

Ventilation and Comfort in Interior Spaces

Meer Mobashsher Ali

Bangladesh is a country in the tropics having a hot-humid climate and it is difficult to obtain reasonable thermal comfort level in interior spaces in buildings. Comfort level depends on various objective factors like air temperature and radiant temperature, relative humidity, vapour pressure in ambient air and precipitation, air velocity and air pollution, solar radiation and glare, metabolic heat production and activity level, clothing, etc. From the study of these factors it can be easily established that due to harsh climatic conditions comfort level cannot be achieved by micro-climatic and structural control only. Besides, only a few of these factors can be controlled by architectural elements. Hence considerable importance is given on air movement. Air movement depends primarily on factors like location of buildings, placement of buildings in relation to one another, orientation of buildings, cross ventilation through interior spaces, orientation of openings both inlet and outlet, size and control of openings.

In hot-humid climate as in Bangladesh evaporative cooling of sweat is the most suitable means to approach attainment of comfort level in absence of outright lowering of temperature.

For evaporative cooling massive air change and considerable indoor air velocity is required about 10,000 cft. per hr. of air volume per person is necessary. If we consider three persons per room a volume of 30,000 cft. per hr. is necessary. This for a room of volume $10' \times 15' \times 8'$ means about 25 air changes per hour. Furthermore, a velocity as high as 300 ft. per min is required to keep continuous process of evaporation without the discomfort of wet skin. 100 ft. per min is slightly over one mile per hour (one mile per hour is 88 ft. per min). This according to Beaufort Scale would slightly exceed the

Meer Mobashsher Ali, B. Sc. Engg., B. Arch., M. Phil, Professor, Co-authored the book "Design Manual" a handbook of small structures. Specialized in housing. Areas of interest are Architectural Education and Design. Team leader of on going research project—" Conservation Study of Dhaka City: Its Historical Buildings and Areas".

speed under classification of "calm". A speed of 300 ft. per min. (approx. 35 miles per hr.) would be under the classification of "slight breeze". This speed will rustle leaves and can be felt on the face. Any speed higher than this might hinder the normal function of the room by blowing paper or light objects.

In Bangladesh outdoor air movement is not much. Specially it is not so during all parts of the day. Sometimes the outdoor is very calm and air is still. Even with proper size and location of windows it will be a mistake to assume air velocities indoors to be more than 40 percent of the outside velocity. To maintain a velocity gradient buildings are to be placed 2H distances apart. Due to various factors like security, dust, noise and privacy windows are mostly grilled and curtained which seriously disturb the badly needed airflow required for comfort.

In view of the prevailing conditions it may be safely assumed that some kind of mechanical means of ventilation is necessary to achieve tolerable comfort level in the indoor environment. As a matter of fact most of the living quarters do have ceiling fans. Those who can afford are keen to make use of ceiling fans, size of the fans being between 36" and 56". An increase of 30 ft. p.m. in the rate of air movement appears to correspond in its effect to a reduction of 1°F in dry bulb temperature. The air velocities and circulation pattern of a particular size of ceiling fan and axial fan are shown in fig. I and fig. II.

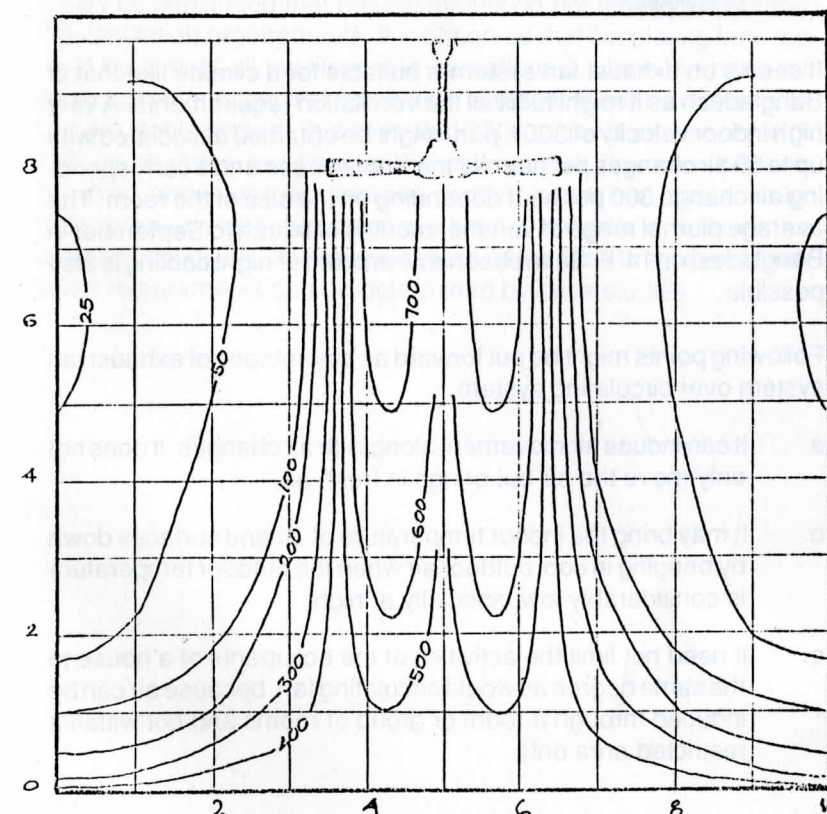


Fig. 1 Air velocity distribution for 36 inches ceiling fan.

