BUILDING DIGEST

CENTRAL BUILDING RESEARCH INSTITUTE INDIA

ARCHITECTURAL CONTROL OF SUNLIGHT PENETRATION THROUGH WINDOWS

Comfort in buildings from the thermal point of view is now receiving more and more attention of architects and planners than paid hitherto. Traditional devices like Chhajas, deep overhangs of eaves and verandahs used for shading purpose, though quite common and fairly effective, do not give complete shadow cover, particularly in the direction of South, South-West and West. They are also either cut down in their projection, or entirely omitted sometimes for reasons of economy. Some of the old ideas of putting awning or weather shades in lighter materials like timber and A.C. Sheets are somehow no longer in vogue. The problem of satisfactory shading devices thus remained unsolved till the new idea of louvers or sun-breakers came to be used in India.

The introduction of this new idea into our contemporary buildings has been so rapid that it has remained, more or less, a blind imitation of Western design rather than based on a scientific approach in relation to the solar path, correct orientation of buildings and their functional requirements.

An important step to solve this difficulty has already been taken by the Central Building Research Institute, by publication of "Climatological & Solar Data for India". It gives a method of designing louvers through worked out examples. Although adequate and enabling a designer to evolve suitable louvers for a given latitude, time and orientation of window, it involves reference to Tables, some calculations and drawing work. The need to simplify it further and to provide some ready made solution for ready references at the planning stage is thus necessary. An attempt has been made in this Digest to fulfil this need. The projections of chhajas and louvers thus obtained will give protection against the Sun only and they may in certain situations be not adequate for the wind and the rain. A fully scientific design for the latter is however not possible at this stage for want of sufficient data.

Basic Principles of louver and Chhajja design

(a) Functional aspects

The function of a chhajja or weather shade is to give protection against rain, sun and glare. It may, however, not necessarily give complete protection because its location being only at the top of window, sides and lower portions are left exposed. One advantage of a chhajja, is that it permits free flow of air through the window.

Louver, as defined by the Oxford Dictionary is "An arrangement of overlapping boards, laths, or strips of glass admitting air but excluding rain". In the broader sense in which it is now used, the boards, laths or glass strips may be considered as having been replaced by insitu or precast reinforced concrete or brick, and their function, as admitting air but excluding not only rain but sun and glare also. The advantage of louvers over chhajja is, that if properly designed, they could give complete protection against sun and glare at the same time. Since, louvers could be provided in both horizontal and vertical direction they can give full shadow cover to the window.

Chhajjas and louvers are very often provided for architectural treatments also. A judicious use of this element in building is therefore essential when the cost of providing them remains fairly high in proportion to their functional efficiency. The designer should decide at the first instance where and for what purpose he would provide them. With a proper study or local climatic conditions it is possible to find out whether simple chhajjas will be adequate or some form of louvers will also be necessary. It is also possible now to verify if only horizontal projection will be needed or only vertical projection will suffice or a combination of both are necessary.

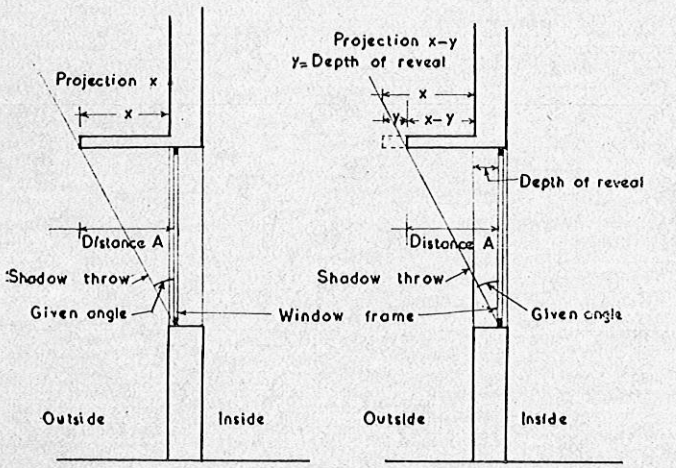
A proper orientation of the building as well as individual rooms, in relation to their use by itself, will go a long way in reducing or even eliminating the need of chhajjas and louvers. Windows facing East or North will require very little protection against sun as compared with South and West. The morning sun from the East is not so oppresive and will generally be welcome. On the North wall too, the amount of solar incidence is much less. In areas where rain is not much of a problem, there will either be no necessity of providing chhajjas or louvers on the North and East or alternatively a smaller projection may be sufficient.

Light and ventilation are the other two aspects closely connected with the design of chhajjas and louvers and it is essential that care is taken to see that these are not unduly affected. An important point, very often overlooked in this respect, is the free circulation of air around the window. The box and

eggcrate type louver being provided are most unsuitable from this point of view. As no space is left between the wall face and louvers the outside hot air gets entrapped into the boxes and transmits the heat into the room through the window. The cooling effect envisaged through the shading is thus reduced to a great extent. Projection of wide louver at the window cill level not only reflects the sun light causing glare and heat radiation, but also leads to the splashing of rain water on the window glass panes. Provision of box or eggcrate type louvers should therefore, be avoided as far as possible, unless required for some special reasons as in case of multistoreyed buildings where a continuous louvered screen is provided for shading windows at all levels.

