

## APERTURES FOR NATURAL VENTILATION IN SINGLE BAY FACTORY SHEDS

Removal of contaminants produced by industrial processes and inducement of air motion for thermal comfort of workers are the two basic functions of ventilation in factories. The contaminants as produced in the form of smoke, fumes and dust etc., are usually required to be extracted out right at the source. This is accomplished by the use of exhaust systems specifically designed to meet the ventilation requirements typical to the relevant contaminant. In factories with a clean atmosphere, the problems concerning the removal of contaminants do not exist. In such cases, natural ventilation can be employed for inducing air motion. The effectiveness with which natural breeze is made use of, depends in part on sizes and location of various openings, and the direction of outdoor wind. The contribution of roof openings to air motion in the working zone in open plan factories was studied by Weston in Australia. Similar investigations pertaining to small factories (single bay sheds) were carried out at this institute. Findings of these studies have led to some simple guidelines for design of apertures for natural ventilation of factory buildings. These guidelines are reported in the present digest.

### Location of Windows

- (1) As far as possible, windows should be provided on opposite walls to facilitate cross ventilation through the building. This helps to enhance air motion in the working zone indoors.
- (2) The height of window sills should be kept around 1.1 metre.

### Location of Roof Openings

The location of roof openings which help to increase air motion at the normal working level in single bay factory sheds with different orientations are depicted in figures 1 to 8. The locations of all openings with respect to on blowing wind are

shown in the relevant perspective sketch of the factory building. The roof light openings located in the end bays and middle bays are denoted by E and M respectively. The various directions of outdoor wind are indicated by arrows; the abbreviations noted thereon refer to the preferred locations of roof openings. It is seen that for achieving enhanced natural air motion indoors, factory sheds should be provided with roof openings as per details given below :

### A. Sheds with Sawtooth Roof

- (1) When sheds are provided with windows only on the East wall, and roof light faces North, roof light should be provided in all the bays for winds blowing from NW, SE and E directions. For northerly and NE winds, roof openings should be restricted to the north and the south end bays respectively (Fig. 1).
- (2) North light factory sheds with wall openings only on the western side should have roof openings in all the bays for winds blowing from W, SW and NE directions. For Northerly and NW winds, roof openings should be provided only in the north and the south end-bays respectively (Fig. 2).
- (3) South light industrial sheds with windows only on the East wall should be provided with roof openings in all the bays for winds incident from E, NE and SW directions. For southerly and SE winds, roof openings can be made use of in the south and the north end-bays respectively, (Fig. 3).
- (4) In the case of sheds having windows only on the west wall and roof light facing south, all the bays should have roof openings if wind blows from NW, SE and W direction. Roof open-

ings should be made use of only in the south and the north end-bays when wind blows from south and SW respectively. (Fig. 4).

- (5) In North light sheds provided with cross ventilation (windows on the east and west walls), provision of roof openings is advantageous for all the bays when outdoor wind is incident from W, SW, E and SE directions. For a northerly wind, roof openings are beneficial only for the North end-bay. (Fig. 5).
- (6) In cross ventilated south light sheds, roof openings should be provided in all the sheds when wind blows from E, NE, W and NW directions. For southerly wind, roof opening should be employed only in the south end-bay. (Fig. 6).

### B. Sheds with Pitched Roof

- (1) Pitched roof sheds having wall opening only on one side, should have roof openings in all the monitor lights for winds incident normally or tangentially to windows. For oblique incidence of wind on wall openings, roof openings should be provided only in the leeward roof lights. (Fig. 7.)
- (2) In cross ventilated sheds, roof openings should be provided in the monitors of all the bays for wind striking normally on windows. When wind blows parallel to windows, roof openings should be provided only in the wind facing monitors. For wind incident obliquely on windows roof openings located only in leeward side monitors help to augment air motion indoors.

### Sizes of Wall Openings

- (1) The width of the wall openings should be about  $\frac{2}{3}$  of the wall width.
- (2) The height of windows should be about 1.6 metre.

Window sizes over and above these dimensions do not contribute significantly to air motion at the working level.

### Sizes of Roof Light Openings

Openings about 0.9 m in height should be provided

over  $\frac{2}{3}$  of the length of the glazed area in the roof lights.

