



a) THE CROSS-SECTIONAL AREA OF THE STREAMTUBE IS LARGER AT (b) THAN AT (a). SINCE FLOW IS INCOMPRESSIBLE, $\rho = \text{CONST.}$

$\therefore V_a > V_b$

b) STEADY FLOW, NO ACCEL OF C.V.

$$\sum F_x = R_x + \int p dS = \int \rho u_x \vec{u} \cdot \vec{n} dS$$

NOTES: a) BY SYMMETRY PRESSURE FORCES ON UPPER AND LOWER STREAMSURFACES WILL BALANCE \therefore ONLY NEED TO CONSIDER PRESSURE FORCES ON LEFT AND RIGHT SURFACES OF C.V.

b) SINCE UPPER AND LOWER SURFACES ARE STREAMLINES (EVERYWHERE PARALLEL TO FLOW) THERE IS NO FLUX ACROSS THEM. NEED ONLY CONSIDER FLUX TERMS ON LEFT AND RIGHT SURFACES OF C.V.

$$R_x + P_a S - P_b S = \rho V_a \cos \beta_a (-V_a \cos \beta_a) S + \rho V_b \cos \beta_b (V_b \cos \beta_b) S$$

MASS FLOW THROUGH SURFACE AT (a) = $\rho V_a \cos \beta_a S$

MASS FLOW THROUGH SURFACE AT (b) = $\rho V_b \cos \beta_b S$

MUST BE EQUAL SINCE NO OTHER FLUXES IN OR OUT OF C.V.

$\therefore R_x = (P_b - P_a) S = \text{force on c.v., meaning force on blade is } \leftarrow \text{ DIRECTION}$

$$\sum_i F_x = R_y + \int_S P dS = \int_S \rho u_y \vec{u} \cdot \vec{n} dS$$

No y-force on left
 & right surfaces
 pressures on top & bottom
 surfaces are equal

$$R_y = \rho V_a \sin \beta_a (-V_a \cos \beta_a) S + \rho V_b \sin \beta_b (V_b \cos \beta_b) S$$

$$R_y = \rho S V_a \cos \beta_a [V_b \sin \beta_b - V_a \sin \beta_a] \quad (< 0)$$

= FORCE ON C.V.

∴ FORCE ON BLADE IS IN +y-DIRECTION