(b) Structural aspect

Chhajjas and louvers, being required to project out considerably from the wall, are normally designed as cantilevers which adds to the construction cost. Though, unavoidable in most cases, it is possible to reduce their actual projection by taking advantage of the depth of reveals by putting the window close or even flush with the inside face of the wall as shown in Figure 1.



PROJECTION OF THE CHAJJA WILL BE MORE IF WINDOW FRAME IS FIXED ON THE EXTERNAL FACE OF THE WALL

PROJECTION OF THE CHAJJA CAN BE REDUCED IF WINDOW FRAME IS FIXED ON THE INTERNAL FACE OF THE WALL

Fig. 1

(c) Design

It is necessary to know the intensity and duration of sunshine on the window in question. The position of the sun and amount of solar incidence at a given time and latitude could be obtained from the charts, graphs and tables published by the CBRI in the "Climatological & Solar Data handbook". It is also possible with this data and a shadow protractor to design a suitable louver for a window facing a given direction at a given time and latitude. The diagrams given in this Digest have been worked out with the help of the above referred publication and they provide an easy and rapid method of determining chhajjas and/or louver projections in advance of the planning stage.

In order to cover most important areas in the country, eight cardinal directions i.e. North, South, West, East, North-East, North-West, South-East and South-West, for the latitude 13 and 23 degrees North have been taken. These, roughly represent Madras and Calcutta regions and will hold true for an area of approx. 100 miles North and South of each of these latitudes. The time taken is the hottest period of the day (10 a.m. to 5 p.m.) and the hottest period of the year (May-July) It allows some amount of sun to penetrate during the morning and evening cool hours in winter months, as there will be only partial shadow cover at this time.

Shadow angles of solar position (azimuth and altitude) for this period and a given direction of the window face, at a given latitude, have been plotted both on horizontal and vertical planes, on which the projection for desired shadow cover depends. The extent of the projections falling within these angles, therefore, will give an adequate shadow cover to a desired window. Where the projection of a single chhajja or louver in either vertical or horizontal planes is abnormally long, the method of using a number of louvers giving the same shadow cover is also shown.

The projection of chhajjas and louvers could be reduced further by putting them in an inclined position both in the vertical as well as horizontal directions. These have been shown in some cases and the alternative positions shown in dotted line indicate enough flexibility of design.

The solar position being the main criteria of determining required projections, no dimension of

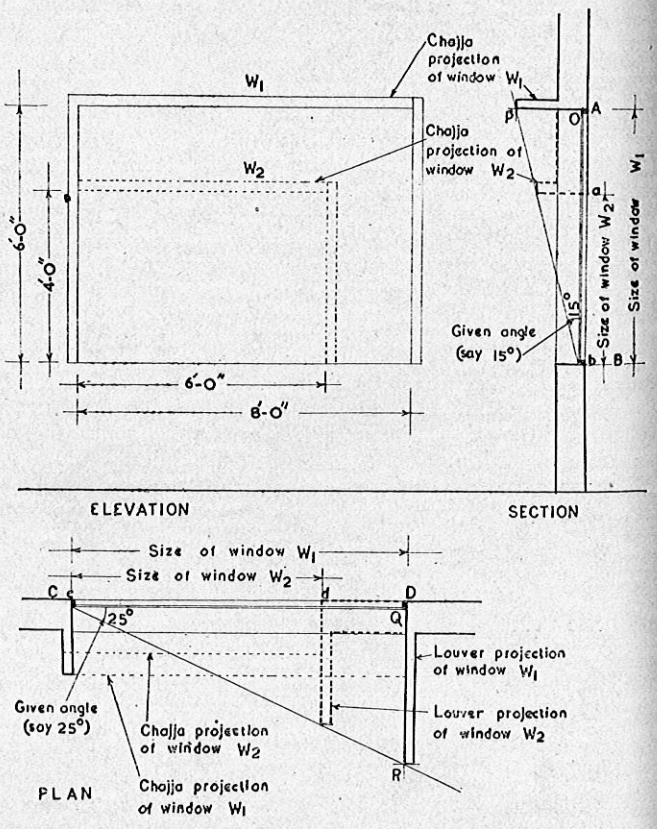


Fig. 2

windows are given in the diagrams. Architects and Engineers can choose their own window sizes and utilize the angles plotted in diagrams to ascertain chhajja and/or louver projections by co-relating the cill and the jamb of the window in question with those of the corresponding window in the diagram, as shown in Figure 2 and as explained in the example.

