its material, must have a noise reduction value of 5 dB to be used as a partial acoustical screen.

Reverberation of the Space

Usually open plan office spaces are highly reverberant and require sound absorbing material to reduce the reverberation time of the space. This is generally achieved by fixing sound absorbing material on the surfaces of thew alls and ceiling. It has been found that sound absorbing type of partitions serve the dual purpose i. e. besides acting as a sound barrier it acts as a functional sound absorber also. Thus the need of using sound absorbing material on the walls/ceiling of the open plan space can be avoided if sound absorbing type of partial screens are used in such spaces.

Definitions of Technical terms used :

Intruding Speech Articulation Index, $\triangle$

It is defined as an index of the ability to recognize the speech components from external intruding sources, such as teacher in the adjoining classroom or a group of workers/worker in the adjacent space in an office. The lower the value of ISAI the higher will be speech privacy in an enclosure. An optimum value of 0.16 has been established.

Background Noise

In any space, the internal and the external noises combine to form what is known as background noise. Background noise exists every where and a certain amount of it is beneficial because very low levels of background noise increases the problem of speech privacy.

Intruding Noise

As the name implies, it originates in an enclosure or a room and travels across common partition into another room where work is in progress.

Noise Reduction :

Noise reduction specifies the overall reduction of sound level from one space to the other. This is the amount of 'acoustical separation' between two enclosures or rooms, and arises from the obstruction of sound by the partition as also from room absorption.

Reverberation

The persistance of sound in an enclosure due to repeated reflection of sound after the source of sound has ceased.

Design of absorbing Screens

Usually open spaces are highly reverberant and require sound absorbing treatment. It has been established that if the absorbing material be used in the form of screen then its effectiveness increases to a greater degree than if the same is used on the wall/ceiling surfaces. With this in view, the absorbing screens of size 3 m x 1.6 m are fabricated by sandwiching 5 cms thick fibreglass or Bartex blanket within a wooden frame work and covered on both sides with tapestry. Each screen consists of two parts each of size 1.5 m x 1.6 m and could be interlocked by a locking arrangement. The screen can then be mounted on a pair of stands with an air gap of 10 cms. so that the effective height is 1.7 cm. as sho-

wn in fig. 1. The entire assembly can be assembled or dismantled easily by one or two persons. These partitions have a total absorption of 5 m^2 units and a noise reduction value of 7 dB.

Method of Measurement

For the determination of ISAI, a sample of intruding sound as talking in the adjoining seats in an office was first recorded. This recorded intruding speech sound was then replayed on the seat under test at different intensities. The intruding speech sound as well as the background sound was picked up by a microphone and recorded on another tape recorder. The analysis of so recorded sound gave the value of ISAI for each level of intruding speech sound.

For the measurement of noise reduction of the acoustical screens, two microphones of identical characteristics were placed on either side of the partition. The noise was produced and recorded by both the microphones. The levels at each microphone was also noted. The difference in the overall levels of the two microphones gave the noise reduction value.

For the measurement of reverberation time a 500 Hz. warble tone was prerecorded on a tape for 15 seconds duration each, six bits of such recording were made in the laboratory. This tape was then replayed in the open plan space where reverberation time was to be measured. This reverberant sound was then recorded in another tape recorder. This final tape was analysed in the laboratory to find the value of reverberation time.

Layout of Screens

There are no defined rules to lay the partitions in an open space. However, it should be seen that the

Table 1 : Acoustical conditions in CBRI open plan office space.

Conditions of the space	Background Noise (dB)	Reverberation Time (sec.)	ISAI
Desired values	Not more than 60	1.0	.16
Before the use of partitions	58	1.5	.205
After the use of partitions.	56.5	1.0	.166

sc eens are uniformly distributed within the entire space so as to cause break in the path of sound and reduce reverberation of the space uniformly. It should also be kept in view that the visual obstruction to the officer–incharge should not be there. In certain cases, where a few locations are excessively noisy, use of absorbing screens can be made to isolate such noisy zones from the working zones.

Six partitions of the size of 3 m x 1.6 m are evenly distributed in the present office hall fig.2. The number of the partition for this size of the hall was taken from the previous study[2,3]. The covering cost of the floor area of the hall from these partitions comes out to be Rs. 12.25 Per m^2.

Results and Conclusions:

For better hearing and speech conditions in an open plan office, the required background noise levels should not be more than 60 dB. In this particular case the investigations showed that for this hall the optimum reverberation time is 1.0 sec. The total absorption present in the hall is in the order of 65 m^2 units which includes the absorption provided by the furniture, occupants, window openings and roof etc. The desired value of ISAI for any open plan office is 0.16.

It has been observed that the total acoustical absorption provided by six numbers of partitions in the hall is about 30 m^2 units. The change brought about in the reduction of background noise level is of the order of 1.5 dB. Ultimately, the most important factor i. e. the ISAI has been reduced to a value of 0.166, which is acceptable for all practical purposes. The absorption coefficient of the partition is of the order of 1.0 because in an open space the acoustical partition behaves as a functional sound absorber. In the present case the absorption coefficient of the material has been increased from 0.58 to 1.0 by using the material in the form of partition. This achieved value of sound absorption is mainly due to the absorption provided by the screens from its both sides and due to diffraction effect.

References

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