7.1.4 Intensity distribution and linear light sources

The distribution of the emission of a point source varies with direction. Nishita et al. (1985) propose the use of point sources with a rotationally symmetric luminous intensity distribution. This distribution may be represented by the curve shown in Fig.7.5. This curve corresponds to the variation of luminous intensity of a lamp including the light center and the illumination axis.

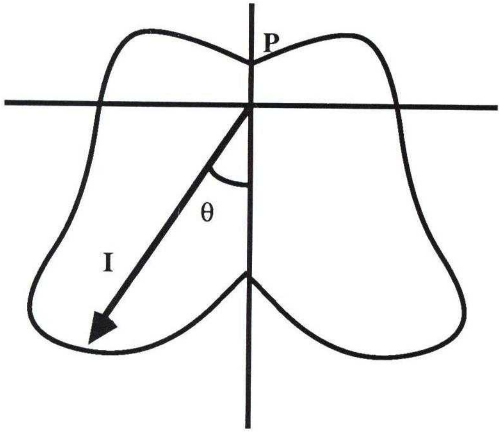

Fig.7.5. Luminous intensity distribution curve. **P** is the point source, **I** is the light intensity $\mathbf{I}_l$(q)

Nishita et al. generally use an intensity distribution such as:

$$I_l(\theta) = \frac{I\,(1 + \cos\theta)}{2} \tag{7.6}$$

where I is the intensity at θ=0.

Only key intensity values (e.g., every 10^o) are given; in-between values are calculated by linear interpolation using look-up tables for the cosine values.

The illuminance E_l from a point light source $\mathbf{P}_l$ at an arbitrary point **P** on a face F is calculated as:

$$E_l = I_l(\theta)\,\frac{\cos\alpha}{r^2} \tag{7.7}$$

where r is the distance between $\mathbf{P}_l$ and **P**, θ is the angle between the illumination axis and the light ray from $\mathbf{P}_l$ to **P**, and α is the angle between the normal of F and the light ray from the source; it is obtained by:

$$\cos\alpha = \frac{d}{r} \tag{7.8}$$

where d is the perpendicular distance between the plane of F and the point light source $\mathbf{P}_l$.

An example is shown in Fig.7.6.

Linear light sources are introduced by Nishita et al. (1985) as linear segments with Lambertian luminous distribution and uniform brightness. Faces that are totally invisible from both end points of the linear source are ignored. When the plane including a face intersects with the linear source, the face receives light from part of the linear source. This means that the linear source must be divided into two parts with the plane. The portion of the visible side of this face is treated as a new light source because the light from the remaining portion is interrupted by the face itself. The illuminance E at an arbitrary point **P** on the face F is calculated as:

Fig. 7.6. Point sources with luminous intensity curves. Courtesy of T. Nishita, Fukuyama University and E. Nakamae, Hiroshima University

$$E = I \int_0^L \frac{\sin\theta \cos\beta}{r^2}\, dl \tag{7.9}$$

where I is the luminous intensity per unit length of the source, L the length of the source, **Q** an arbitrary point of the source, r the distance between **P** and **Q**, and β the angle between the vector **PQ** and the normal of the face F.

Nishita et al. (1985) explain how to calculate the integral in Eq. (7.9) in an efficient way by separating the calculation into three cases: the light source is parallel to F, the light source is perpendicular to F, and the light source forms any angle with F. Similarly Nishita and Nakamae (1983) describe area sources and polyhedron sources with Lambertian distribution characteristics of the sources. Brotman and Badler (1984) also introduce polyhedron sources (see Sect. 9.6.2).