### Procedure to be Followed in Fenestration Design

The two factors which need optimization in respect of fenestration design for natural ventilation are; (1) Size and (2) Location of openings. In factories, usually high rates of air motion are needed for thermal comfort indoors. The speed of the outdoor wind, which is the prime source of inducing air motion indoors, varies over a wide range. Therefore the design should aim at making the best use indoors of the available outdoor wind. To this end the dimensions of openings for a given factory size should be taken as described earlier. For the actual location of roof openings, the type of roof, orientation of the building whether it is with north light or south light should first be considered. Next, the placing of windows, whether on one wall or on opposite walls should be decided upon. Then the perspective sketch representing the given situation should be selected from amongst figures 1 to 8. Finally, knowing the prevailing wind directions during summer and rainy seasons for the station in question, the desired location of roof openings should be worked out from the relevant sketch. It may be mentioned here that shutters should be provided in the openings in order that these may be closed for protection against the undesirable winds.

### Illustrative Example

Suppose it is required to find out the preferred location of roof openings for factory sheds on the basis of the following data.

- (i) Type of roof — Sawtooth roof.
- (ii) Direction of roof lights — North.
- (iii) Location of windows. — On west wall only.
- (iv) Prevailing wind direction. — W/NW during summer and rainy season.

### Solution

Preferred location of ventilation openings in the north facing roof lights for sawtooth roof sheds

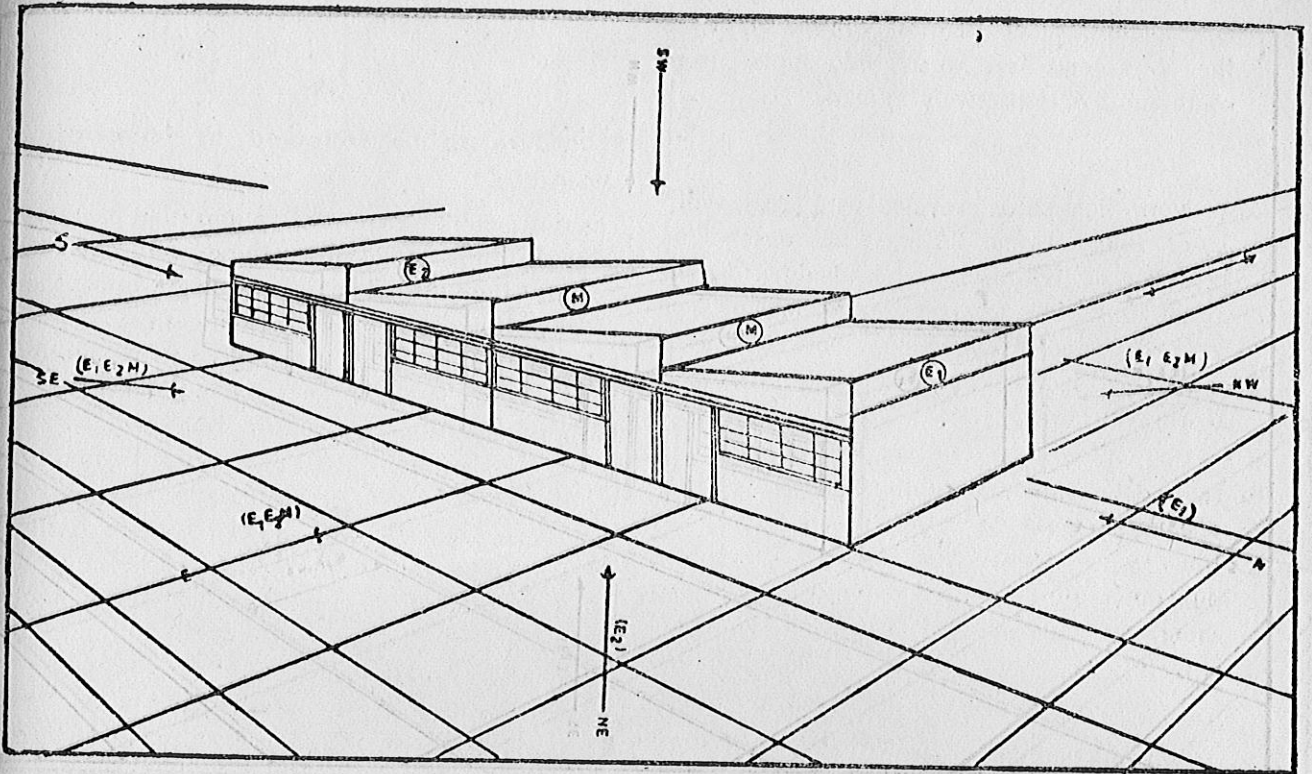


Fig. 1. Preferred Location of Roof Openings in Northlight Sheds Having Windows on East Wall Only.

