Control effectiveness and reversal:-

The flexibility of the major aerodynamic surfaces (wing, vertical and horizontal tails) adversely affects the effectiveness of the corresponding control surface (ailerons, rudder and elevators). For example the downward deflection of an aileron causes a nose-down twisting of the wing which consequently reduces the aileron → incidence thus the wing twist tends to reduce the increase in lift produced thereby the rolling moment to a value less than that for a rigid wing. The aerodynamic twisting moment on the wing due to aileron deflection increases as the square of the speed but the elastic restoring moment is constant since it depends on the torsional stiffness of the wing structure. Therefore, ailerons become markedly less effective as the speed increases until, at a particular speed, the aileron reversal speed aileron deflection does not produce any rolling moment at all. At higher speeds reversed aileron movements are necessary in that a positive increment of wing lift requires an upward aileron deflection and vice versa.

Similar, less critical problems arise in the loss of effectiveness and reversal of the rudder and elevator controls. They are complicated by the additional deformations of the fuselage and tailplane-fuselage attachment points which may be as important as the deformations of the tailplane itself. We shall concentrate in this section on the problem of aileron effectiveness and reversal.