Example

To find out chajja and louver projections for a window :

Size	:	8′-0″ wide x 6′-0″ high.
Direction	:	Facing North
Latitude	:	13° N.
Time	:	10.00 A.M. to 5.00 P.M.
Months	:	May-June-July

(A) By graphical method :

W_1 (fig. 3) is the given window as above drawn to a desired scale (preferably $\frac{1}{2}$″=1′-0″) with its head and cill marked A & B in section and jambs as C & D on plan respectively corresponding to a, b, c and d- head, cill and jambs of W_2 (fig. 4). Superimpose (as shown

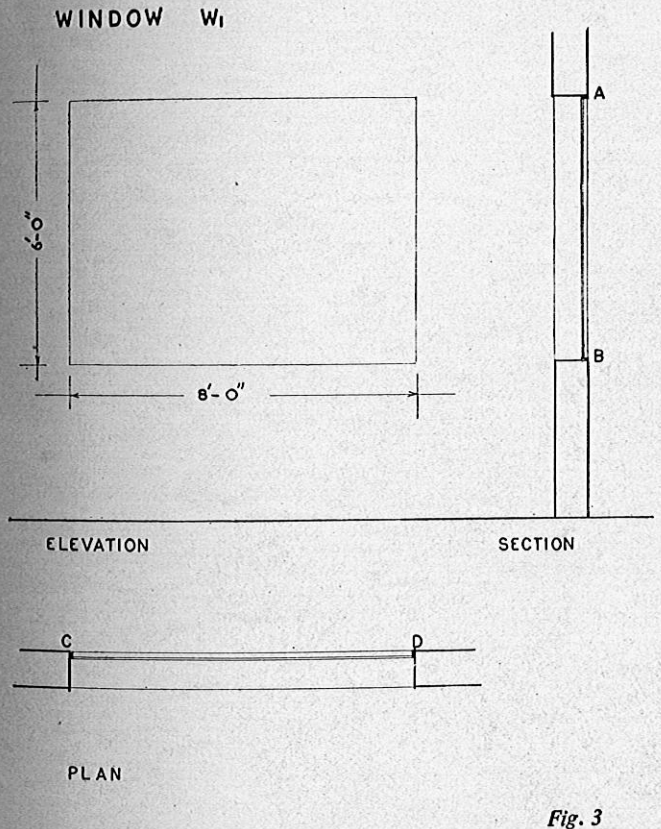


Fig. 3

in fig. 2) section of W_1 over that of W_2 so as to make cill B and frame A B to coincide with cill b and frame a b of W_2. Draw chajja projection line A P to cut the line of 15° angle at P, the distance O P is then the required projection, i.e. 1′-7″ as measured in actual drawing.

Similarly for the projections of louver on the right side superimpose (as shown in fig. 2) the plan of W_1 over that of W_2 so as to make the jamb C and frame C D to coincide with jamb c and frame c d of W_2. Draw louver projection line D R to cut the line of 25°

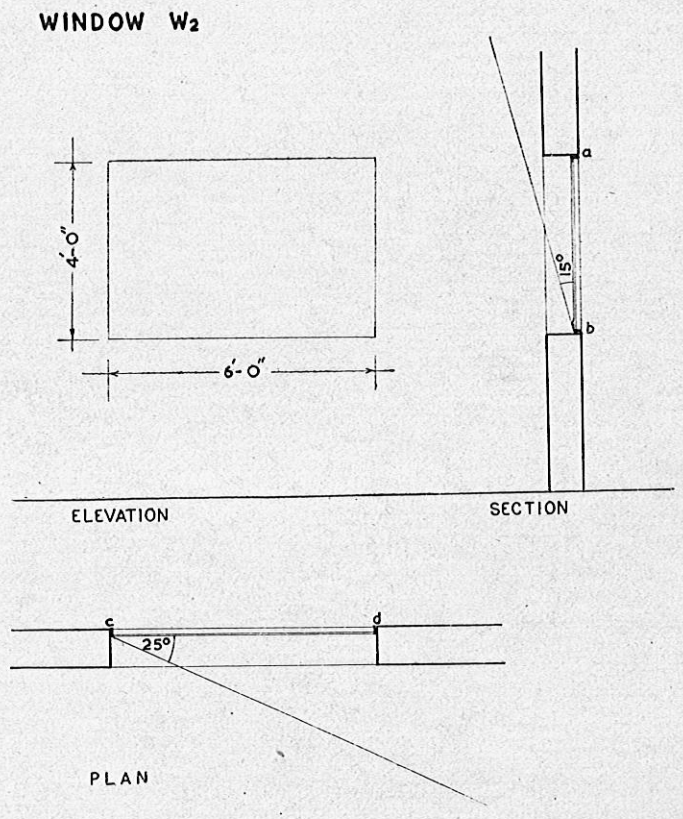


Fig. 4

angle at R, the distance Q R is then the required projection i.e. 3′-9″ as measured in actual drawing. The projection of louver on the left side to be same as the chajja projection.

(B) By numerical calculation for accuracy.

Projection OP=Tan∅ x A B

Where ∅ is the angle of sun's position in altitude and A B is the height of window W_1 then

O P=0.2679 x 6=1.61 feet

Projection Q R=Tan ∅′ x C D

Where ∅′ is the angle of sun's position in azimuth and C D is the width of window W_1 then

Q R=0.4663 x 8=3.73 feet.

Note: -1. The greater louver projection of 3.73 feet is because entire shadow cover is dependent on only one chajja and two louvers, but will get reduced further if one or two more louvers are introduced in between the two jambs.

