SCHOOL BUILDING DIGEST 18.

Asian Regional Institute for School Building Research
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P. O. Box 1368, Colombo, Ceylon.

INDONESIA - JAVA: DESIGN FOR DAYLIGHT IN SCHOOLS

This Digest can be used to :-

(a) assess the illumination levels on tops of desks and other working surfaces as provided by a given arrangement of windows;

(b) calculate window sizes to give desired illumination levels on desks and other working surfaces in schools.

The sections that follow give a simple, stage by stage explanation of the method of calculation.

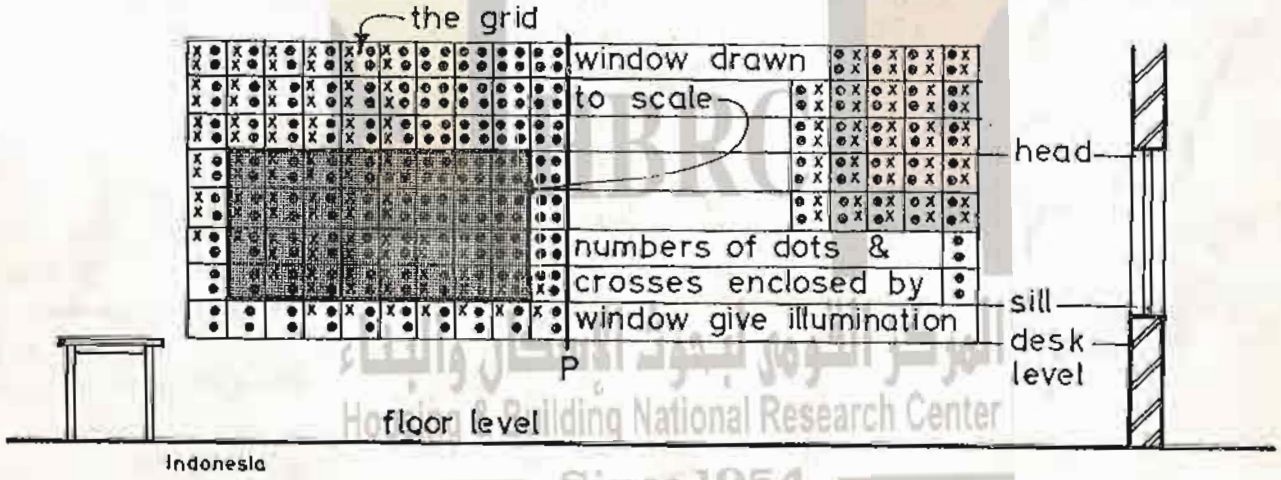
Metric units are used throughout and in this connection:-

1 foot candle	=	10.76 lux
2 feet	=	60 cm

Introduction

The Digest includes a grid on which is marked a number of dots and crosses. The grid represents the outside wall of a classroom or other teaching space *above* desk level. By drawing the shapes of the windows in the wall on the grid and simply counting the number of dots and crosses within the window outlines, the illumination can be found. If, on the other hand, the desired illumination is known, then the size of windows can be determined by making them big enough to enclose the number of dots and crosses that give the illumination. Figure 1 illustrates the idea in principle.

Using this method, of which several practical examples are given below, window design for daylight need take only a matter of minutes instead of the hours sometimes taken using other, more cumbersome methods.



