

Issues of Day Lighting and Combined Illumination

Overview

Light is the part of the electromagnetic radiation spectrum that can be seen by the human eye. The wavelength lies between 400 and 700 nm. Light is divided into:

- Day light, artificial light and joint light
- Dazzles

Measurement and evaluation of light

Luminous Intensity I (unit cd)

is the wavelength-weighted power emitted by a light source in a particular direction per solid angle. It is based on the average visual sensitivity of the human eye to light of different wavelengths. 1 Candela (cd), the SI unit for light strength, is defined as the intensity of monochromatic electromagnetic radiation in a given direction with the frequency of $5,40 \times 10^{12}$ Hz and with the radiant intensity being 1/683 W per steradian.

Steradian (sr) is the SI unit of spatial angle. Spatial/solid angle is a 2D angle in a 3D space, which is subtended by an object. It measures how large that object appears to an observer looking at it from a point. A small object nearby may subtend the same solid angle as a larger object farther away, and therefor appears as the same size. This is why the moon may overlap the sun during an eclipse, even though it's much smaller.

Brightness B (unit cd/m²)

is the perception of the luminance of a visual target

Luminous flux Φ (unit lm)

is the quantity of the energy of the light emitted per second in all directions. 1 Lumen (lm) is defined as the energy of the uniform point light source that has an intensity of 1 cd contained in 1 sr.

Luminosity E (unit lx)

is also called illumination or intensity of lighting. 1 lux (lx) is defined the amount of illumination provided when one lumen is evenly distributed over an area of 1 m².

Natural (day) Lighting

Day lighting is the natural lighting provided by the sun. Lighting provides us with sight which we are largely dependent to perform daily tasks. Humans are adapted to be awake and work during periods of daylight. Light is the strongest zeitgeber (German: time giver) which synchronizes our circadian rhythm to the light and dark cycle. It is known that proper lighting increases human performance and also has positive effects on our psych. In buildings, the the main source of light during daytime is natural lighting, captured by windows. Humans are best adapted to top lighting, i.e. light originating from above, however most of the light is lateral in origin.

Measurement of daylight

Natural light varies throughout the day; therefor the intensity is expressed as factor of day illumination (D). D expresses the ratio between indoor and outdoor daylight.

$$D = E_{\text{int}} / E_{\text{ext}}$$

Evenness of lighting (r) expresses the ratio between minimum and maximum or average D values.

$$r (\text{lateral lighting}) = D_{\text{min}} / D_{\text{max}}$$

$$r (\text{top lighting}) = D_{\text{min}} / D_{\text{avg}}$$

Measurement of day lighting can be done at level of the whole room or at the point of an individual working area. At whole room level, the measurement is done at a comparable level throughout the room, e.g. 0.85-0.90 m above the floor. For individual working areas the measurement is done at that specific place. A day lighting map is created by isolines (called isophots) of factor of illumination. The lines connect places with identical D values.

Daylight factors are used in building design in order to assess the internal natural lighting levels in a work place. It is done in order to see if it ensures sufficient illumination (E) for the supposed activity. A properly designed building should aim to capture as much daylight as possible, because this decreases the need of artificial lighting which is energy consuming and of less quality.

Visual Stress

Visual stress (also called Meares-Irlen syndrome or Scotopic sensitivity syndrome) is the experience of unpleasant visual symptoms when reading. Research has shown that 15 - 20% of people suffer visual stress to some extent. The reader may feel like the text changes in shape, color and clarity or even that the texts moves. This can cause sore eyes, headaches and affect comprehension. Visual stress can affect the development children's reading skills, because it decreases comprehension and makes reading an unpleasant and irritating activity that children will tend to avoid.

Links

Related artcles

- Issues of Artificial Illumination

Bibliography

- BENCKO, Vladimír. *Hygiene & Epidemiology : Selected Chapters*. 2nd edition. Karolinum, 2011. Chapter 1.7.5: Lighting. ISBN 978-80-246-0793-1.

External Links

- Visual Stress (<http://www.lucid-research.com/visualstress.htm>)
- Daylight Factor (http://en.wikipedia.org/wiki/Daylight_factor)
- [http://en.wikipedia.org/wiki/Artificial_light Artificial Light]