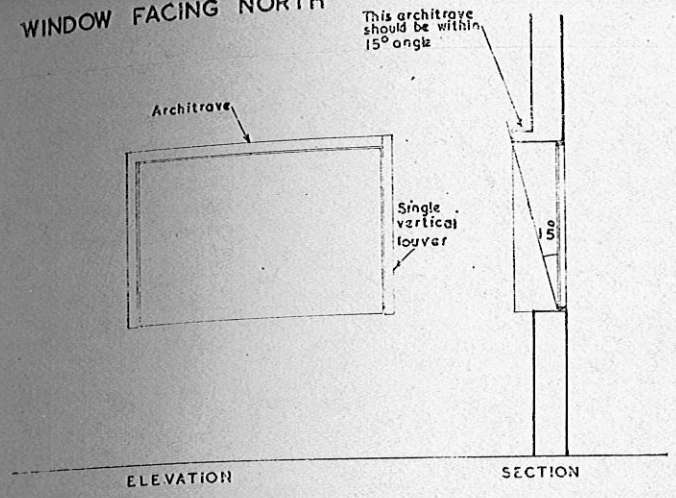
2. W_1 cited in the above example could in fact, for the purpose of superimposition, be any window drawn on tracing paper for which the louver and chajja projection for a given latitude and direction of facing is to be found out, and W_2 a window facing the same direction and the same latitude corresponding to those given in the attached charts.

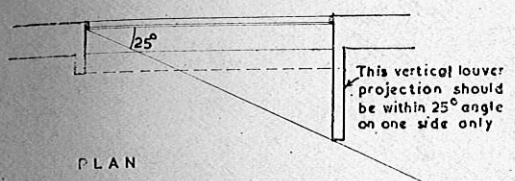
3. For the purpose of restricting the size of this digest windows for only two latitudes *i.e.*, 13°N and 23°N have been taken into account. Louvers and chajja projections similarly worked out for the latitudes 19° and 29° are available from this Institute. So also, the prints of diagrams on larger scales for all the four latitudes are available.

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 eighteenth in the series.

Prepared by M.H. Pandya and S.V. Bondale at the Central Building Research Institute, Roorkee April, 1963.

WINDOW FACING NORTH

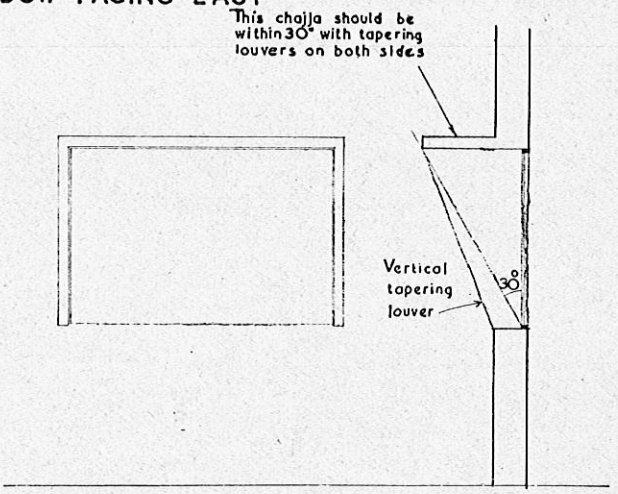


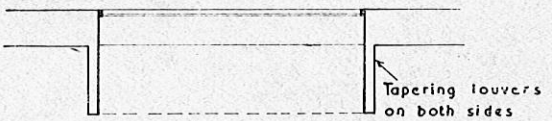


LATITUDE 13° NORTH, TIME 10 A.M. TO 5 P.M.

MONTHS MAY JUNE & JULY

WINDOW FACING EAST

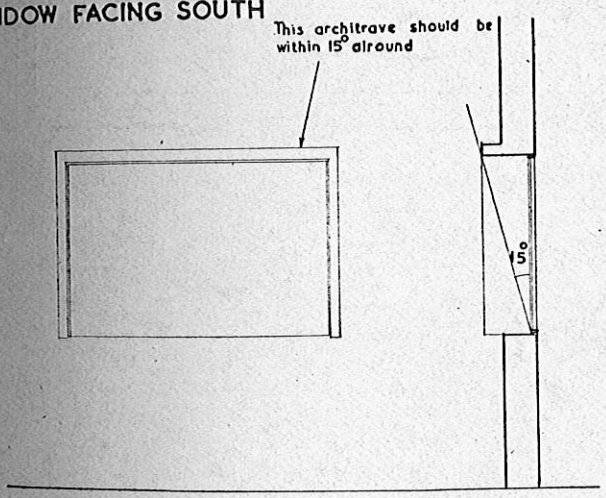


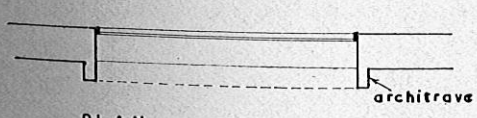


LATITUDE 13° NORTH, TIME 10 A.M. TO 5 P.M.