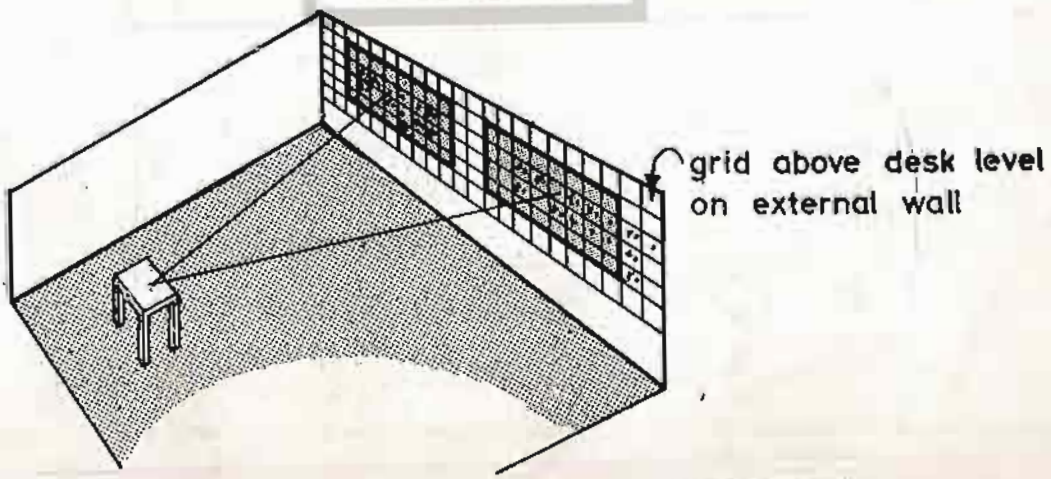


FIGURE 1

The Grid

It will be noticed that the grid representing the wall has no scale and thus the first step is to decide on the size of one square of the grid so that the window outline can be drawn on it. Table 1 and Figure 2 show how this is done.

Suppose that it is decided to use a window of size 2.40m x 1.20m high (8ft x 4ft high) and it is desired to check the illumination this window will give on a desk which is 600 cm (20ft) from it. Take a piece of tracing paper and lay it over the grid and sketch on the window shape remembering (from Table 1) that the size of one square of the grid is equal to 60cm x 60cm (2ft x 2ft). Figure 3 shows the window in position.

If it was desired to know the illumination at a desk only 300cm from the window, then, from Table 1, it will be seen that the size of one square of the grid equals 30 x 30cm. The window drawn on the tracing paper overlay would then appear, as shown in Figure 4, to contain many more dots and crosses. This is to be expected as, the closer the desk is to the window, the better the illumination on it.

Sill height of window

The illumination on a desk only comes from that part of the window that is above its surface. The desk receives no illumination from any part of the window that is below its surface. Normally then, the sill of the window will be arranged either at or above desk top height. Where, for some reason or other, the sill of the window is *below* the surface of the desk, then the dots and crosses in the grid below desk height *should not be counted*. Figure 5 explains this.

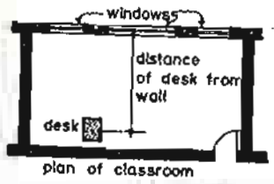


FIGURE 2

distance of desk from wall in cm.	width of one square of grid, cm.
600	60
450	45
300	30
150	15

TABLE 1

The value of the dots and crosses

The value of the dots and crosses has to be known if the illumination on the working surface is to be expressed in units of illumination or Lux units:

One dot has a value of 2 lux
One cross has a value of 1 lux

Thus, in Figure 3 below, the illumination on the desk 600cm from the wall is :-

20 dots	=	40 lux
12 crosses	=	12 lux
TOTAL	=	52 lux

Similarly for the situation in Figure 4, where the desk is 300cm from the wall in the same room, the illumination is :-

78 dots	=	156 lux
48 crosses	=	48 lux
TOTAL	=	204 lux

Of course, as the desk in Figure 4 is nearer to the window than that in Figure 3, it receives more illumination.

The interior finish of the room

The illumination on a desk or other similar horizontal work surface is affected, not only by the size of the windows, but also by inter-reflections of light within the room itself. If the internal finishes are dull and dark, then the inter-reflections will be less and the illumination on the desk somewhat lower, than if the rooms had been finished in lighter colours. This Digest shows how to correct the lux calculation, given above, for two sorts of interior finish, namely:

Finish A — Walls and ceiling of unfinished wood; floor of cement.

Finish B — Walls above sill level – white; Walls below sill level – dark; floor of cement.

