Planform and Dihedral Considerations

Figure 1 compars the span efficiency of wings with three types of taper and no washout twist. The additional benefit of going from a single taper to double taper is very modest, and has to be weighed against greater structural complexity.

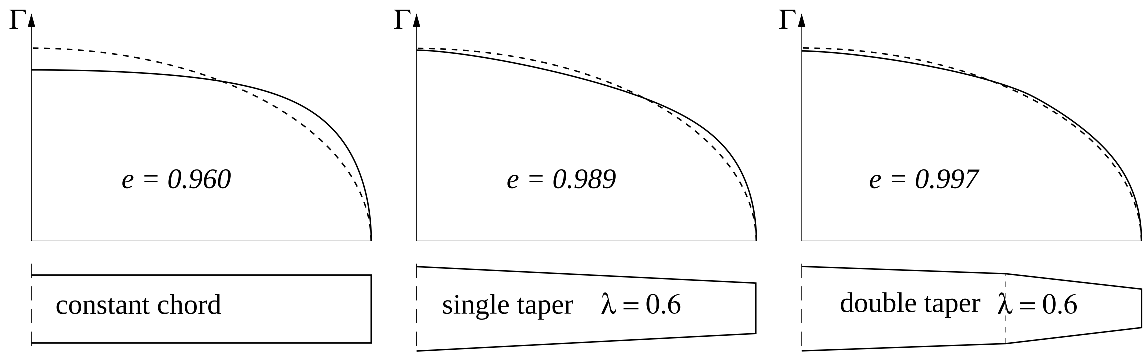

Figure 1: Span efficiency of three different planform untwisted wings. Dashed lines are elliptical loadings with the same lift.

A meaningful way to define the taper ratio λ for a multi-taper wing is in terms of the root chord c_r and average chord c.

$$c_r \;=\; c\,\frac{2}{1+\lambda} \qquad\qquad \lambda \;=\; 2\,\frac{c}{c_r} \;-\; 1$$

This λ definition reduces to the usual definition $\lambda = c_t/c_r$ for a straight-taper wing. Because the root chord c_r dominates the structural bending properties of a wing, any two wings with the same area, span, and λ values will likely have very similar bending properties, regardless of the planform details.

Figure 2 shows different types of dihedral layouts. The theoretically ideal dihedral distribution for rudder/elevator control is a shallow arc or parabola, in that it gives the smallest induced drag increases during rolling maneuvers and steady turns. But the induced drag differences are typically less than 2%, and arc dihedral is difficult to manufacture. Hence, the arc dihedral is typically approximated to varying degrees by discrete panels, from the simplest V-dihedral to multiple-panel polyhedral layouts.

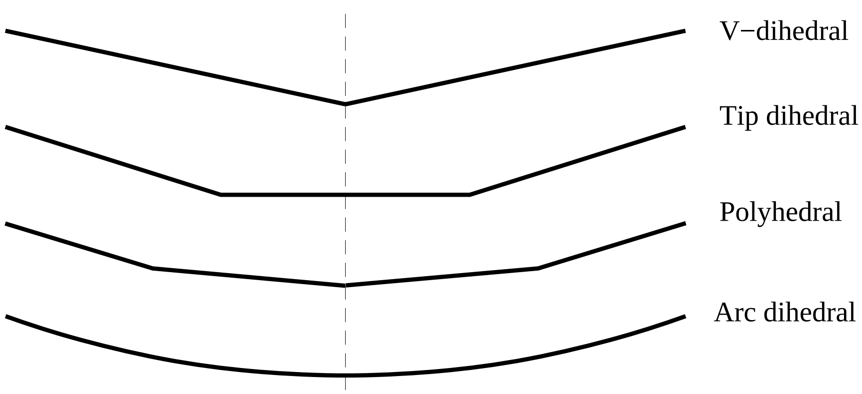

Figure 2: Different dihedral layouts approximating the ideal continuous arc dihedral distribution.