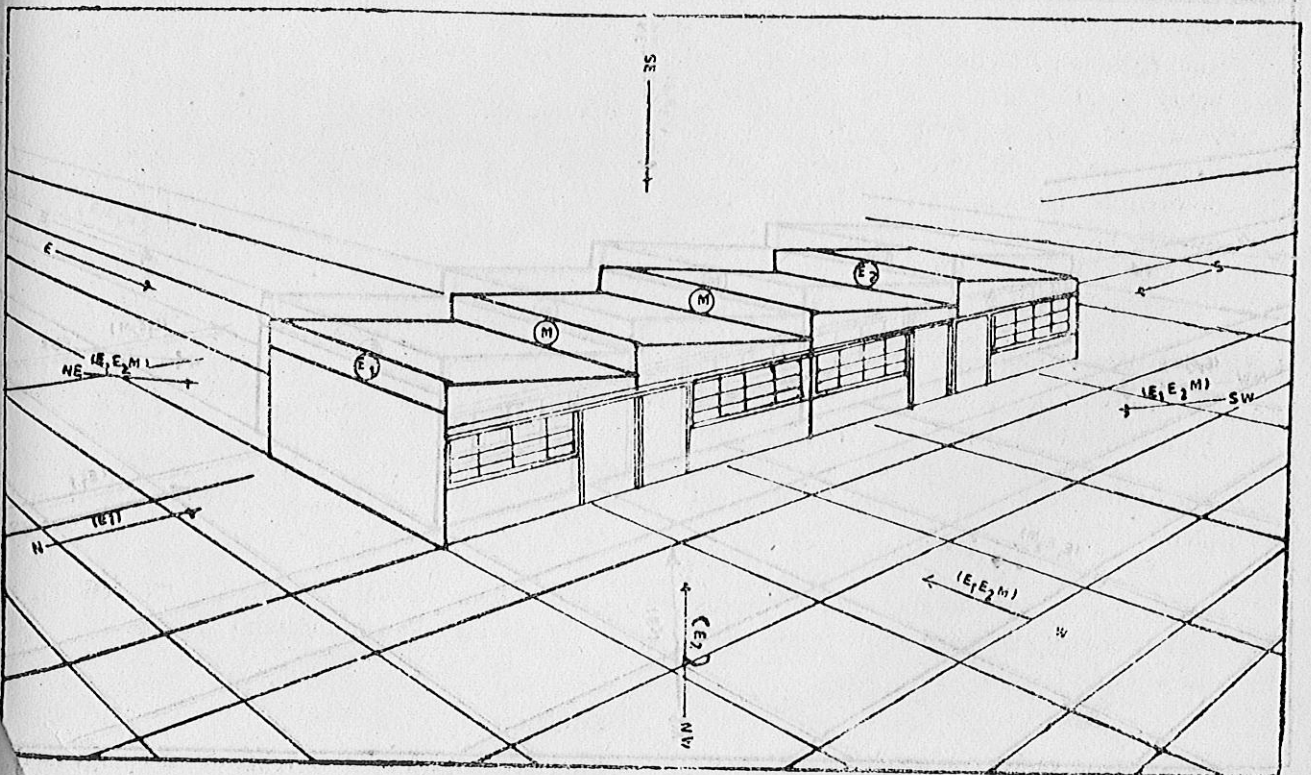


Fig. 2. Preferred Location of Roof Openings in Northlight Sheds Having Windows on West Wall Only.