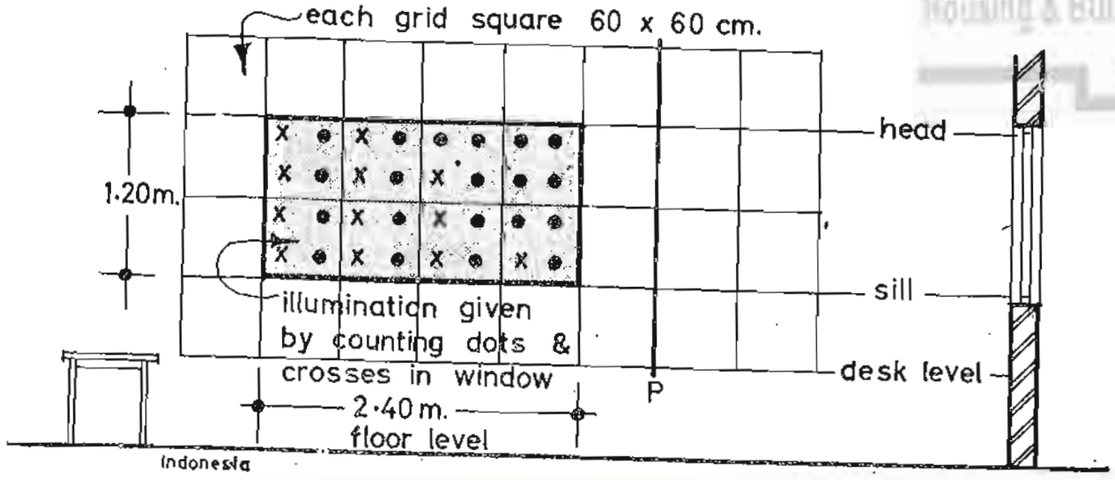


FIGURE 3

TABLE 2 gives the correction factors.

Distance of desk from wall in cm.	Correction per grid square in lux	
	Interior Finish A	Interior Finish B
600	0	+3.0
450	-1.7	0
300	-3.0	-2.0
150	-3.7	-3.5

How is the correction factor applied?

Consider the example shown in Figure 3 – that is of a desk 600cm from the wall. Assume that the room in which the desk stands has Finish B – that is, the room has light finishes –

The method for applying the correction factor for this case is as follows :-

Count *the squares* enclosed by the outline of the window.... there are eight. Multiply the number of squares by the correction factor for Finish B which from Table 2 with a desk at 600cm from the window is, + 3.0

the correction is thus: 8 x 3.0 = 24.0

Now add this to the lux value as calculated by counting dots and crosses.

From dots and crosses, illumination	=	52 lux
correction (see above)	=	24 lux
TOTAL ILLUMINATION	=	76 lux

If the correction factor is negative, then the result of the correction calculation must be deducted from the illumination estimated by counting dots and crosses.

Consider the example in Figure 4 of a desk 300cm from the window wall and assume in this case that the room has Finish A – that is, wood walls and ceiling and cement floor.

The number of squares enclosed by the window in Figure 4 is 32. The correction factor for this example is, from Table 2, shown to be -3.0.

The correction is thus:

(-3.0 x 32) = minus 96 lux

and the illumination of the desk is thus –

from dots and crosses, illumination	= +	204 lux
correction (see above)	= —	96 lux
TOTAL ILLUMINATION	= +	108 lux