MONTHS MAY JUNE & JULY

WINDOW FACING SOUTH





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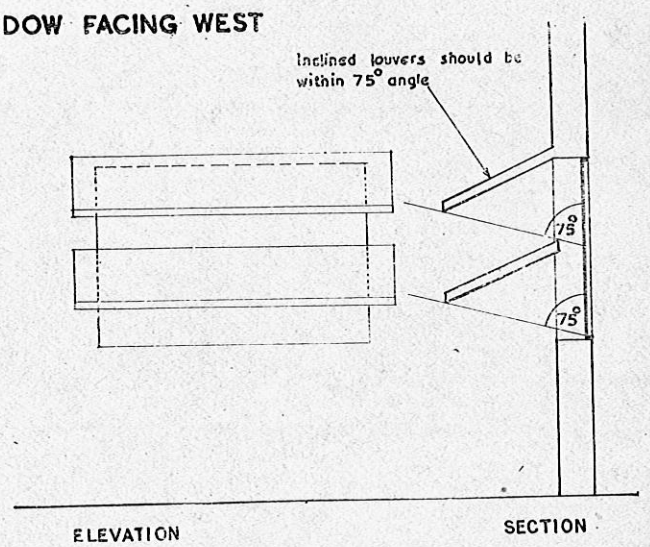
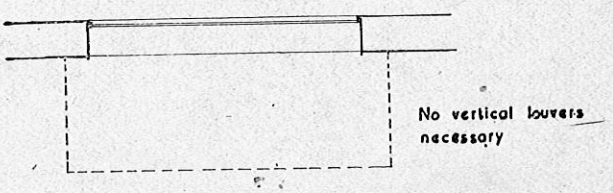
MONTHS MAY JUNE & JULY

WINDOW FACING WEST

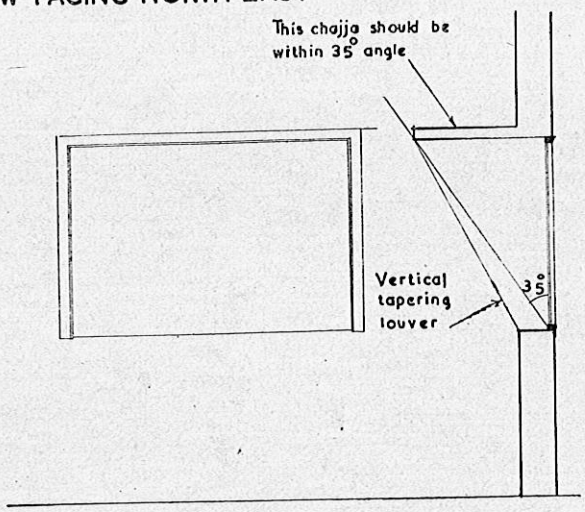


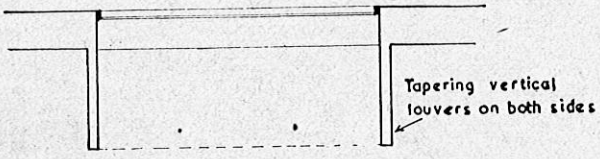


LATITUDE 13° NORTH, TIME 10 A.M. TO 5 P.M.

MONTHS MAY JUNE & JULY

WINDOW FACING NORTH-EAST



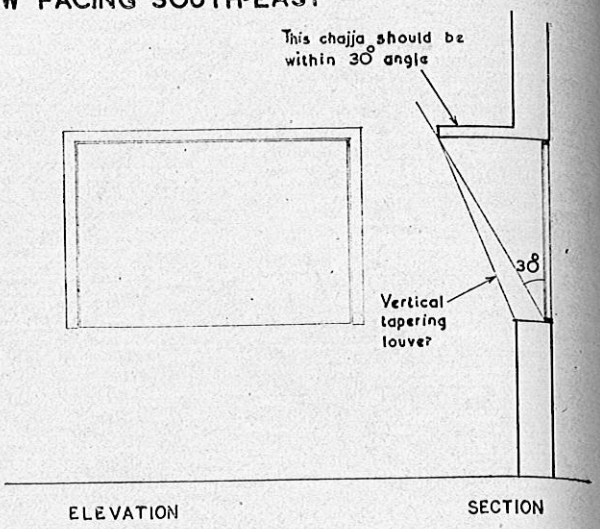


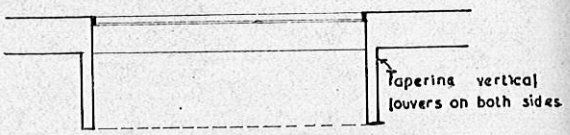
PLAN

LATITUDE 13° NORTH, TIME 10 A.M. TO 5 P.M.

