SBS5312 Lighting Technology

http://ibse.hk/SBS5312/

Experiment 1: Lighting Survey and Assessment

Objectives

- To perform a lighting survey to evaluate the visual environment in an indoor space.
- To assess the lighting levels, potential glare problem and energy efficiency of the lighting system.

Introduction

Light is a fundamental factor in any building design. Lighting surveys are the measurement tool of the lighting designer and its main purpose is to gather information concerning the characteristics and the current condition of lighting systems and the lighted environment. It can be used to verify the performance of a lighting installation and improve the efficiency of lighting in the building space.

On site illuminance measurements are the core of any lighting survey and the illuminance can be measured by a portable instrument called a lightmeter or luxmeter. A luxmeter indicates the illuminance at the point of measurement only, not the average in the space. To find the average illuminance in an area at the time, it is necessary to divide the area into a number of equal areas which should be as nearly square as possible. The illuminance at the centre of each square is then measured, and the results averaged. The minimum number of equal areas required for accuracy can be determined by first working out the room index.

$$\text{Room Index (k)} = \frac{\text{Length} \times \text{Width}}{\text{Hm} \times (\text{Length} + \text{Width})} \tag{1}$$

where Hm is the height of the luminaries above the plane of measurement. The working plane is usually taken to be 0.85 m for work benches or 0.72 m for desk top height unless the main plane of the work is known to be some other height above floor level. If the work is performed down to floor level, then the floor is taken as the working plane and plane of measurement. Table 1 shows the minimum number of measurement points required for different accuracy.

Table 1. Minimum number of measurement points

Room index (k)	Minimum number of measurement points	
	± 5%	± 10%
k < 1	8	4
1 ≤ k < 2	18	9
2 ≤ k < 3	32	16
3 < k	50	25

If the proposed points coincide with luminaire positions, or are in constant relationship with the luminaire positions, it is necessary to increase the number of measurement points. It is important to remember that the field measurements are only valid for the conditions which exist at the time of the survey. Therefore, it is important to record the information about the surveyed area, details of the luminaire, condition of interior surfaces (clean or dirty), meter make and serial number, and so on. Photographs showing the prevailing conditions, actual visual environment and the state of luminaries will be useful. Inspection and detection in the building space using human eyes will also be helpful when identifying the common lighting problems.

Theory and Calculations

The lumen method is the most widely used approach to the systematic design of electric lighting and it can be used to estimate the average illumination on a working plane.

$$E = \frac{F \times n \times N \times UF \times MF}{A} \quad (2)$$

where E = average horizontal illuminance on the working plane (lux)
F = lamp lighting design luminous flux (lumens)
n = number of lamps per luminaire
N = number of luminaires
UF = utilisation factor
MF = maintenance factor
A = area of the working plane (m^2)

The utilisation factor *UF* is an experimentally derived factor taking into account the performance of the light fittings, the shape of the room and the reflectances of room surfaces. The maintenance factor *MF* takes into account the light lost due to dirt on the fittings and the room surfaces.

Calculations of illuminance on the working plane ensure that there will be sufficient light for the task. However, they do not indicate the general luminance pattern in the room. To find this, the relative illuminances on the working plane, walls and ceiling must be calculated. Combining these with a knowledge of the surface reflectances enables limited guidance to be made on an acceptable range of luminances, as illustrated in Figure 1.

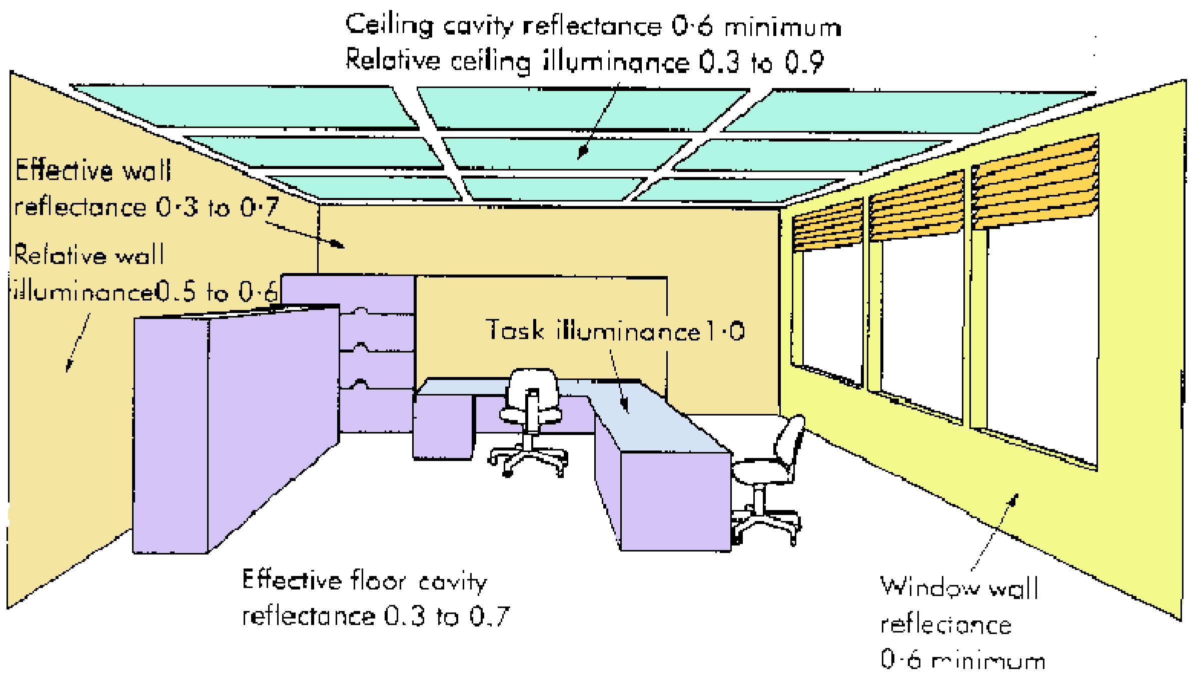

Figure 1. Recommended range of reflectances and illuminances for room surfaces of a working interior (extracted from CIBSE Code for Interior Lighting 2004)

