RESEARCH

Efficient Acoustical Conditioning For Open Plan Office Spaces

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Due to increased demand of office accommodation in busy urban centres and for better utilisation of spaces, the concept of open plan offices has become popular in this country. The design based on such concept not only economises the space requirement and construction cost but also helps in improving the functional efficiency of the space provided. With the resulting cost and efficiency benefits on one hand, such open plan spaces lack in acoustic performance on the other. These open spaces are highly reverberant and provide inadequate speech privacy due to unabated noises from different noise sources normally present in space itself.

A system of partial partitions has been found to be very useful in controlling unwanted sounds from various groups of people. Further improvement in acoustical conditions is made by introducing absorptive type of partial screens. These screens besides acting as noise barriers reduce reverberation of the space to the desired value. Proper layout of the partitions cause break in the path of sound and achieve acoustical privacy between different spatial pockets while maintaining the visual continuity and functional openness in the overall plan.

The article describes the principle and design method of the system of such acoustical screens to achieve suitable acoustical environment in open plan office under Indian conditions.

In the recent past the increasing demand for office buildings has led to the introduction of open-plan office—comparatively a new concept in the design of office buildings in this country. The designs based on such concept, besides economising on the space requirement and cost of partitions of separate cabins, help in improving the functional efficiency of the space provided. With the resulting cost and efficiency benefits, tendency amongst architects and user administrators to adopt open-plan office spaces is gaining popularity. An obvious demerit of the system is that the absence of partitions lead to the problem of speech privacy due to unabted sounds building up into intruding noise, consequently vitiating the internal environment. Thus the problem for the designer is, to achieve acoustical privacy between different spatial pockets while maintaining the visual continuity and functional openness in the overall plan.

A system of partial acoustical screens has been developed at the Central Building Research Institute, which may be effectively utilized to impede the flow of intrusive speech sounds flowing between various space pockets or groups of workers, thus creating an environment with desirable acoustical privacy. The present paper describes the principle, and design method of the system of such acoustical screens to achieve suitable acoustical environment in open-plan offices for Indian conditions.

BASIS FOR THE STUDY

Good acoustical environment in an open type of office should permit an occupant to talk easily with a visitor without distracting attention of the other occupants. Three parameters governing such a situation are (a) the noise source, including persons and the office machines, (b) the noise transmission/absorption elements constituting the architecture of the office such as ceilings, walls, floors, curtains and furniture, (c) the people working in the area and receiving the noise. It is presumed that mostly people working in an office space have a common sensitivity.

In most of the zones in an office space a common minimal privacy is required depending upon the acceptable value of intruding speech articulation index (0.10).[1] Only a few important zones require confidential privacy such as "Zero phrase intelligibility".[2] According to the other part of the study the average male conversation speech at a distance of 0.3 metre from the speaker has a broad band level of 73 db. Besides

this, to avoid interference caused by the common office equipment and ventilation system, the noise levels should be kept below 60 dbA throughout the office space in Indian conditions. Fortunately, it is seen in our previous study based on survey of office buildings that the noise level in office buildings generally obtained is more than 60 dbA and hence no artificial means are required to produce the sufficient background noise to achieve the required speech privacy. Instead, sound absorbing materials are required in the space to bring down the high reverberation time.

Noise from office machines like typewriters, telephones etc. could be isolated from the adjacent work area with larger than normal partitions if the work load is extensive.

Absorbing type of partial partitions developed at the Institute are useful in reducing the high reverberation time in open plan offices. In cases where there are lot of delayed reflections from the ceiling, walls etc., additional sound absorbing treatment to the ceiling would be essential.

