

6.1 Total Drag

- Total drag is the sum of two main components:
- $\text{Total Drag} = \text{Parasite Drag} + \text{Induced Drag}$

6.2 Parasite Drag

- Parasite drag includes all types of drag that are not associated with the production of lift. It
- increases as the square of the airspeed. If you double your speed, you quadruple your
- parasite drag. It is made up of three components:
- ☐ Skin Friction Drag: Arises from the friction of the air moving over the aircraft's surfaces. It
- is affected by the smoothness of the surface and the nature of the
- boundary layer (the thin layer of air closest to the surface). The boundary layer can be
- smooth (
- laminar) or chaotic (turbulent). Turbulent flow produces more skin friction drag but is more
- resistant to separation. 126126126126
- ☐ Form (Pressure) Drag: Results from the pressure differential created by the separation of
- the boundary layer from the surface of a body. 127A streamlined shape (like an aerofoil) is
- designed to minimize this separation and reduce form drag.
- ☐ Interference Drag: This is generated by the mixing of airflows at the junctions of aircraft
- components, such as the wing root where it joins the fuselage. Fillets are used at these
- junctions to smooth the airflow and reduce interference drag.

6.3 Induced Drag

- ☐ As discussed previously, induced drag is an inherent by-product of lift generation from a
- finite wing.
- ☐ It is caused by the wingtip vortices tilting the lift vector rearward.
- ☐ Induced drag is highest at low airspeeds (high AOA) and decreases as airspeed increases.

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6.4 The Total Drag Curve

- ☐ This curve plots the different drag components against airspeed.
- ☐ Low Speeds (High AOA): Induced drag is the predominant force.
- ☐ High Speeds (Low AOA): Parasite drag is the predominant force.
- ☐ Vmd (Minimum Drag Speed): There is a specific airspeed where the total drag is at its minimum. This speed is known as Vmd. It occurs at the point where the induced drag curve and the parasite drag curve intersect (i.e., induced drag equals parasite drag).
- ☐ Flying at Vmd corresponds to the optimum angle of attack for the maximum L/D ratio.

6.5 Factors Affecting the Drag Curve

- ☐ Aircraft Weight: An increase in weight requires more lift for level flight. This increases induced drag at all speeds, shifting the total drag curve up and to the right, resulting in a higher Vmd.
- ☐ Configuration: Lowering landing gear or flaps increases the frontal area and disrupts airflow, significantly increasing parasite drag. This shifts the total drag curve upward, increasing total drag at all speeds and decreasing the Vmd.
- ☐ Altitude: If an aircraft is flown at a constant IAS, the dynamic pressure is constant, and therefore the drag will not vary with altitude.

6.6 Speed Stability

- Speed stability refers to an aircraft's tendency to maintain a constant airspeed. It is directly related to the drag curve and thrust available.
- ☐ Stable Region (Front Side of the Drag Curve): At speeds above Vmd, if a disturbance causes the speed to decrease, the drag also decreases. Since thrust is now greater than drag, the aircraft accelerates back to its trim speed. This is a region of stable speed.
- ☐ Unstable Region (Back Side of the Drag Curve): At speeds below Vmd, if a disturbance causes the speed to decrease, the drag increases due to the sharp rise in induced drag. Since

- drag is now much greater than thrust, the aircraft will continue to decelerate unless the pilot
- intervenes by adding thrust. This is a region of unstable speed, often called the "region of
- reversed command."

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