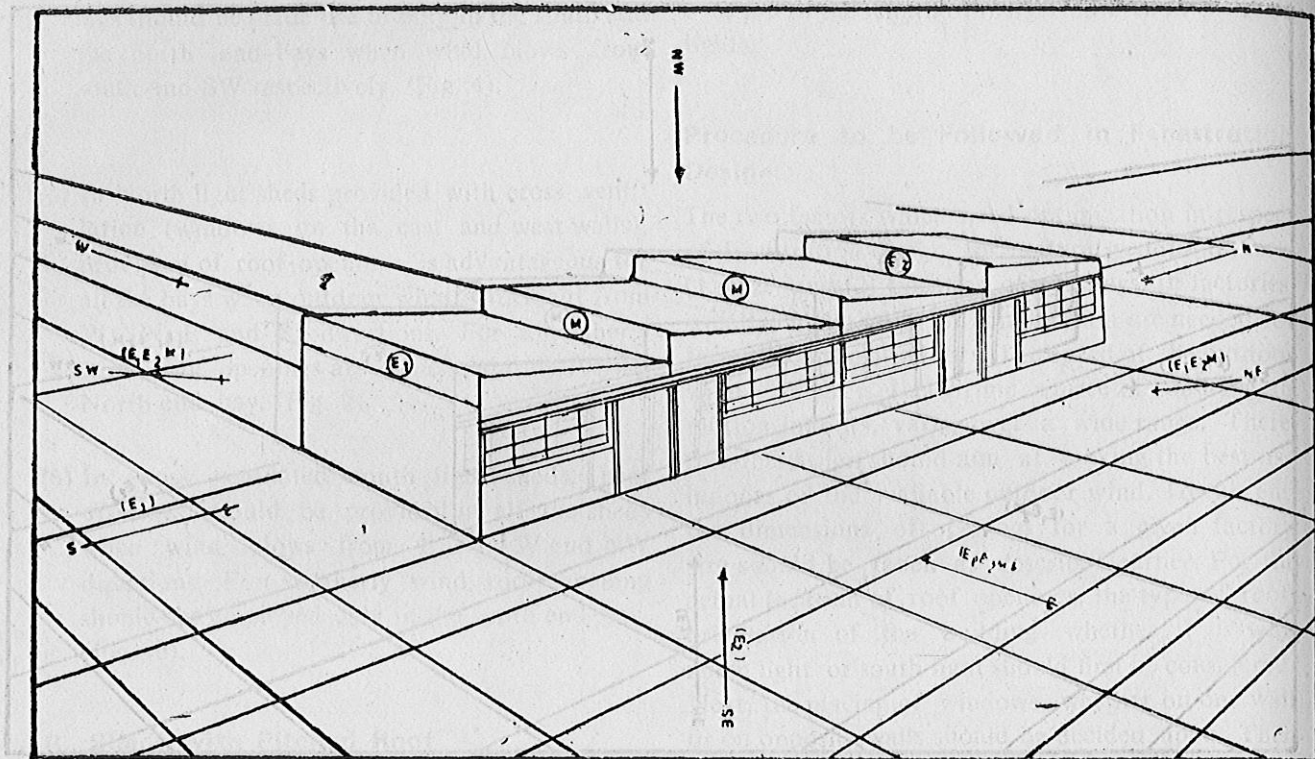


Fig. 3. Preferred Location of Roof Openings in Southlight Sheds Having Windows on East Wall Only.

