**12. FLOW OVER SUBMERGED BODIES**

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| 1. When a fluid flows and passes the submerged body with a relative velocity (), every differential surface area experiences a pair of forces due to Pressure & Wall shear stress. 2. Therefore, the body observes a net resultant force, which has 2 components,    1. Drag Force: Along the axis of    2. Lift Force: Perpendicular to the direction of | | |  |
|  | = Shear or Friction Drag | Pressure Drag | |

|  |  |
| --- | --- |
| **CLASSIFICATION OF BODY** | |
| **STREAMLINE BODY** | **BLUFF BODY** |
| A body whose surface coincides with the streamlines of flow. | A body Which obstructs the streamlines of flow is known as bluff or blunt body. |
| Pressure Drag is very low & total drag is also less. | Relatively Higher Pressure Drag & Total Drag is high. |
| Boundary layer separation is low. Hence, lesser eddies and subsequent losses. | Boundary layer separation is high. Hence, Higher eddies and subsequent losses. |
| E.g. Fishes Shape, Aerofoil, Hydrofoils, etc… | E.g. Cylinders, etc… |

**DRAG FORCE:**

|  |  |  |
| --- | --- | --- |
|  | Coefficinet of Drag  Characteristic area | |
|  | |  |

**POWER LOST DUE TO DRAG:**

mostly acting in the direction opposite to desired motion of the body.

**LIFT FORCE:**

|  |  |
| --- | --- |
|  | Coefficinet of Lift  Plan area |

**Note:** If effective area is mentioned, then replace With

|  |  |
| --- | --- |
| **DRAG ON SPHERES:**   1. If , the flow is known as **Stokes Flow**. And Stokes Law is valid. | **STOKES LAW:**  **For Stokes Law,** |
| **Q.** Obtain Terminal Velocity of a sphere falling(down) under gravity in a dense and viscous fluid. Assume stokes law is valid.  At equilibrium Condition, | **TERMINAL VELOCITY:**  The constant Velocity obtained by a body when it reaches equilibrium. |

**DRAGS ON CYLINDERS:**

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| When the , The vortices in the region of wake become highly unstable loading to shading of vortices. This phenomenon is referred as “Karman Vortex Trails” (Shown in fig.). | | Development and Characterization of an Aeroelastic Instability Energy  Harvester |
| Frequency of vortex Shading |  | |

If the Frequency of vortex shading matches with the natural frequency of cylinder, then resonance takes place. Due to resonance a sound is developed & it’s known as singing of wires.

**MAGNUS EFFECT:** The lifting effect generated on rotating body when it’s placed in a stream of flow. E.g. Lifting of table tennis ball When given a spin, etc…

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| **LIFT ON CYLINDER:**   |  |  | | --- | --- | |  | Density of Fluid | | Free Stream Velocity of Fluid relative to the body | **Circulation** | | Length of the Cylinder |  1. on Cylinder Experiencing Magnus Effect 2. Velocity on a cylinder Experiencing magnus Effect:   Condition for a single stagnation point, | Does the Magnus effect relate to fluid mechanics? - Quora |
| If |
| If |
| **AEROFOILS:** Stall Condition:   |  |  |  |  | | --- | --- | --- | --- | | Area | Aspect Ratio | Span | Chord | | Angle of Attack | |  | |   At stall Condition, 1) BL Separation take place, 2) drastically increases  Circulation around an aerofoil,  Lift Force on aerofoil,  For Aerofoil, | Angle of Attack - AviationChief.Com |

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| --- | --- | --- | --- | --- | --- |
| **UNDER STEADY LIFT OF AEROPLANE:**  In the Steady State Condition,  Forces Acting/Developed in the Aeroplane,   |  |  | | --- | --- | | Drag Force | Lift Force | | Weight of The Aeroplane | Thrust Developed by Aeroplane |   Power Required to overcome Drag, | Drag |