- *Luminance* = the brightness of a surface or a light source ($cd.m^{-2}$)
- *Illuminance* = the amount of light incident on a test area ($lm.m^{-2}$ or lux)

The vast majority of buildings contain windows. In considering the lighting of the indoor space, a decision should be taken on the relative roles of daylight and electric light. If daylight can be integrated effectively with electric light, energy saving and improved indoor environment can often be achieved.

Equipment and Instruments

- Measuring tape
- Laser distance meter (Mileseey S6)
- Digital light meter (LUTRON LX-1108)
- Digital camera, your "eyes" and common sense

Laser distance meter
(Mileseey S6)
http://www.mileseey.net/

Digital light meter (LUTRON LX-1108)
http://www.siliconinstrument.com.sg/pdf/Lutron/LX-1108.pdf

Procedure

General assessment:

1. Check the room dimensions and measure layout of the lighting fittings.
2. Assess the conditions of the surveyed area, interior surfaces (surface colours, reflectances, clean or dirty), daylight availability, weather conditions, etc.
3. Assess the details of luminaire, number of lamps per luminaire, wattage and controls method.

Illuminance measurement for general lighting:

4. Calculate the room index and decide the number of measurement points (assume 5% accuracy).
5. Design a suitable grid or matrix for the measurements.
6. Perform lighting measurements at a horizontal working plane at 0.8 m from the floor for the following conditions:
   - Windows and openings are covered by curtains, blinds or panels to exclude daylight (mainly study the performance of the electric lighting system).
   - Windows and openings are not covered and the electric lighting is switched ON (study the performance of combined electric lighting and daylighting).

Assessment of potential glare or other lighting problems:

7. Select a position in the room where the users usually stay and work. Examine if there is any bright light source or surface in the field of view (take digital photos if necessary).
8. Identify the possible types of tasks, the task position(s), the work plane (horizontal or vertical) and/or the object(s). Measure the illuminance at the task position(s) or object(s).
9. Evaluate the potential glare or other lighting problems in the space (such as improper contrast, poor light distribution, and flicker).

Results

- Present the basic information of the surveyed room, lighting system and visual environment.
- Record the lighting measurements in a tabular format.
- Prepare contour diagrams to show the illuminance gradients or patterns under different lighting conditions.

- Determine the maximum, minimum and average illuminance levels for the different conditions from the measurements.
- Calculate the average illuminance level using the lumen method. The utilisation factor *UF* and maintenance factor *MF* can be determined from the relevant lighting design handbooks or lighting software by selecting luminaires of similar characteristics.
- Assess the risk of glare (direct and reflected) and propose possible mitigation measures.
- Calculate the average lighting power density ($W.m^{-2}$) for the installed wattage of the system (assuming 12% ballast or control gear loss to be added to the wattage). Evaluate the energy efficiency of the lighting system.

Discussions

Based on the results obtained, try to:

- Discuss the factors affecting the accuracy of the lighting measurements.
- Evaluate the visual and energy performance of the lighting installation.
- Recommend some measures for improving the performance of the lighting installation, such as on lighting level, visual comfort, energy efficiency and glare control.

Laboratory Report

Each student should prepare their own report based on the data and information obtained during the experiment. While the results from the observations and measurements can be shared among the members in the same student group, each student shall generate information to show his/her own understanding and ideas. Students making direct copy of the information in other's report (plagiarism), if found, will be disqualified.

The laboratory report shall be submitted within **FOUR weeks** after completion of the experiment.

Useful Information

Labour Department, 2008. *Lighting Assessment in the Workplace*, Occupational Safety and Health Branch, Labour Department, Hong Kong. (http://www.labour.gov.hk/eng/public/oh/Lighting.pdf)

Lighting Ergonomics - Survey and Solutions (Canadian Centre for Occupational Health & Safety) http://www.ccohs.ca/oshanswers/ergonomics/lighting_survey.html

Measurement of illuminance in electrically lit spaces (SLL Fact File No.3, August 2012) http://www.cibse.org/getmedia/aa97f816-c3b9-430a-a585-6fbd94c9e543/Lighting-Factfile-3-b.pdf.as

References

EMSD, 2015. *Code of Practice for Energy Efficiency of Building Services Installation*, 2015 Edition, Electrical and Mechanical Services Department, Hong Kong.

Fetters, J. L., 1998. *The Handbook of Lighting Surveys and Audits*, CRC Press, Boca Raton, Florida. [621.3225 F4]

Raynham, P., 2012. *The SLL Code for Lighting*, Chapter 15: Measurement of lighting installations and interpreting the results, Society of Light and Lighting (SLL), London.

SLL, 2009. *The SLL Lighting Handbook*, Chapter 20: Lighting performance verification, Society of Light and Lighting (SLL), London.

Smith, N. A., 2000. *Lighting for Health and Safety*, Chapter 14: Lighting Surveys, Butterworth-Heinemann, Oxford and Boston.