

Airplane Flying Handbook



U.S. Department
of Transportation

Federal Aviation
Administration



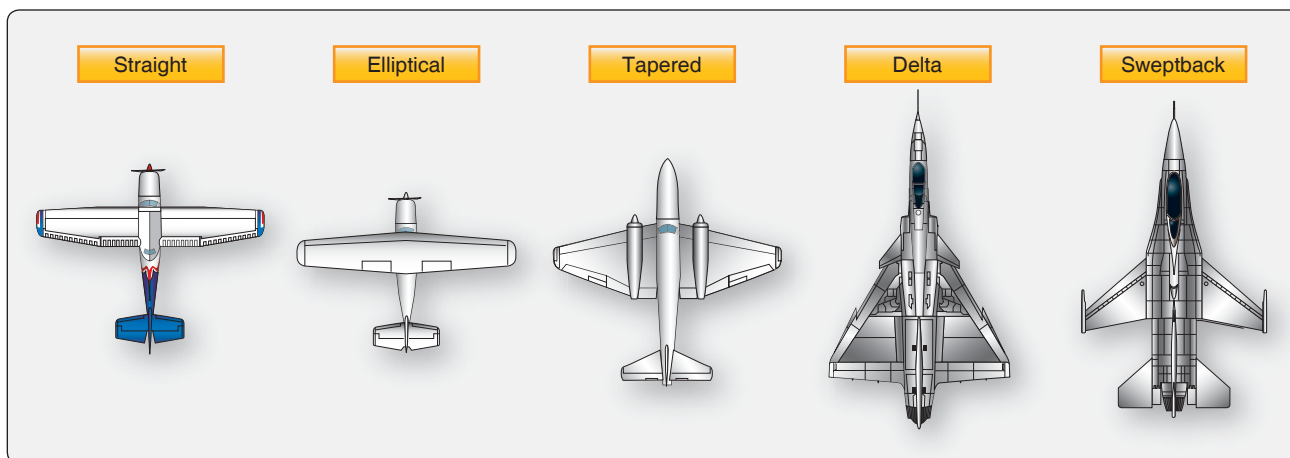


Figure 11-1. Airfoil types.

Transition to a complex airplane, or a high-performance airplane, can be demanding for most pilots without previous experience. Increased performance and complexity both require additional planning, judgment, and piloting skills. Transition to these types of airplanes, therefore, should be accomplished in a systematic manner through a structured course of training administered by a qualified flight instructor.

Airplanes can be designed to fly through a wide range of airspeeds. High speed flight requires smaller wing areas and moderately cambered airfoils whereas low speed flight is obtained with airfoils with a greater camber and larger wing area. [Figure 11-1] Many compromises are often made by designers to provide for higher speed cruise flight and low speeds for landing. Flaps are a common design effort to increase an airfoil's camber and the wing's surface area for lower speed flight. [Figure 11-2]

Since an airfoil cannot have two different cambers at the same time, one of two things must be done. Either the airfoil can be a compromise, or a cruise airfoil can be combined with a device for increasing the camber of the airfoil for low-speed flight. Camber is the asymmetry between the top and the bottom surfaces of an airfoil. One method for varying an airfoil's camber is the addition of trailing-edge flaps. Engineers call these devices a high-lift system.

Function of Flaps

Flaps work primarily by changing the camber of the airfoil which increases the wing's lift coefficient and with some flap designs the surface area of the wing is also increased. Flap deflection does not increase the critical (stall) angle of attack (AOA) and, in some cases, flap deflection actually decreases the critical AOA. Deflection of a wing's control surfaces, such as ailerons and flaps, alters both lift and drag. With aileron deflection, there is asymmetrical lift which imparts a rolling moment about the airplane's longitudinal

axis. Wing flaps acts symmetrically about the longitudinal axis producing no rolling moment; however, both lift and drag increase as well as a pitching moment about the lateral axis. Lift is a function of several variables including air density, velocity, surface area, and lift coefficient. Since flaps increase an airfoil's lift coefficient, lift is increased. [Figure 11-3]

As flaps are deflected, the aircraft may pitch nose up, nose down or have minimal changes in pitch attitude. Pitching moment is caused by the rearward movement of the wing's center of pressure; however, that pitching behavior depends on several variables including flap type, wing position, downwash behavior, and horizontal tail location.

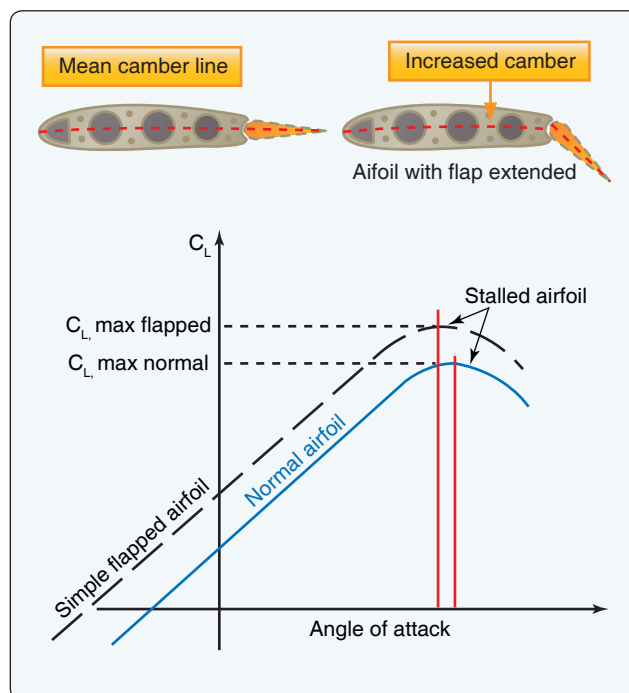


Figure 11-2. Coefficient of lift comparison for flap extended and retracted positions.