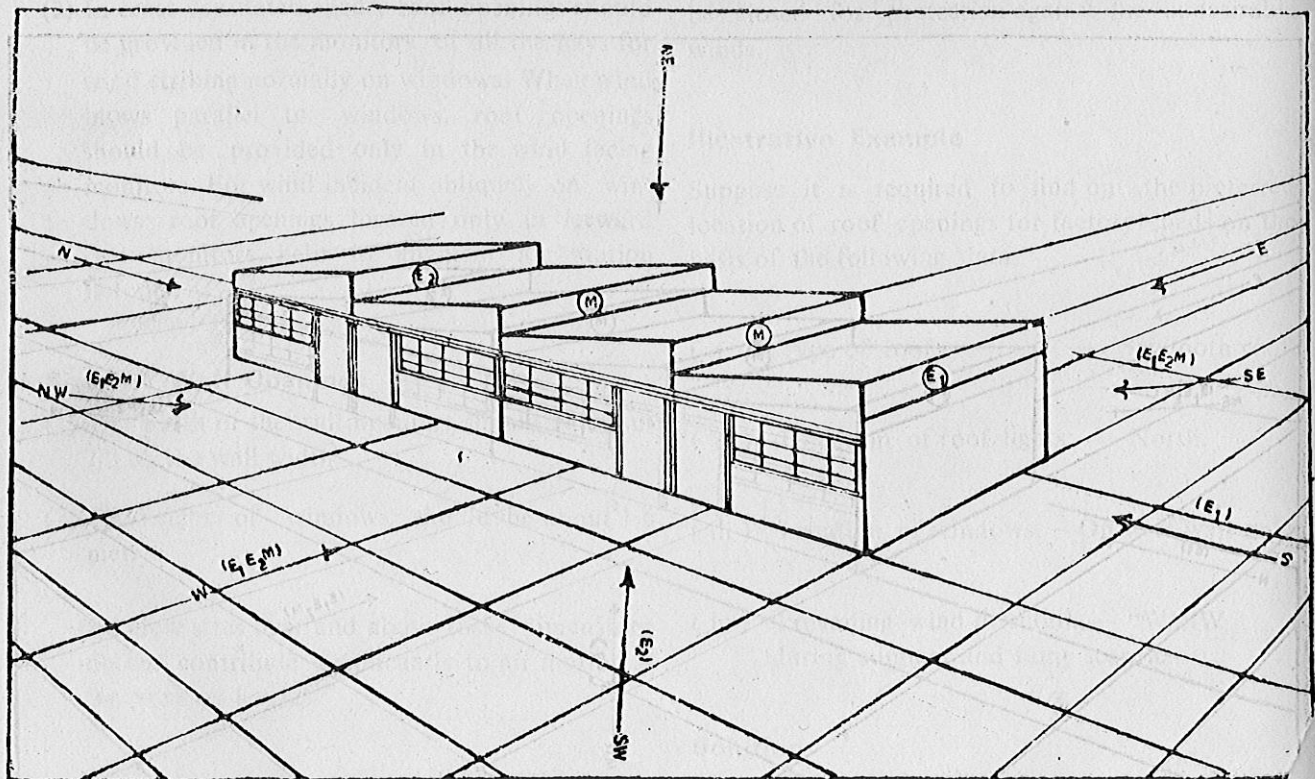


Fig. 4. Preferred Location of Roof Openings in Southlight Sheds Having Windows on West Wall Only.

