BUILDING DIGEST

CENTRAL BUILDING RESEARCH INSTITUTE INDIA

THE DESIGN OF WINDOWS FOR NATURAL VENTILATION IN TROPICS

The necessity of providing sufficient ventilation for comfort in buildings, particularly in the tropics is well known. The design of a building for ventilation has many aspects and a judicious understanding of the needs pertaining to a particular building depends on the following important conditions:

(1) Climate of the region.

(2) Orientation of the building with respect to the generally prevailing wind direction.

(3) Amount of ventilation sought for; depending on the purpose for which the building is intended.

(4) Size and location of windows for optimum utilization of the fresh wind available outside.

The climate of a particular region suggest the type of construction suitable for the purpose. For example in cold regions provision of large openings is undesirable and other considerations play an important role in keeping the indoor climate healthy and free from harmful effect. In hot and arid regions a different set of considerations apply and good ventilation and elimination of heat is important. The design in such cases can be worked out from a knowledge of the number of air changes required for the specific purpose. The design of buildings for comfort, particularly in hot and humid climate, depends not only on the number of air changes but also on the distribution or the pattern of airflow within. The distribution of air flow in turn depends on the sizes of the inlet and outlet and their judicious location in the building.

The purpose of this Digest is to provide the designers information on the optimum sizes of windows in the tropics, from ventilation point of view. The distribution of indoor air velocities and other relevant data have been obtained by wind tunnel experiments on models in the CBRI as also elsewhere. The data obtained through model tests has also been checked with the prototype in a few specific cases and they conform closely with in experimental limits.

The results and conclusion given in the Digest hold for normal rectangular or square shaped rooms in which one of the windows is assumed to be in the wall facing the natural outdoor wind. Since window heads are normally in the same level as the door heads and window sills are fixed at 2′—6″ to 3′—0″ from floor level, window height has been kept at 1/3rd of the room height. The effect of changes in window size on room ventilation is summarised below:

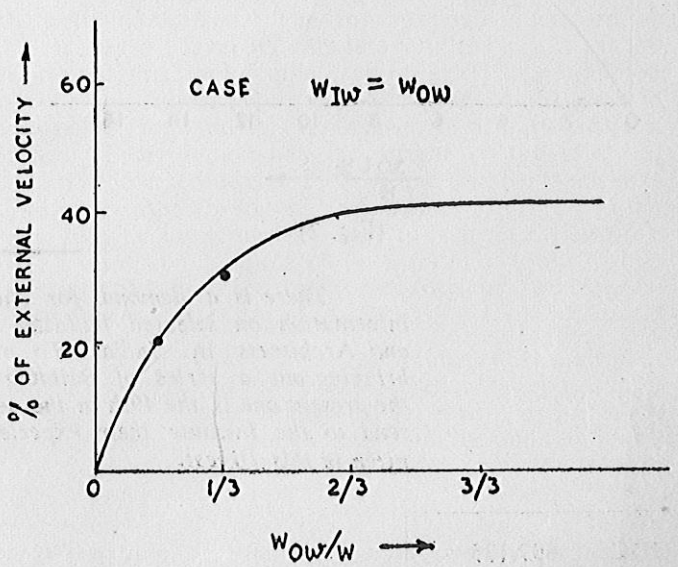
(1) The average internal air velocity in a room with a significantly with either increasing the width of the window or changing the orientation with respect to the coming air. It has been observed that the average inside velocity increases from 13% of the outside for a window width 1/3rd of the wall width to nearly 18% for the full width.

(2) The average inside velocity in a room having window in opposite walls does not change significantly if the inlet opening is increased while the outlet is kept constant. However, if the inlet opening is kept fixed and outlet opening increased, the average indoor velocity shows a definite upward trend. Thus it is always preferable to keep the outlet as large as possible.