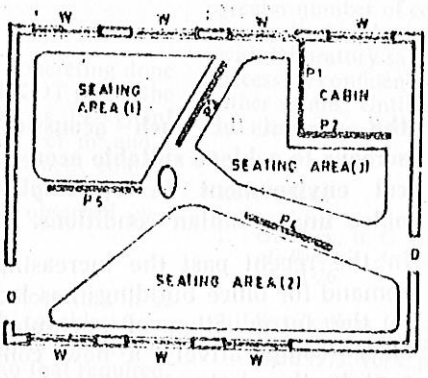

Fig. 1

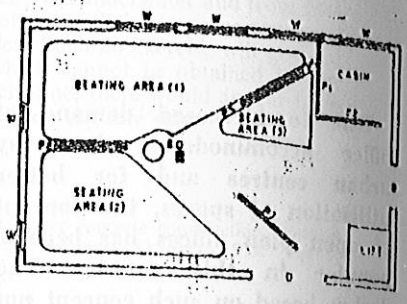

Fig. 2

To achieve acoustical privacy in a typical open plan layout mainly three provisions are required (i) proper location and sizing of partial partition (ii) desired sound absorption at ceiling and walls surfaces (iii) background masking sound system. Study shows that sound absorbing type of partial partitions can be usefully positioned for achieving better acoustical conditions in open plan office space without disturbing the use pattern. The height of the ceiling should be 3.4 m if plain and reflective type. For increasing absorption by ceiling further use of undulated types of ceiling should be considered which is helpful in reducing delayed reflection and flutter echo. Walls normally do not require any additional acoustical treatment due to location of windows etc. Under Indian conditions, the use of background masking sound is not required because background noise levels available are normally more than 60 dbA.

NEED FOR ABSORBING SCREENS

Partial acoustical barrier is one of the basic requirements of the open plan office. It serves both a sound attenuator and a sound absorber. If there is no barrier the distance will determine the reduction in intensity of speech sounds between two working spaces which is generally insufficient to produce the desired effect. A screen placed between the two has the effect of

Definition 1: **Intruding Speech Articulation Index** Intruding speech articulation index is an index of the ability to recognize speech components from external intruding sources, such as a T.V. set or a conversation in the adjoining spaces.

Definition 2. **Zero Phrase Intelligibility** Zero phrase intelligibility is numerically equal to the intruding speech articulation index when it becomes zero.

attenuating direct sound waves that must either pass through it or bend around its edges. In practice the transmission loss needed is 5 db which is sufficient to reduce the level of transmitted sound to be below that of diffracted sound. The diffracted sound reaching the listener's ear is reduced in intensity depending on the geometry

MEASUREMENTS

Partial acoustical screens are fabricated by sandwiching the fibreglass blanket between two layers of tapestry. The constructional details of the screen are given in an earlier paper. It is seen that by the use of these screens, the higher reverberation time in the

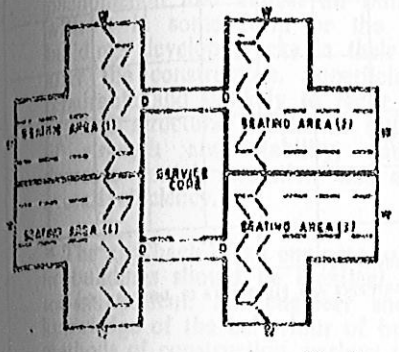

Fig 3

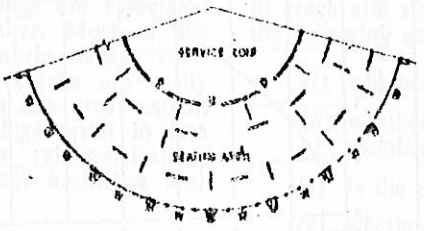

Fig. 4

and location of the partition. The larger the screen and the closer it is to the speaker or listener, the lesser will be the transmission due to diffraction. The performance efficiency of these partitions can be increased if irregularity in the edges or periphery is architecturally acceptable.

office spaces had been reduced to the desired (optimum) value. Also the intruding speech articulation index was reduced from a high value of 0.21 to a permissible value of 0.16 in a typical case, shown in table 1. Subjective assessment was also made in which a questionnaire was prepared for the staff seated in open type office spaces for assessing their subjective reaction to the use of these partitions. It was seen that the majority of the workers acknowledged a feeling of calm and comfort in their working conditions.

Table 1

Variation of Intruding Speech Articulation Index, Δ in the screened areas of partial partitions. ISL = 66dBA on the source side near the partition background NL = 60dBA.

R. T. of the room with partitions	Plywood hard partition	Absorbing type partition of perforated board	of fibre glass tapestry
	H = 2.0 m W = 3.0 m	H = 2.0 m,* W = 3.0 m	H = 1.7 m, W = 3.0 m
1.2	0.15 — 0.16	0.075 — 0.09	0.075 — 0.085
1.3	0.19 — 0.22	0.095 — 0.145	0.1 — 0.12
1.4	0.21 — 0.25	0.11 — 0.14	0.13 — 0.16

*Exact values of Δ for height of 1.7 m in case of perforated Boards are not available, however fibre glass with tapestry will perform better even if height of the other type is reduced to 1.7 m.

LAYOUT OF THE PARTITIONS

Based on earlier findings, partitions 3 m x 1.6 m in size were fabricated from 2.5 cm thick fibreglass and mounted on a wooden frame. Sides were finished with tapestry facing. The screen is finally supported by two side-stands with a gap of 10 cms at the bottom so that the effective screen height is 1.7 m.