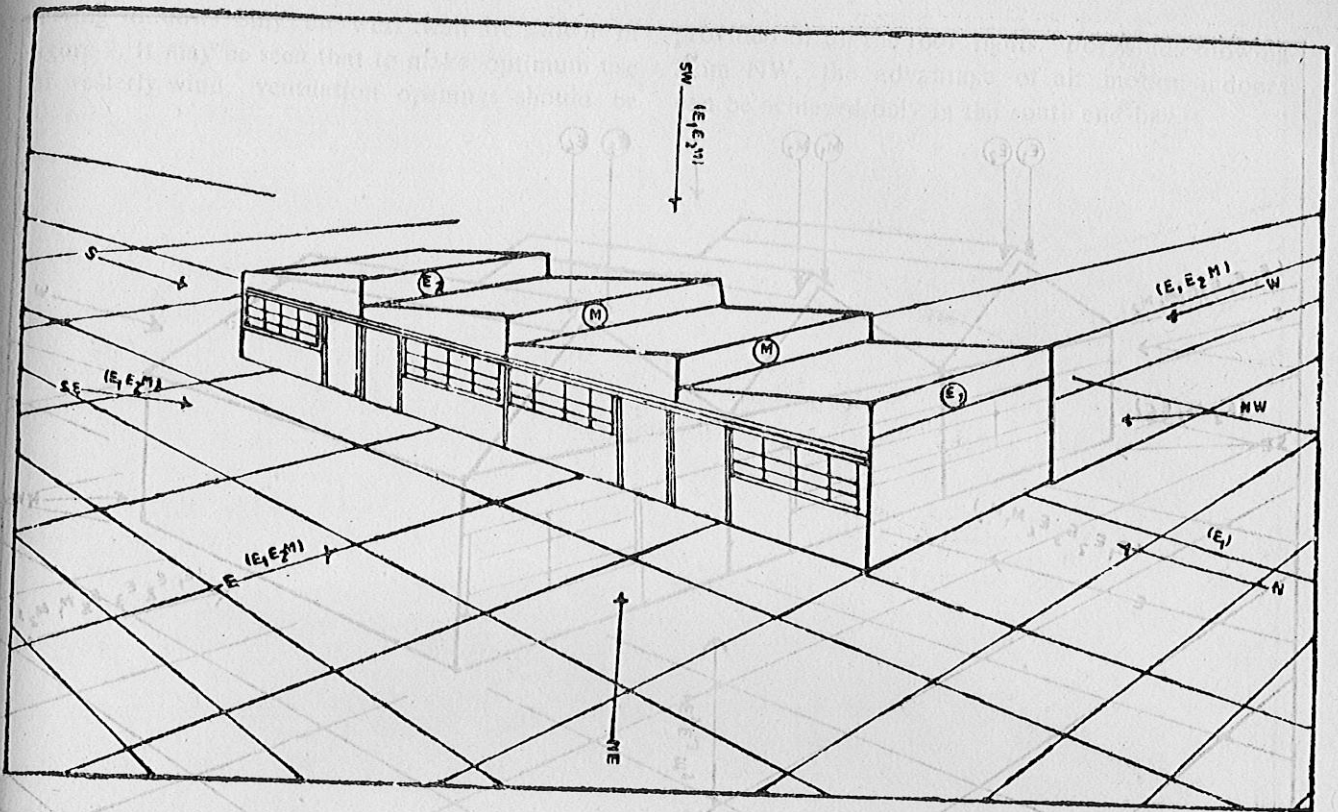


Fig. 5. Preferred Location of Roof Openings in Northlight Sheds Having Windows on East & West Walls.

Fig. 7. Preferred Location of Roof Openings in Pitched Roof Sheds Having Windows on one Wall Only. (East Wall).

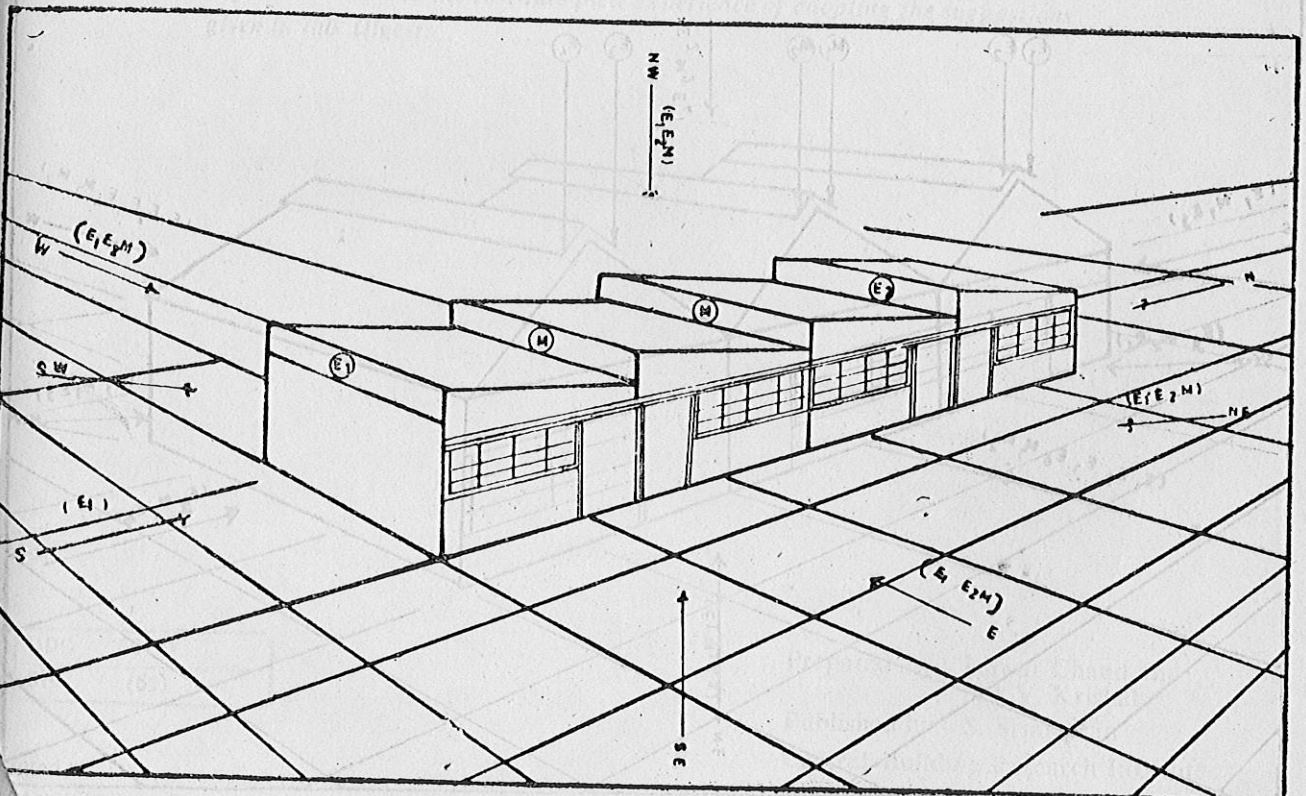


Fig. 6. Preferred Location of Roof Openings in Southlight Sheds Having Windows on East & West Walls.