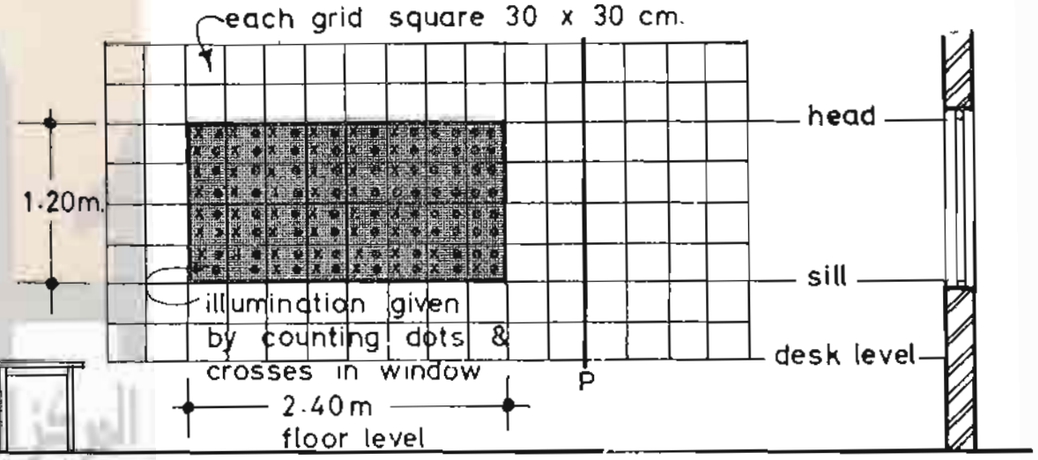


FIGURE 4

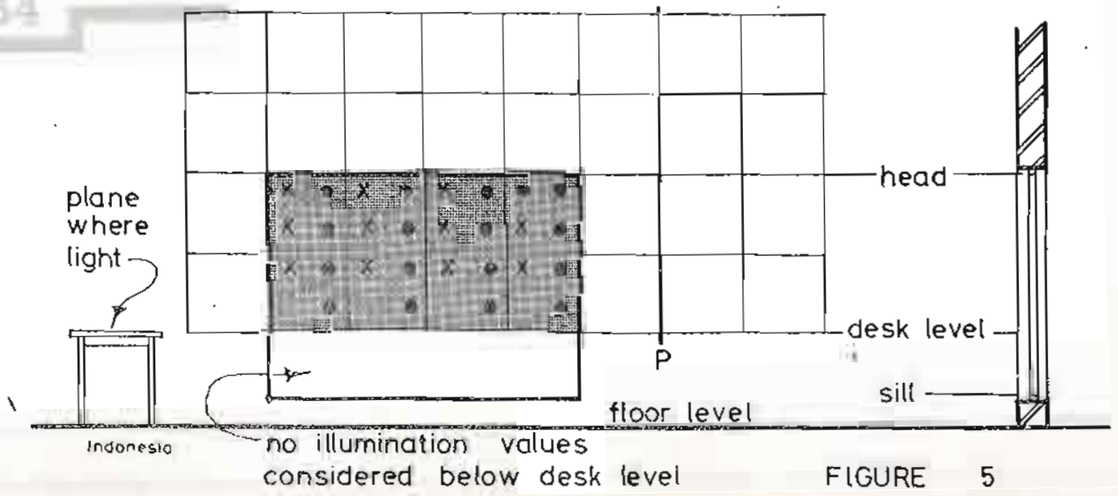


FIGURE 5

vels of Illumination

In the absence of any local regulations or requirements concerning illumination levels in teaching spaces, following can be used as desirable minima :-

Classrooms	108 lux
Laboratories	160 lux
Art Rooms	216 lux
Workshops:	
Coarse work	108 lux
Fine work	432 lux

In general, the finer the work, the greater the illumination needed to undertake it satisfactorily.

The preceeding ideas are now explained below in a ies of practical examples.

***ample 1* – Illumination from a given set of windows**

Figure 6 shows a classroom having light-coloured, " type interior finish and in which it is desired to eck the illumination levels on two desks. (Note:- s not necessary to check the levels on *all* desks; only those in what appear to be the less well illuminated sitions in the room, i.e. desks furthest from the ndows or desks behind piers).

nsider desk I first:-

Fix the scale of the grid from Table 1. The desk 00cm from the wall and thus the size of one square the grid is 60 x 60cm. Take a piece of tracing paper l lay it over the grid. Draw the elevation of *all* windows on it with the point P_1 on the plan, coincidwith the heavy line at P on the grid. Make sure t the desk height, which is the base of the grid, is correctly related to the sill height. Figure 7 shows what should appear on the tracing paper.

Next, count the dots and crosses enclosed by the outlines of *all* the windows and add them together:-

	Dots	Crosses
Window A	12	4
Window B	16	12
Window C	8	2
TOTAL	36	18

1 dot = 2 lux and 1 cross = 1 lux therefore the total illumination is given by:-

2 x 36	=	72
1 x 18	=	18
TOTAL		90 lux

Correcting for finish; the correction factor for Finish A, from Table 2 is 0. The illumination at desk I is thus 90 lux.

Now consider desk II.

