## LIGHTING DESIGN

It is essential that the decision about the method of lighting is taken at an early stage in the design of the building and the architect should consult the lighting engineer and others concerned during the conceptual stage. The first step is to establish the general requirements for the artificial lighting in terms of the main visual tasks to be carried out in the building.
The next step is to determine the lighting requirements in terms of revealing the form of the building and helping to create the right character of the interior (sometimes referred to as the ‘Building lighting’). The possibility of changes in the use of the building should consider at this stage.

The architect and the lighting engineer should be able to consider more detailed aspects of the lighting design under the following headings:-

1. The extent to which artificial lighting will be used alone, or to supplement the day lighting
2. The illuminances required for lighting specific visual tasks
3. The required luminance throughout the interior
4. The evaluation of discomfort glare in terms of the whole visual environment
5. The directional characteristics of the lighting required to give the desired modelling effects and to reveal form and texture.
6. The main features of the colour schemes of the building interior in terms of type, chrome and colour rendering.

## LUMEN METHOD OF DESIGN

The Lumen method is the most widely used approach to the systematic design of electric lighting. The method depends essentially on the utilization factor, for example ratio of the lumens which are received on the working plane to the total output of the lamps in the room.

The aim of the lumen method is to give a reasonably even spread of light over the horizontal working plane. How this spread of light is achieved depends upon the way the light is distributed from the fittings, not only in relation to fittings lay be related to the height at which the fittings are mounted over the working plane. The ratio mounting height to the spacing of the fittings will vary with the choice of fitting: the greater the concentration of light distribution from the fitting, the closer must be the spacing relative to the mounting height.

The following equation is used in the lumen method of design:-

$$E = \frac{F \times N \times U \times M}{A}$$

Where:-

E = the average horizontal illumination at the working plane in ***Lux***
F = the lamp lighting design ***Lumens***
N = the number of lamps
U = the utilization factor
M = the maintenance factor
A = the area of the working plane in Square metres ($m^2$)

**UTILISATION FACTOR (U)**

This is the ratio of the lumens received on the working plane to the total flux output of lamps.

**MAINTENANCE FACTOR (M)**

This is a ratio which takes into account the light lost due to an average expectation of dirtiness of light fittings and the room surfaces. For normal conditions a factor of ***0.8*** may be used. For air-conditioned rooms a factor of ***0.9*** may be used, while for an industrial atmosphere where cleaning is difficult, a factor as low as ***0.5*** may sometimes be used.

**SPACING-TO-HEIGHT (SHR)**

Spacing-to-height ratio (SHR) is the centre-to-centre (S) distance between adjacent luminaires to their mounting height (H) above the working plane. Manufacturer's catalogues can be consulted to determine maximum SHR's, e.g. a luminaire with trough reflector is about 1.65 and an enclosed diffuser about 1.4.

**ROOM INDEX**

There is an infinite range of room dimensions but it has been found that the behaviour of light in rooms is a function not of the room dimensions but of the room index, which is the ratio of the area of the horizontal surfaces to that of the vertical surfaces in the room. For the lumen method of design the vertical surfaces are measured from the working plane to the centre of the fitting.
This is expressed by the equation:-

$$\textit{Room Index} = \frac{\textit{Length (m)} \times \textit{Width (m)}}{\textit{Height of light fitting above the working plane( Length + width)}}$$

$$\textbf{Room Index} = \frac{L \times W}{H\,(L + W)}$$

**LIGHTING DESIGN USING THE LUMEN METHOD**

The lighting installation may be designed using the following steps:-

1. Decide upon the illumination required in Lux Calculate the room index
2. Calculate the room index
3. Find the utilization factor for the luminaire to be used.
4. Assume a suitable maintenance factor
5. Calculate the number of fittings from lumen method of design formula
6. From table 1 find the ratio of spacing to mounting height of fitting
7. Draw the layout of the fitting to a suitable scale.

**TABLE 1:** Ratio of spacing to mounting height of fitting

| British Zonal (BZ) classification | Maximum spacing/mounting height ratio |
|---|---|
| 1 and 2 | 1 : 1 |
| 3 and 4 | 1.25 : 1 |
| 5 and 6 | 1.5 : 1 |

**EXAMPLE 1**

A general office measuring 15m x 9m x 3m high is to be illuminated to a design level of 400 lux using 85W fluorescent fittings having a BZ classification of 3. The fittings are to be flush with the ceiling and the working plane is to be 850mm above the floor. Design the lighting system for the office when the installed flux is 8000 lumens per fitting.

