On the other hand, the smooth form of the curves of Figure 20.19 suggests that it may be possible to describe them analytically, thus avoiding the need to use a computer each time a particular value is required. A convenient way of doing it is, first, analysing the correspondence between the optimal inclination angle and latitude. It is worth noting that the larger the latitude, the larger the difference between summer daytime and winter daytime and, in turn, the larger the difference between the summer and the winter irradiation. Therefore, it can be anticipated that as latitude increases, the optimal inclination angle should progressively give priority to the collection of summer over the collection of winter. This can be observed in Figure 20.20, where the values of $\beta_{\text{opt}} - |\phi|$ have been plotted against the latitude, for the 30 above-mentioned different locations.

It is useful to fit a linear equation to these values

$$\beta_{\text{opt}} - |\phi| = 3.7 - 0.31|\phi| \quad \text{or} \quad \beta_{\text{opt}} = 3.7 + 0.69|\phi| \tag{20.50}$$

where β and ϕ are given in degrees. It is worth mentioning that the observed dispersion of the cluster of points around equation (20.50) (also depicted in Figure 20.20) is, in fact, of negligible importance, due to the very low sensibility of the energy collection to deviations from the optimal inclination angle. For example, the point corresponding to Delhi ($\phi = 28.6^\circ$) – marked as ♥ in the figure – indicates a value of $\beta_{\text{opt}} = 29.6^\circ$, while equation (20.50) leads to $\beta_{\text{opt}} = 23.4^\circ$. The 6.2° of difference can appear relatively large (≈20%), but a detailed simulation exercise would disclose that $G_{\text{dy}}(23.4^\circ)/G_{\text{dy}}(29.6^\circ)$ is 99%, that is, such a difference is irrelevant when translated into energy content. A similar reasoning also justifies the validity of the usual assumption $\beta_{\text{opt}} = \phi$. Now, a second-order polynomial describes very well the curves of Figure 20.19.

$$\frac{G_{\text{dy}}(\beta)}{G_{\text{dy}}(\beta_{\text{opt}})} = 1 + p_1(\beta - \beta_{\text{opt}}) + p_2(\beta - \beta_{\text{opt}})^2 \tag{20.51}$$

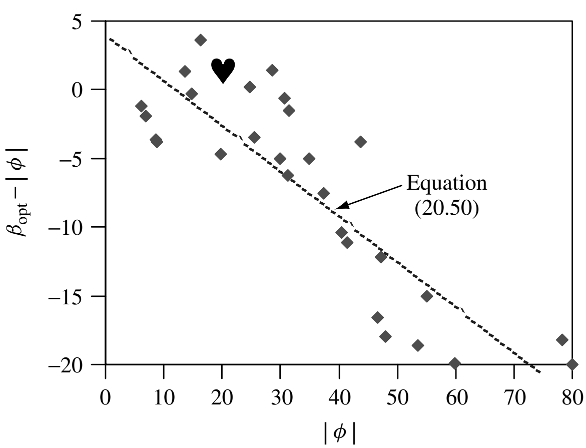

Figure 20.20 Optimal inclination angle versus latitude. The difference between $\beta_{\text{opt}} - |\phi|$ is plotted against the latitude $|\phi|$. The cluster of points corresponds to the different places listed in Table 20.5