The accuracy of different transfer matrix approaches, widely used to solve the stationary effective mass Schrödinger equation for arbitrary one-dimensional potentials, is investigated analytically and numerically. Both the case of a constant and a position-dependent effective mass are considered. Comparisons with a finite difference method are also performed. Based on analytical model potentials as well as self-consistent Schrodinger-Poisson simulations of a heterostructure device, it is shown that a symmetrized transfer matrix approach yields a similar accuracy as the Airy function method at a significantly reduced numerical cost, moreover avoiding the numerical problems associated with Airy functions.