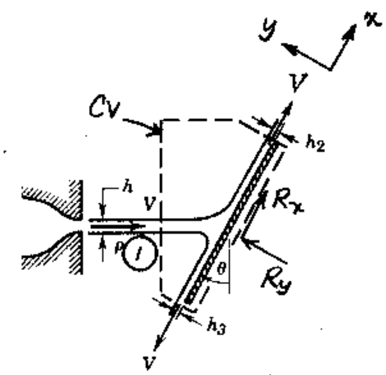
Given: Plane jet striking inclined plate, as shown. No frictional force along plate surface.

Find: (a) Expression for h_2/h as a function of θ.
(b) Plot of results.
(c) Comment on limiting cases, $\theta = 0$ and $\theta = 90°$.

<u>Solution</u>: Apply the x component of the momentum equation using the CV and coordinates shown.

Basic equation:



$$F_{S_x}^{=0(1)} + F_{B_x}^{=0(2)} = \frac{\partial}{\partial t}\int_{CV} u\rho\, d\forall^{=0(3)} + \int_{CS} u\rho \vec{V}\cdot d\vec{A}$$

Assumptions: (1) No surface force on CV
(2) Neglect body forces
(3) Steady flow
(4) No change in jet speed: $V_1 = V_2 = V_3 = V$
(5) Uniform flow at each section

From continuity for uniform incompressible flow $0 = -\rho V w h + \rho V w h_2 + \rho V w h_3$

or

$$h = h_2 + h_3 = h_1 \quad \text{or} \quad h_3 = h_1 - h_2$$

From momentum

$$0 = u_1\{-|\rho V w h_1|\} + u_2\{+|\rho V w h_2|\} + u_3\{+|\rho V w h_3|\}$$

$$u_1 = V\sin\theta \qquad u_2 = V \qquad u_3 = -V$$

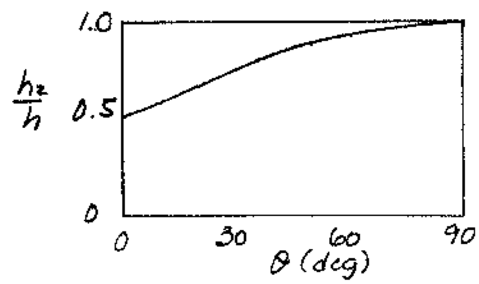
$$0 = -\rho V^2 \sin\theta\, w h_1 + \rho V^2 w h_2 - \rho V^2 w h_3$$

Substituting from continuity and simplifying

$$0 = -\sin\theta\, h_1 + h_2 - (h_1 - h_2) \quad \text{so} \quad \frac{h_2}{h} = \frac{h_2}{h_1} = \frac{1+\sin\theta}{2}$$

$\frac{h_2}{h}$

Plot:



At $\theta = 0$, $\frac{h_2}{h} = 0.5$; flow is equally split when plate is $\perp$ to jet.

At $\theta = 90°$, $\frac{h_2}{h} = 1.0$; plate has no effect on flow.