MONTHS MAY JUNE & JULY

WINDOW FACING SOUTH-EAST



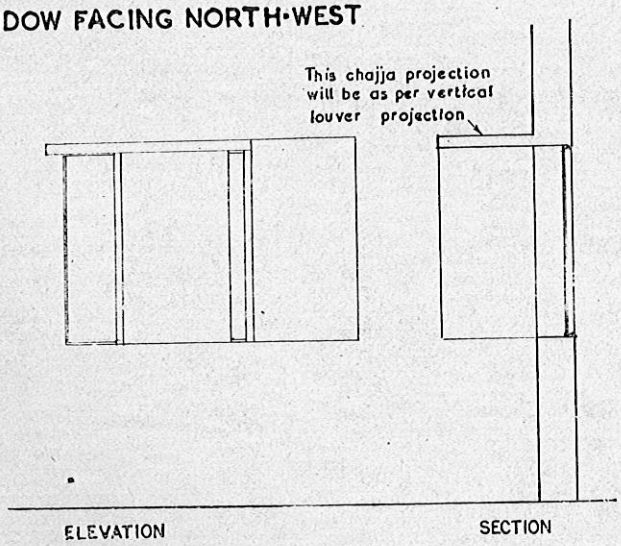


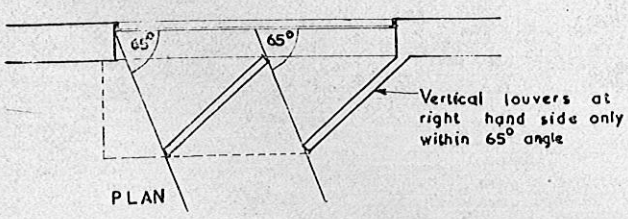
PLAN

LATITUDE 13° NORTH, TIME 10 A.M. TO 5 P.M.

MONTHS MAY JUNE & JULY

WINDOW FACING NORTH-WEST





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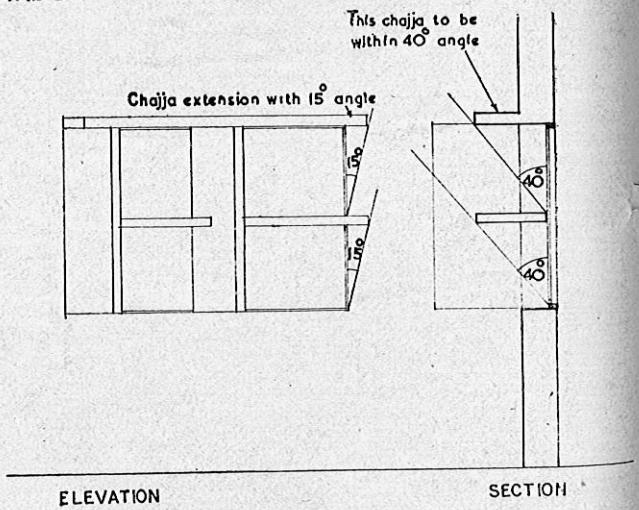
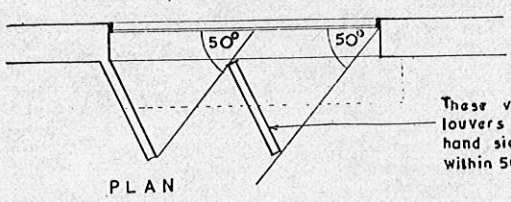
MONTHS MAY JUNE & JULY

WINDOW FACING SOUTH-WEST





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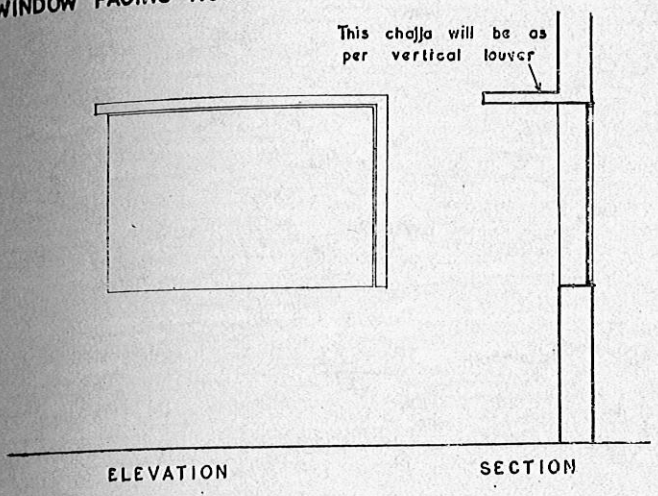
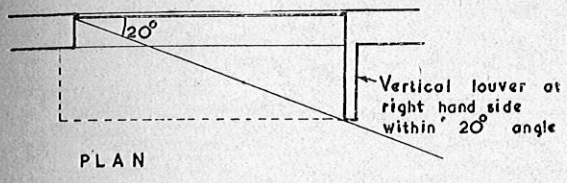
MONTHS MAY JUNE & JULY