The desk is 150cm from the window wall and thus the size of a square on the grid is 15 cm. Take a piece of tracing paper and lay it over the grid. Draw the elevation of all the windows on it with the point P_2 on the plan coinciding with the heavy line at P on the grid. Check that the base of the grid is at the level of the desk and correctly located in relation to the height. Figure 8 shows what should appear on the tracing paper.

It will be noted that the window on the left extends beyond the grid. The part of it outside the grid may be assumed not to contribute to the illumination in the room.

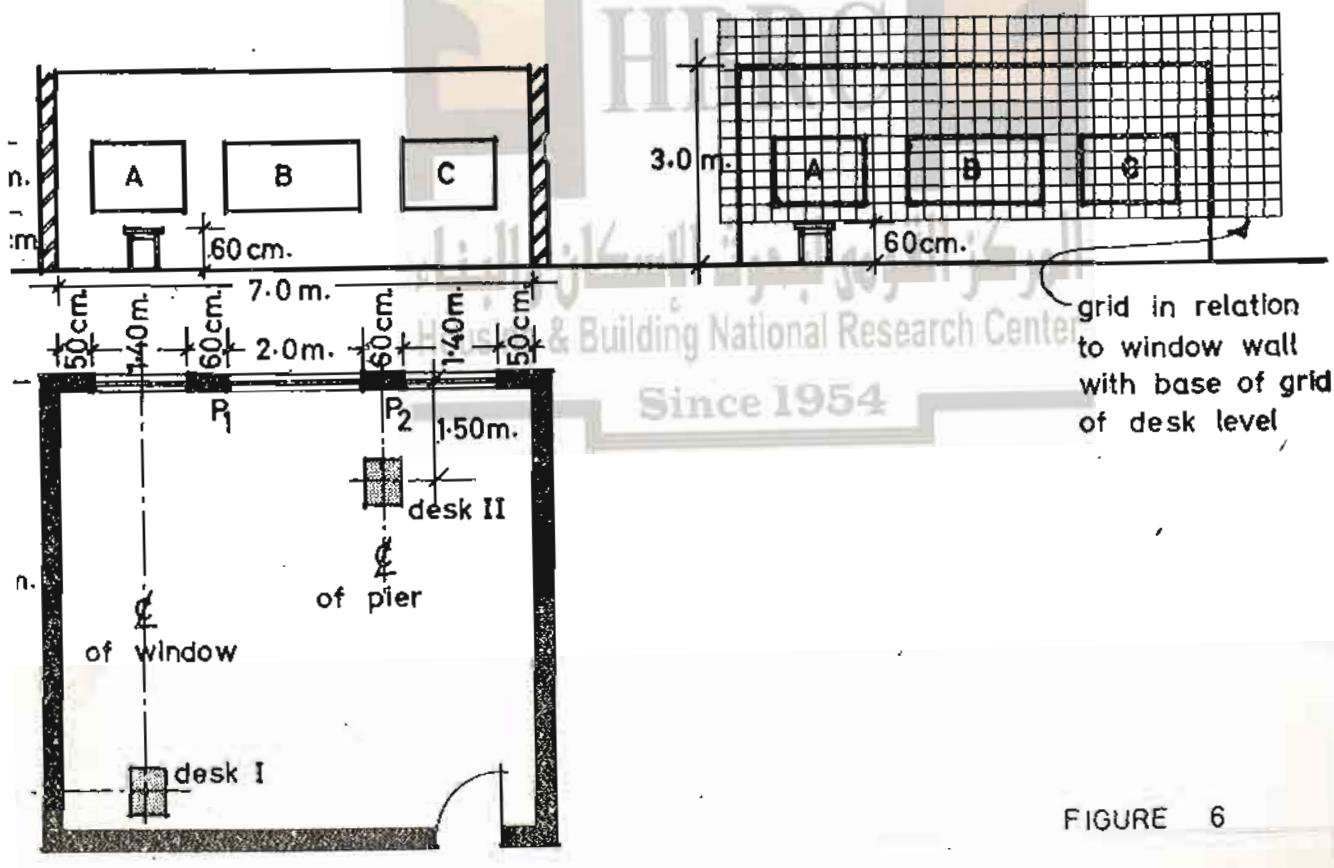


FIGURE 6