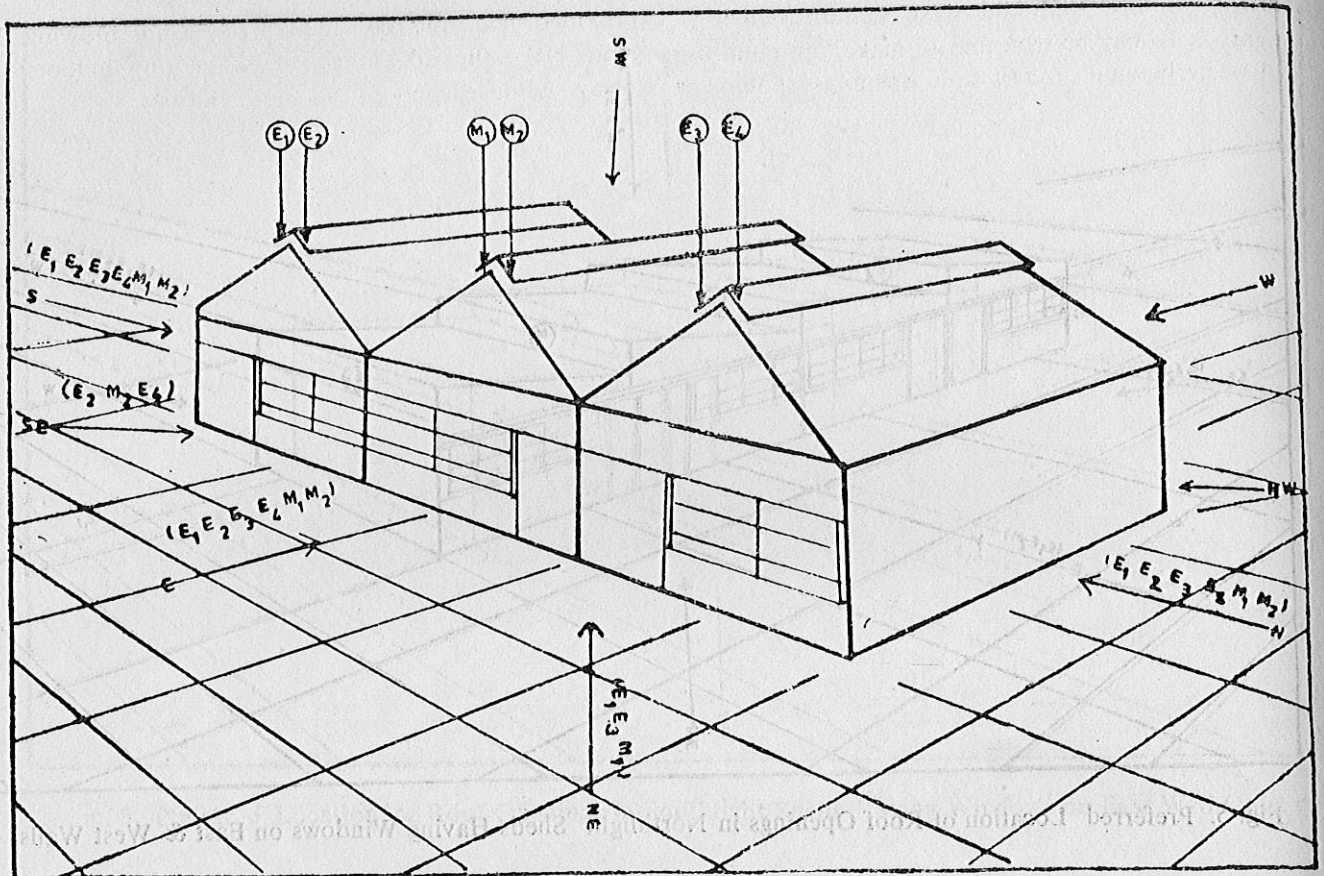


Fig. 7. Preferred Location of Roof Openings in Pitched Roof Sheds Having Windows on one Wall Only. (East Wall).