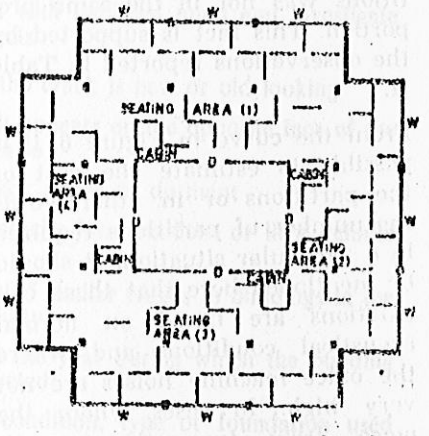

Fig. 5

As a matter of fact there is no hard and fast rule to put the partitions at a particular place in an open plan office space. But they should be evenly distributed in the hall so as to cause break in the path of sound and produce absorption of sound all over the hall. Nevertheless, it is also necessary if desired, to keep these partitions in such a way so as to have a minimum visual obstruction to the section officer seated in the hall as shown in Figs. 1 and 2. Also, it may be possible in certain layouts to concentrate these partitions near to the noisy locations such as

near service core etc. as shown in Figs. 3, 4 & 5.

As mentioned earlier, in each of the big halls an enclosure was provided for zero phrase intelligibility by using two such partitions. It was observed that as the floor area of the hall was increased the increase in the number of partitions was not in the same proportion. This fact is supported by the observations reported in Table II.

From the curve in Figure 6, it is possible to estimate the cost of the partitions or in other words the number of partitions required in a particular situation. It should be mentioned here that these calculations are based on normal acoustical conditions and where the office machine noises are not very high. In cases where the noise from typewriters, ventilators are exceeding 60 db, these would have to be enclosed at an isolated place in the hall and thus the number of partitions would have to be increased accordingly.

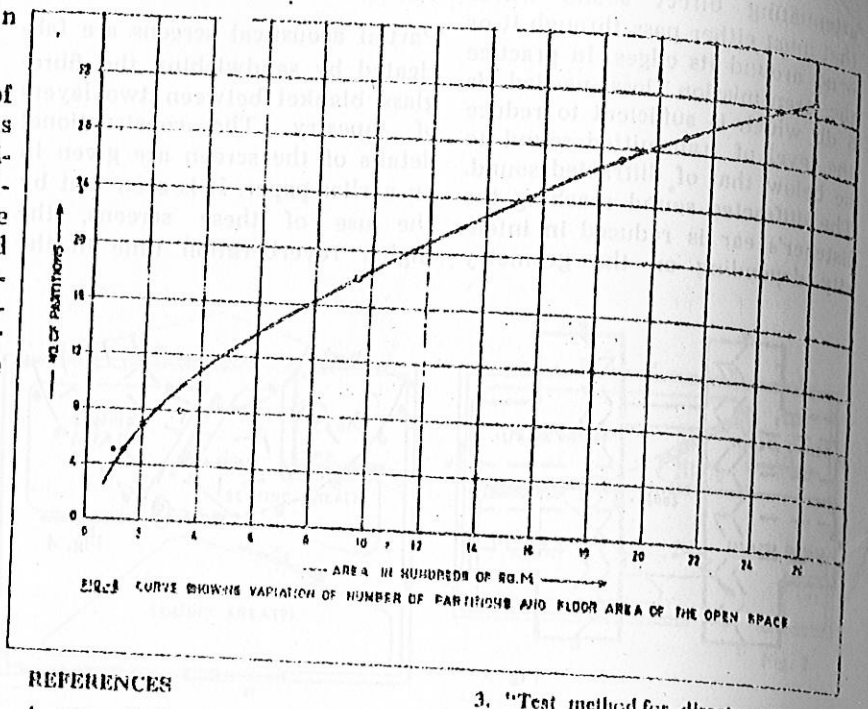

FIG. 6 CURVE SHOWING VARIATION OF NUMBER OF PARTITIONS AND FLOOR AREA OF THE OPEN SPACE

Table II

Number of partitions and cost indices in an open plan office space.

Area Sq. m.	No. of screens used	Cost Rs. (@ Rs. 350/- per partition of 2 units each	No. of persons seated	Approx. cost/m²
199	5	1750	25	17.50
225	5	1750	30	14.50
196	7	2450	40	12.25
324	8	2800	55	9.00

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