(3) The results of the average velocity in a room with inlet and outlet openings of the same dimensions are shown in Fig. 1. It is interesting to note that as the dimensions of both windows are increased simultaneously the average indoor velocity (v) increases significantly. The indoor velocity increases from 20% for window width 1/6 of the wall width to 45% for full width. A close fit for the curve of Fig. 1 is found to be given by the equation.

$$\frac{v}{V}=0.45(1-e^{-3.84\,x}),$$

where V is the outdoor velocity.



(Fig. 1)

Here it is seen that beyond x=0.6 the average indoor velocity remains nearly 40% of the outdoor velocity which means that any increase in the window size beyond this value affords only a small possibility of

Percentage of opening to floor area:

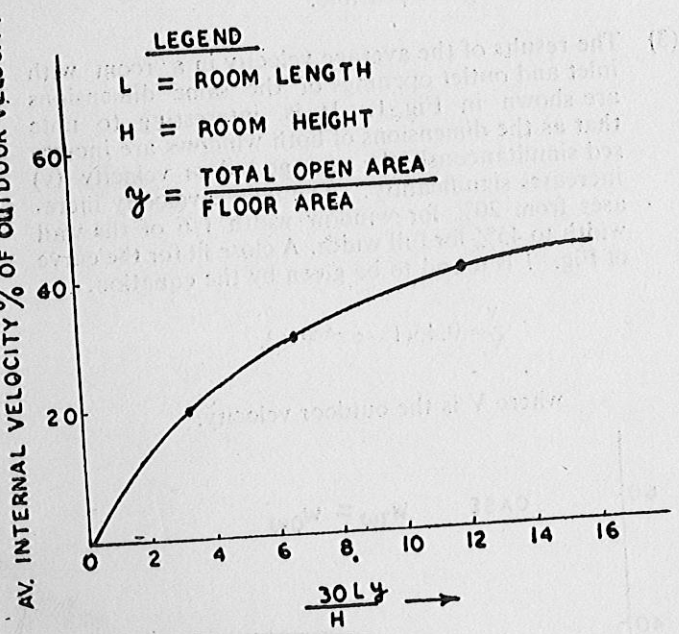
The thumb rule procedure adopted by designers in calculating the sizes of the windows is the percentage of the floor area. Fig. 2 helps to deduce this percentage, having once decided upon the desired wind velocity inside. The later is dependent on the prevailing climatic conditions as also the purpose which the building is required to serve and Table 1 gives air velocities for achieving comfort conditions under different temperatures and relative humidities. The following example brings out the procedure.

Example:

The windows of a habitable room are to be designed on the basis of the following climatological data.

Dry bulb temperature	=26.6°C
Relative humidity	=72%
Outside wind velocity	=8 km/hr.
Inside desired velocity	=1.8 km/hr.
Length of the room (L)	=3.6 m
Height of the room (H)	=3 m
Percentage velocity $\frac{1.8}{8}$ x 100	=22.5

From Fig. 2, corresponding to 22.5% velocity



(Fig. 2)

$\frac{30\ Ly}{H}=4$

Hence y=0.11

Thus 11% of the open area to the floor area is to be provided to achieve the required indoor velocity.

Table—1

DESIRED WIND SPEED FOR COMFORT
(Effective temperature 75°F)
(24°C)

Dry bulb temp.°F	Relative Humidity (percent)	Desired wind speed (km/hr.)
80	60	0.40
80	70	1.82
85	30	0.40
85	40	2.5
85	50	5.4
85	60	7.3
85	70	10.9
90	30	9.1
90	40	14.5

Nomenclature.

H=Wall Height

L=Wall Length

W=Wall Width (the wall containing a window and facing the outside wind.)

W_o =Outlet window width

W_{iw}=Inlet window width

$x=\frac{W_w}{W}$

y=Ratio of the area of opening to floor area

v=Average internal velocity

V=Outdoor free wind velocity.

There is a demand for short notes summarising available information on selected building topics for the use of Engineers and Architects in India. To meet the need, this Institute is bringing out a series of Building Digests from time to time and the present one is the 49th in the series. Readers are requested to send to the Institute their experience of adopting the suggestion given in this Digest.

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