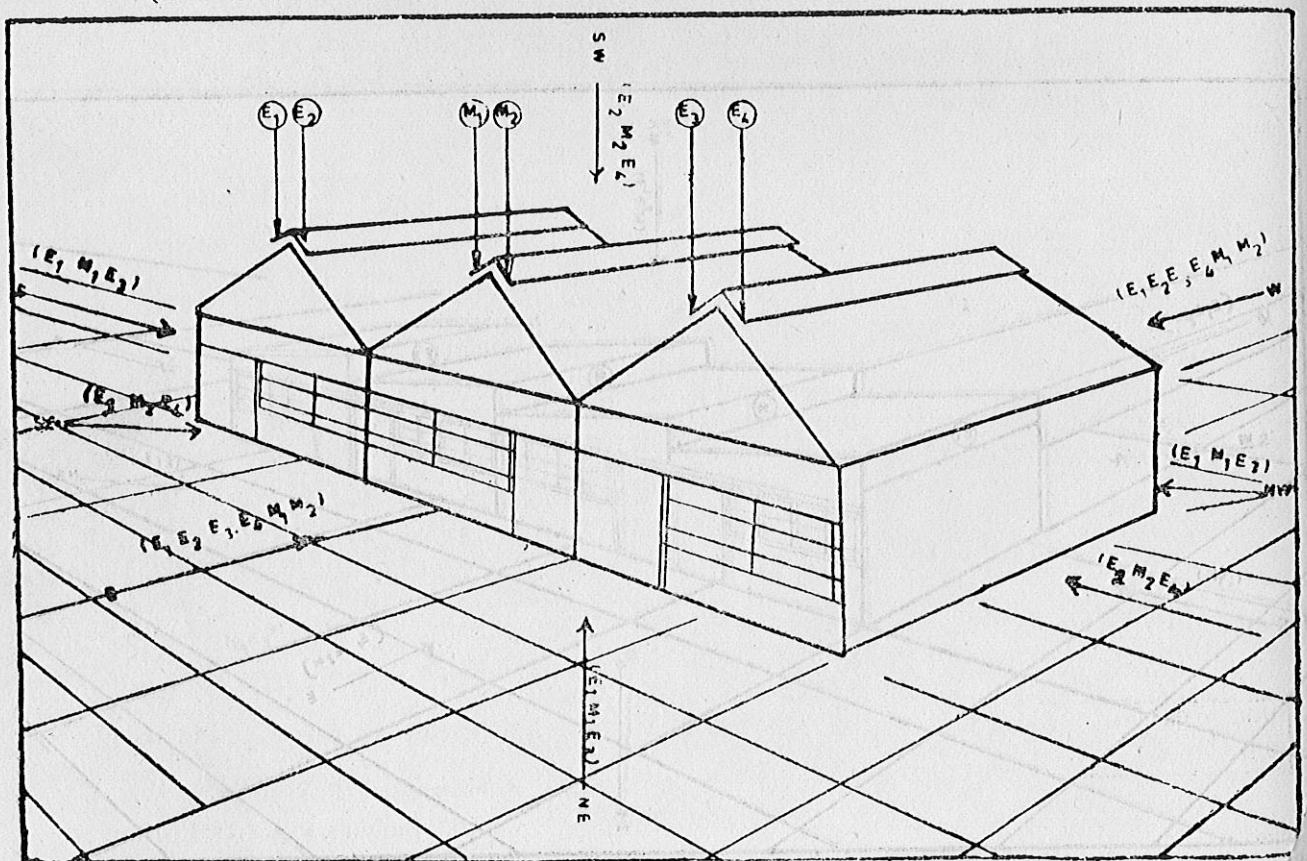


Fig. 8. Preferred Location of Roof Openings in Cross Ventilated Pitched Roof Sheds.

having windows only on west wall are shown in figure 2. It may be seen that to make optimum use of westerly wind, ventilation openings should be

provided in all the roof lights. For winds blowing from NW, the advantage of air motion indoors can be achieved only in the south end-bay.

*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 128th in the series. Readers are requested to sent to the Institute their experience of adopting the suggestions given in this Digest.*

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