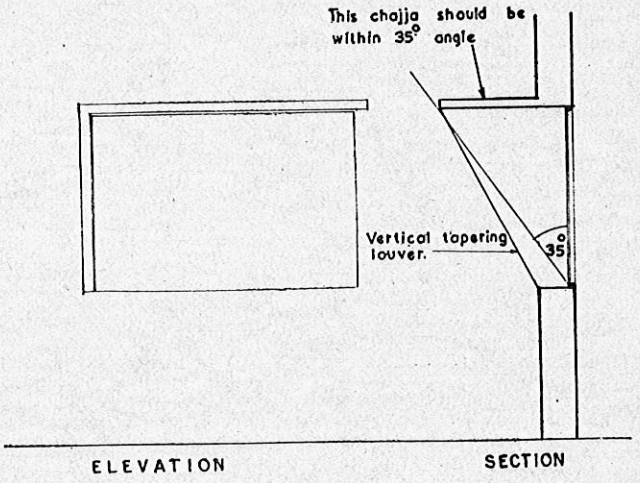
WINDOW FACING NORTH

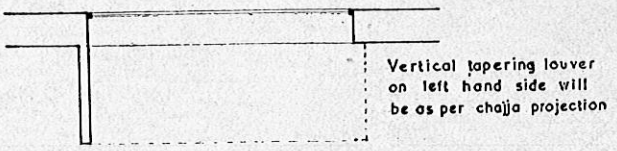




LATITUDE 23° NORTH, TIME 10 A.M. TO 5 P.M.
MONTHS MAY JUNE & JULY

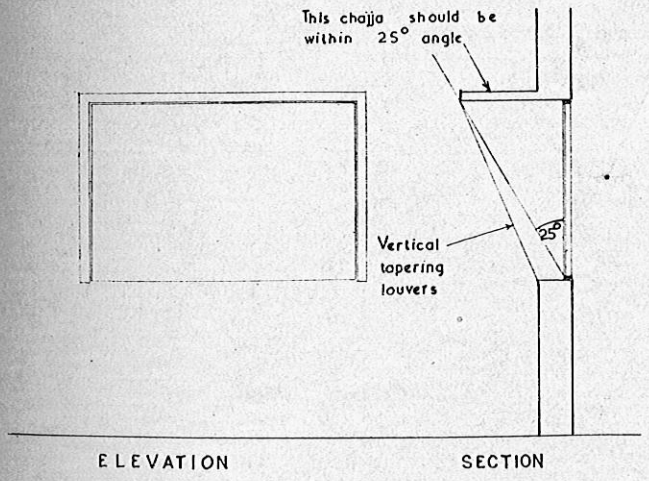
WINDOW FACING EAST

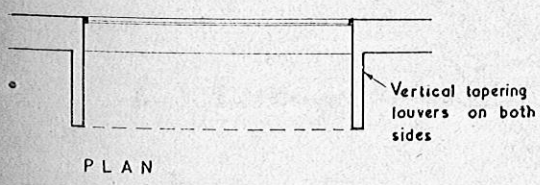




LATITUDE 23° NORTH, TIME 10 A.M. TO 5 P.M.
MONTHS MAY JUNE & JULY

WINDOW FACING SOUTH





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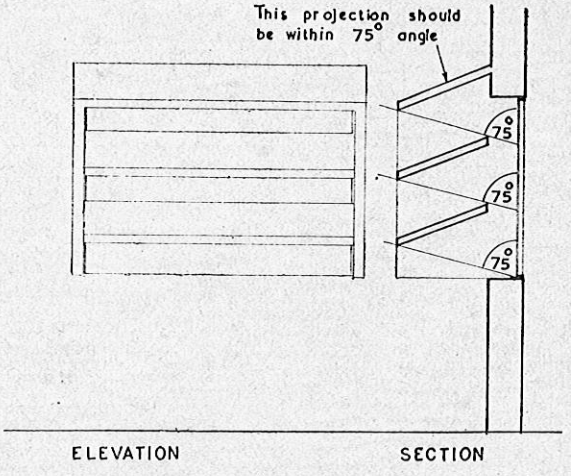
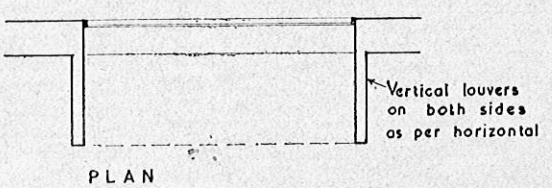
MONTHS MAY JUNE & JULY

