When $\theta_{\text{max,in}}$ is 1/4°, as for the sun, this equation gives a maximum concentration ratio of 100. We see that the parabola is not an ideal concentrator, but at a rim angle of 45° it does achieve half of the maximum possible concentration. As the rim angle becomes small, it actually approaches an ideal concentrator because then $\cos\theta_r \approx 1$, but at small rim angles the concentration ratio is also lowered. A parabola can be used in conjunction with various secondary concentrators located at the receiver to boost the concentration toward the ideal. If we have an ideal secondary concentrator that transforms $\theta_{\text{max},r}$ into $\theta_{\text{max,out}}$, then it would have a concentration of $C_{\text{secondary}} = \sin\theta_{\text{max,out}}/\sin\theta_{\text{max},r}$. The combined concentration of the parabola and secondary is

$$C_{\text{tot}} = C_{\text{secondary}} C_{\text{parabola}} = \cos\theta_{\text{max},r} \frac{\sin\theta_{\text{max,out}}}{\sin\theta_{\text{max,in}}}$$

This differs from an ideal concentrator of maximum output angle and high concentration by the cosine of the rim angle and approaches an ideal for small rim angles. In practice, small rim angles result in a rather unwieldy shape and a compromise is sought. The f-numbers in the range of 0.7 to 1 are usually specified when using a secondary concentrator.

For three-dimensional paraboloidal concentrators, one squares the above ratios to get the concentration. Specifically,

$$C = \cos^2\theta_{\text{max},r} \left(\frac{\sin\theta_{\text{max},r}}{\sin\theta_{\text{max,in}}}\right)^2$$

and at a rim angle of 45°, we have

$$C = \frac{1}{4}\left(\frac{1}{\sin\theta_{\text{max,in}}}\right)^2$$

This gives a concentration ratio of 10 000 for a perfect paraboloid with $f = 0.6$.

Parabolic dishes are thus capable of quite high-concentration ratios. In practice, slope errors, or waviness in the reflective surface, degrade the performance. This can be analyzed to first approximation by realizing that a slope error of value θ_s will cause the reflected ray to deviate from the intended path by $2\theta_s$, and this will add to the angle of arrival $\theta_{\text{in,max}}$. A high-quality paraboloid for solar concentration use might have $\theta_s = 1/8°$, thus doubling the divergence of light from the sun from 1/4° to 1/2°. This has the effect of decreasing the concentration by one-fourth, to 2500 for a three-dimensional concentrator, or one-half, to 50, for a two-dimensional trough. Detailed designs should be conducted with actual ray-tracing programs, but this gives an idea of the results that can be achieved.

Parabolic concentrators are more highly developed for solar thermal applications in which high temperature is desired and flux uniformity is not so big an issue as with PV receivers. The successful Luz trough concentrators generate heat for steam turbines and have a combined output of over 300 MW [48]. A comprehensive review of parabolic dishes for solar thermal applications is given in [49].

In practice, reflective dishes can achieve higher concentration than desired for PV receivers. There is no need for SOEs to increase concentration, so the concentration ratio