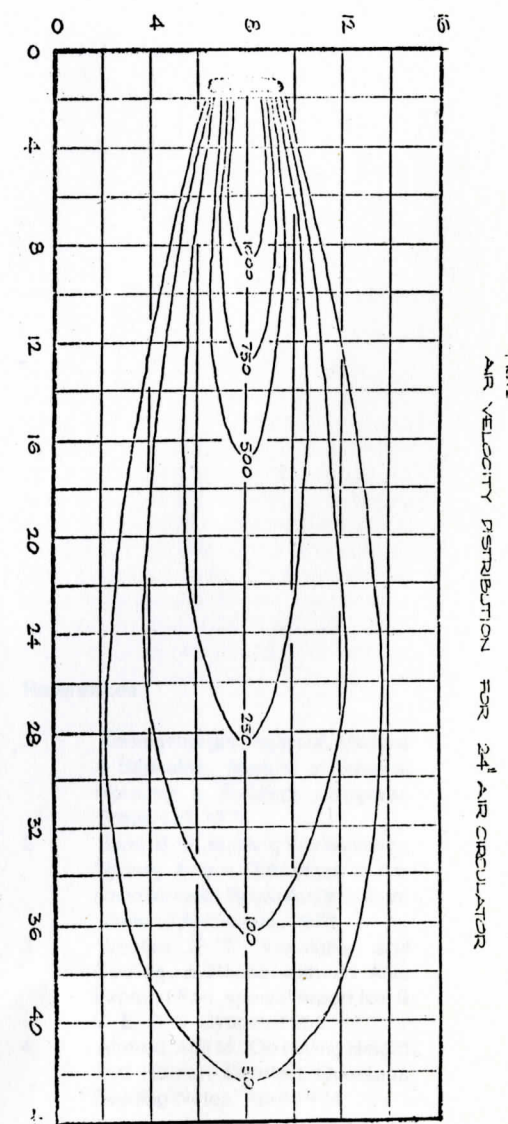


Fig. 2 Air velocity distribution for 24 inch axial fan.

The circulating fans have some inherent disadvantages. Main disadvantages are :

- a. It doesn't induce air change. It churns the air in the surrounding air. Sensation of coolness is mainly achieved by enhanced evaporation from the skin.
- b. At least one fan is necessary in every room.
- c. Air velocity directly below the fan may be annoying.
- d. Fans might be noisy at high speed.
- e. Since it is suspended from the ceiling, height of the ceiling has to be increased by 2 feet or more.

Mechanical ventilation system are usually installed in one of the following forms:

- a. Exhaust system : where indoor air is forced out and fresh air finds its way through grills or openings. Indoors are under slightly reduced pressure.
- b. Plenum system : where air is forced in from outside through grills. Indoors are under slightly increased pressure.
- c. Balanced system : where air is both supplied and removed by mechanical means. Mostly used when heated or cooled air is supplied.

It seems an exhaust fan system is suitable for a climate like that of Bangladesh as it might fulfill all the ventilation requirements. A very high indoor velocity of 300 f. p.m. might be obtained associated with up to 80 air changes per hour for the whole house and a corresponding air change 300 per hour depending on the size of the room. The average diurnal range of summer months of March to September in Bangladesh is 14°F. So a reasonable amount of night cooling is also possible.

Following points might be put forward as advantages of exhaust fan system over circulating system.

- a. It can induce air movement along with air changes. It does not only move the air but brings in fresh air.
- b. It may bring the indoor temperature of air and surfaces down by bringing in cool outdoor air when the outdoor temperature is considerably low, specially at night.
- c. It need not limit the activities of the occupants of a house to the same degree as would circulating fan, because air can be induced through a room or group of rooms and not within a restricted area only.

- d. With a centralized system less noise will be perceptible; the source (fan) being away from rooms.

- e. It is possible to lay out the buildings more close to one another to achieve a greater density level specially with low rise buildings. The rules of open type layout to ensure a suitable outside air velocity need not be adhered to.

- f. It gives more freedom to the arrangement of rooms. Only single bay arrangement of rooms are suitable to ensure reasonable ventilation by natural means. In exhaust fan system double banked arrangement of rooms may be used efficiently :

- g. A little deviation from the optimum orientation from ventilation point of view will not be critical under exhaust fan system. Orientation can give maximum consideration to solar radiation.

- h. Room height need not be excessive. A height of eight feet is satisfactory because no extra height for fixtures like circulating fan would be necessary.

- i. For further improvement of the system blow fans might be installed to induce air inside.

It may be concluded that natural means do not adequately satisfy the ventilation requirements. It is observed that circulating fans are used by almost all dwellers who can afford it. Once the need for some sort of mechanical ventilation is established, next step is to find a suitable system. It is seen that 300 f. p. m. of air velocity with 100 air changes per hour is the optimum air flow requirement. Anything above will not improve comfort conditions appreciably. With a centralized exhaust fan system it is possible to achieve the optimum condition. The specifications of the fans and other installation requirements can be determined by case studies.

References

1. Koenigsberger, Ingersoll, Mathew & Szokolay., Manual of Tropical Housing & Building, Longman Group Ltd. 1974.
2. Saini, B. S., Building Environment, Sydney Angus Robertson in Association with Royal Australian Institute of Architects, 1973.
3. Weston, E. T., Ventilation and Cooling, a House with an Attic Exhaust Fan, special report No. 9 C. E. B. S. Sydney 1952.
4. Ahmed, Adil M., On ceiling Height and Human Comfort Overseas Building Notes, April 1974.