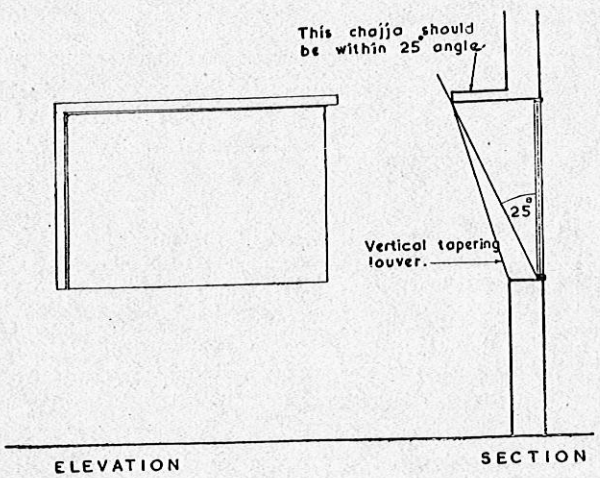
WINDOW FACING WEST

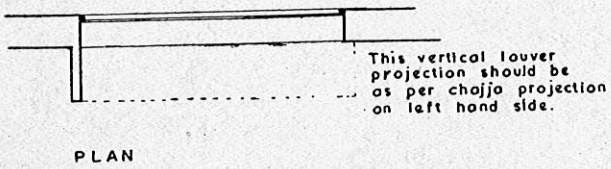




LATITUDE 23° NORTH, TIME 10 A.M. TO 5 P.M.
MONTHS MAY JUNE & JULY

WINDOW FACING NORTH-EAST





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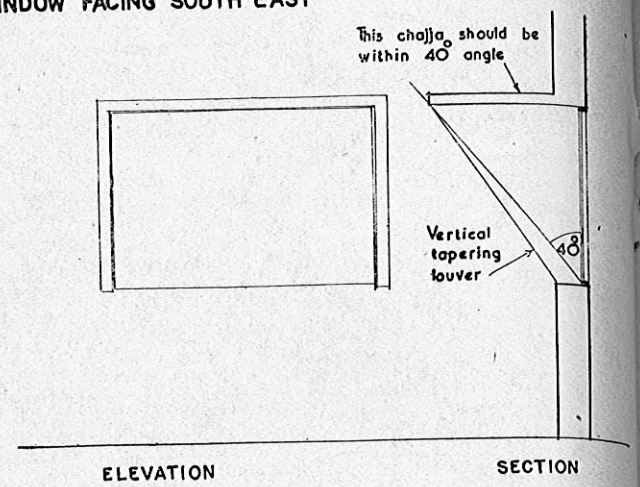
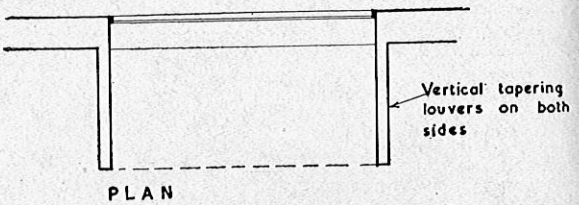
MONTHS MAY JUNE & JULY.

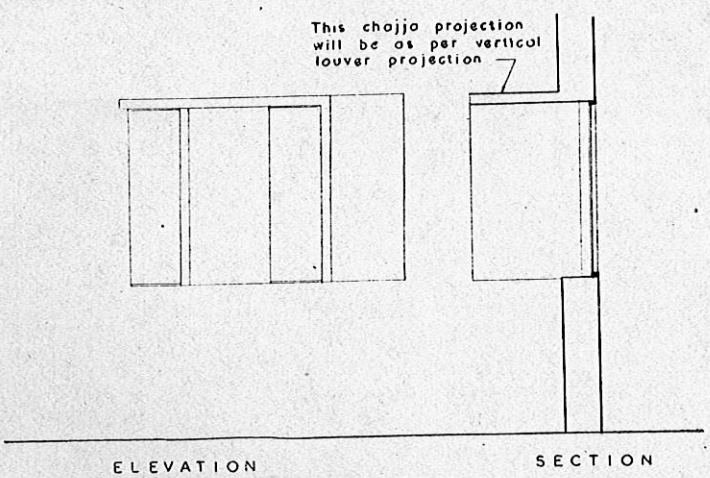
WINDOW FACING SOUTH-EAST

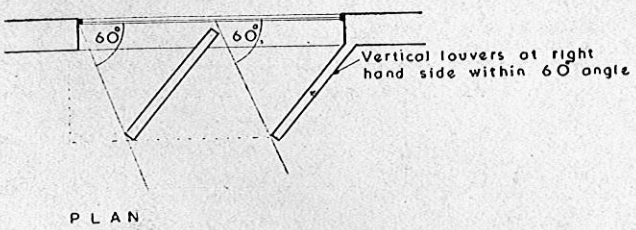




LATITUDE 23° NORTH, TIME 10 AM TO 5 P.M.
MONTHS MAY JUNE & JULY

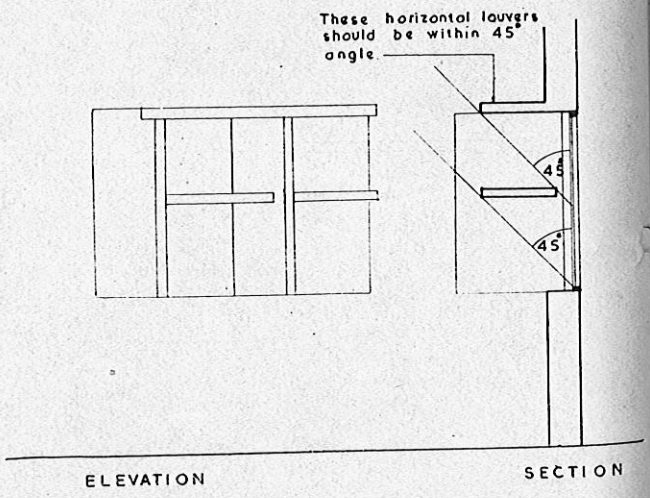
WINDOW FACING NORTH-WEST

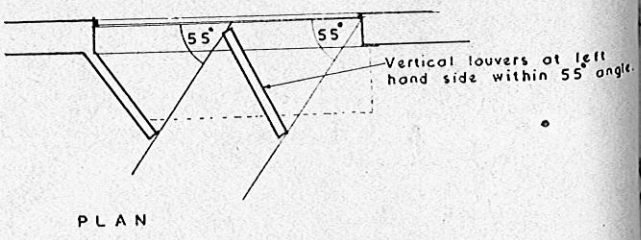




LATITUDE 23° NORTH, TIME 10 A.M. TO 5 P.M
MONTHS MAY JUNE & JULY.

WINDOW FACING SOUTH-WEST





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