

## Method

The average daylight factor is the mean daylight factor on the horizontal working plane. It is given by the following equation:

$$\bar{D} = \frac{A_g \theta \tau}{A (1 - \rho^2)} \quad (16.4)$$

When there are several windows, with different glazing or different angles of external obstruction,  $\bar{D}$  is calculated for each window separately, and the results are added together. If the windows have similar characteristics the daylight factor can be calculated from the total glazed area.

The symbols in equation (16.4) have the following meanings:

- $A_g$  Glazed area of windows (not including window frames, glazing bars or other obstructions).
- $A$  Total area of enclosing room surfaces (ceiling, floor, walls including windows).
- $\theta$  Angle of visible sky, measured in section from a reference point in the centre of the window opening in the plane of the inside window wall (see Figure 16.7).
- $\tau$  Transmittance of glazing to diffuse light, including the effect of dirt. The diffuse transmittance of clear single glazing is approximately 0.8, clear double glazing approximately 0.7. Typical maintenance factors are given in Chapter 14, Table 14.3 and glass transmittances in section (i).
- $\rho$  Mean reflectance of enclosing room surfaces. During design, this can often be only an educated guess; typical values are 0.5 for a room with white ceiling and light-coloured walls, 0.3 for a normal office or living room. Page 159 contains a list of typical reflectances.

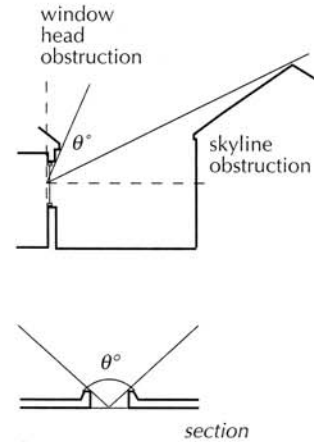
When the method is used at the early design stage to find the area of glazing needed in a room to give a particular average daylight factor, the equation is inverted:

$$A_g = \frac{\bar{D} A (1 - \rho^2)}{\theta \tau} \quad (16.5)$$

The main equation, (16.4), is valid only when the external obstruction gives a horizontal skyline. If the skyline is uneven but the mean height of the obstructions is approximately constant across the skyline, this mean height makes an acceptable approximation. In other cases, such as where a window looks into a courtyard, a different form of the equation can be used:

$$\bar{D} = \frac{A_g 2 D_{sv} \tau}{A (1 - \rho^2)} \quad (16.6)$$

where  $D_{sv}$  is the vertical sky component on the outside window wall, calculated as in section (a) above. In this equation an approximation is made by balancing the light reflected onto the window by the ground and external obstructions against skylight screened by the window head.



**Figure 16.7** Sky angle,  $\theta$ , for a side window and a rooflight. The reference point is the centre of the window opening on the plane of the inside surface.

**Table 10.3** Room appearance and average daylight factor: values associated with rooms in temperate climates

Average daylight factor	
5% or more	The room has a bright daylit appearance. Daytime electric lighting is usually unnecessary.  High levels of daylight may be associated with thermal problems.
2–5%	The room has a daylit appearance but electric lighting is usually necessary in working interiors. Its purposes are:  – to enhance illuminances on surfaces distant from the window, – to reduce contrast with the view outside.  The use of daylight with supplementary electric lighting is often the best choice for energy efficiency.
Below 2%	Electric lighting is necessary, and appears dominant. Windows may provide an exterior view but give only local lighting.

## Example

This calculation finds the mean daylight factor in the office illustrated in Figure 16.1, initially with only the original obstructing building. Assume that the internal reflectances are: ceiling 0.7, wall surfaces 0.4, floor 0.2.