E = 400 ***Lux*** F = 8000 ***Lumens***
U = 0.56 M = 0.8
A = 15m x 9m N = the number of lamps ??

The utilization factor can be found from manufacturers' tables from the value of the room index.
*Height of fitting above the working place (H) =* ***1.65***

$$\textit{Room Index} = \frac{L \times W}{H\,(L + W)}$$

$$= \frac{15 \times 9}{1.65\,(15 + 9)} = 3.4$$

The utilization factor from the tables is found to be 0.56 and the maintenance factor of 0.8 may be assumed;

$$E = \frac{F \times N \times U \times M}{A}$$

By transposition;

$$N = \frac{E \times A}{F \times U \times M}$$

$$N = \frac{400 \times (15 \times 9)}{8000 \times 0.56 \times 0.8} = 15$$

In terms of illumination, 15 fittings would provide398 lux and would probably be satisfactory.
In terms of spacing, however, 16 fittings would be required which would provide the following illumination level;

$$E = \frac{8000 \times 16 \times 0.56 \times 0.8}{15 \times 9} = 424.77 \text{ lux}$$

Spacing: The fittings have a BZ classification of 3 and therefore the maximum spacing to mounting height ration is 1.25 : 1 (Refer to Table 1)

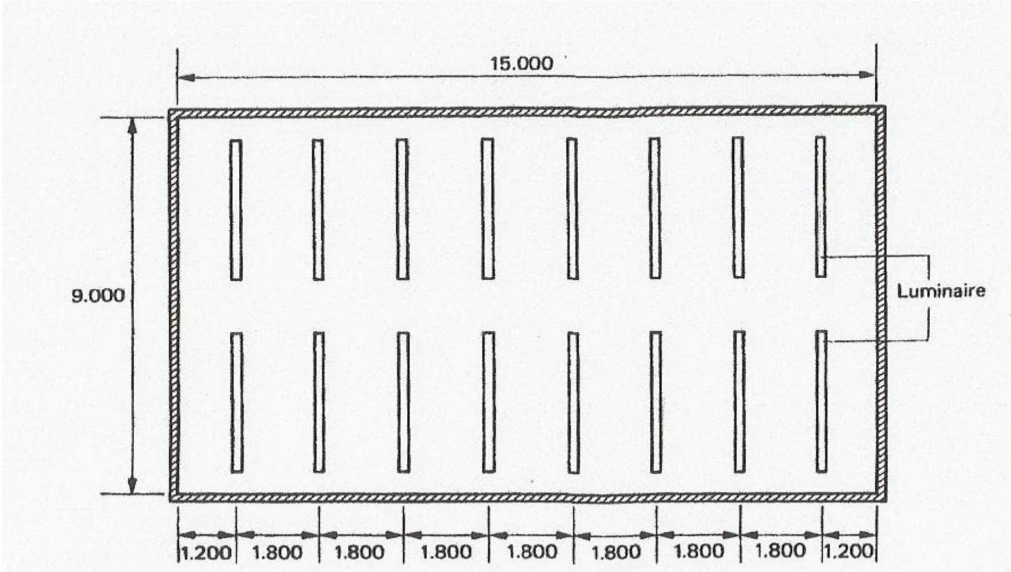
**Mounting height = 3 m – 0.85 m (850mm) = 2.15m**

**Maximum spacing = 2.15 x 1.25 = 2.7 (approx.)** – (centre-to-centre of fittings)

The distances of the fittings from the wall should not exceed half of the above spacing, and less if there is a working surface near to the wall.

The maximum distance from the centre of the fittings to the wall is therefore **2.7/2 = 1.35m**.

Figure 1 shows one method of spacing of the fittings for the office.




**EXAMPLE 2**

An office 8m long by 7m long requires an illumination level of 400 lux on the working plane. It is proposed to use 80 W fluorescent light fittings having a rated output of 7375 lumen each. Assuming a utilization factor of 0.5 and a maintenance factor of 0.8, calculate the number of light fittings required.

| | |
|---|---|
| E = 400 lux | A = 8m x 7m |
| F = 7375 lumens | N = ? |
| U = 0.5 | M = 0.8 |

$$N = \frac{E \times A}{F \times U \times M}$$

$$N = \frac{400 \times 8 \times 7}{7375 \times 0.5 \times 0.8}$$

***N = 7.59 fitting ~ use 8 fittings***