$A_g$	Glazed area 3 windows, each 2.2 m high, 1.3 m wide overall, assuming 20% of total area is obstructed by frame and glazing bars	6.9 m <sup>2</sup>
$A$	Area of enclosing room surfaces Ceiling (32 m <sup>2</sup> ) + walls and windows (72 m <sup>2</sup> ) + floor (32 m <sup>2</sup> )	136 m <sup>2</sup>
$\theta$	Angle of visible sky Measured in section: 90° – 15° (window head) – 18° (obstructing building)	57°
$\tau$	Transmittance of glazing 0.8 (diffuse transmittance of single glazing) × 0.8 (maintenance factor)	0.64
$\rho$	Mean reflectance of room surfaces based on reflectance of ceiling, 0.7; vertical surfaces excluding windows, 0.4; window glazing, 0.1; floor, 0.2	0.41

The room reflectance is an area-weighted mean. That is, each surface area is multiplied by the corresponding reflectance, and the total of these is then divided by the total area:

$$\frac{32 \times 0.7 + 65.1 \times 0.4 + 6.9 \times 0.1 + 32 \times 0.2}{136} = 0.408$$

Then, using equation (16.4):

$$\bar{D} = \frac{6.9 \times 57 \times 0.64}{136 \times (1 - 0.41^2)} = 2.225\% \approx 2\%$$

The method in its alternative form (equation (16.6)) makes it possible to compare the original obstruction with the total shading caused by the new obstruction. We use the vertical sky components calculated in section (a) above:

$D_{sv}$	Vertical sky component	with existing building	33.5%
		with proposed extension	30.75%

Then:

$$\bar{D} \text{ (original obstruction)} = \frac{6.9 \times 2 \times 33.5 \times 0.64}{136 \times (1 - 0.41^2)} \approx 2.6\%$$

$$\bar{D} \text{ (with new extension)} = \frac{6.9 \times 2 \times 30.75 \times 0.64}{136 \times (1 - 0.41^2)} \approx 2.4\%$$

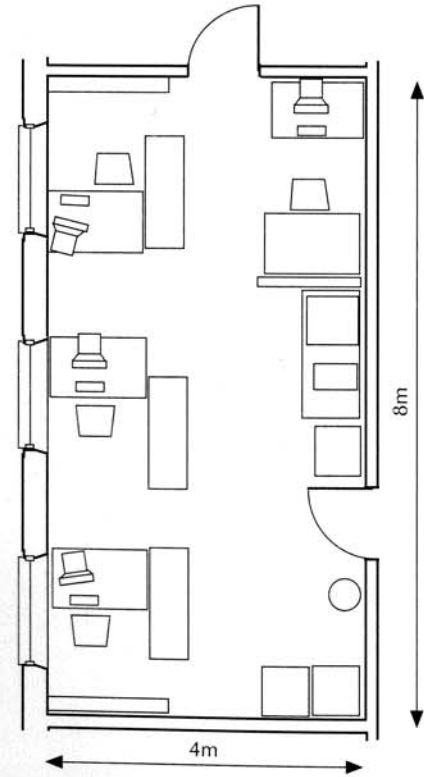
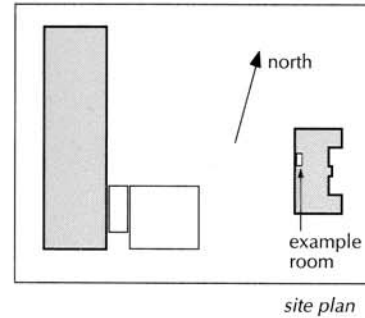
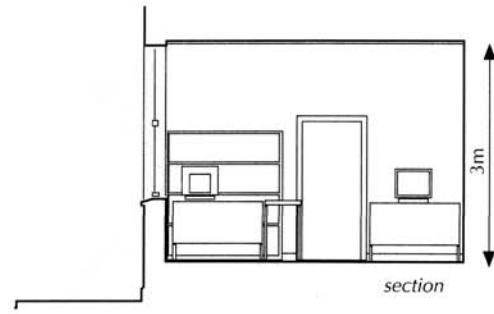


Figure 16.1 Example building.