SA/L03 30/11

Effects of viscosity & gravity

Viscosity — inertial / viscous

$$Re = \frac{VR}{\nu}$$

$R = \frac{\text{area}}{\text{perimeter}}$

500 — 12500 transitional (inclusive)

Gravity

Froude Number — $\sqrt{\frac{\text{inertia}}{\text{gravitational}}}$

$$Fr = \frac{V}{\sqrt{gD}}$$

$D = \frac{A}{B}$ — $\frac{\text{area}}{\text{top width}}$

Combined eff. state of flow

wide channel

$b >> h$

$m^3/s/m$ (per meter width)

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side slope → j : j

side : ~~ht~~

Ex. 1.1



Celerity

$C \rightarrow g/d$

Ex. 1.2

Velocity distribution



Velocity distribution

Kinetic energy of flow passing ΔA per unit time

$$\frac{1}{2} m u^2$$

$$\frac{1}{2} \rho \Delta V \times u^2$$

$$\frac{1}{2} \rho \Delta A L u^2$$

$$\frac{1}{2} \rho \Delta A \frac{1}{t} u^2$$

$$\frac{1}{2} \rho \Delta A u \times u^2$$

$$= \frac{\rho}{2} u^3 \Delta A$$

$$\frac{\rho}{2} \int_0^A u^3 dA$$

$$\alpha \frac{\rho}{2} v^3 A = \frac{\rho}{2} \int_0^A u^3 dA$$

$$\Rightarrow \alpha = \cdots$$

velocity distribution coeff.

$$V = \frac{Q}{A} = \frac{1}{A}\int_0^A u\,dA$$

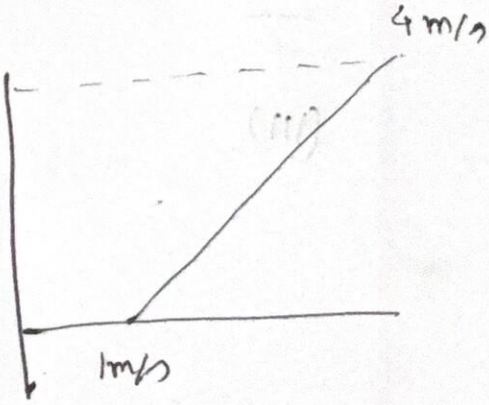
α, β

$$\beta = \frac{\int_0^A u^2\,dA}{V^2 A} \simeq \frac{\Sigma u^2 \Delta A}{V^2 A}$$

$\alpha > \beta$ usually

Ex 1.4

$$u = 1 + \frac{3z}{h}$$



velocity profile

$Q = AV$

$\Rightarrow \frac{Q}{b} = \frac{A}{b} V$

$\Rightarrow q = hV$

Sol: Alt 1: $V = \frac{1}{A}\int_0^A u\,dA = \frac{1}{h}\int_0^h u\,dz = \frac{1}{h}\int_0^h \left(1 + \frac{3z}{h}\right) dz$

$= \ldots = 2.5$ m/s

Alt 2: $\bar{V} = \frac{1+4}{2} = 2.5$ m/s

(i) $q = \bar{v}h = 2.5 \times 5 = 12.5 \ m^3/s/m$

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Wide channel,

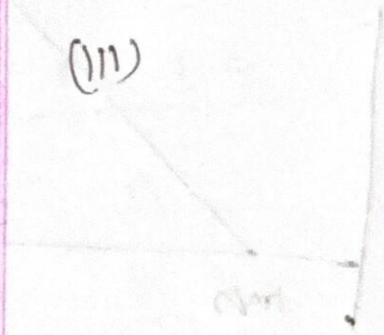
$R = D = h$

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(ii)

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(iii)



Ex. 1.5

$$\frac{0+2.95}{2} + \frac{2.95+3.31}{2} + \frac{3.31+3.62}{2} + \cdots$$

$$\frac{1}{2}\left[\frac{0}{2} + 2.95 + 3.31 + 3.62 \cdots\right]$$



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Pressure distribution

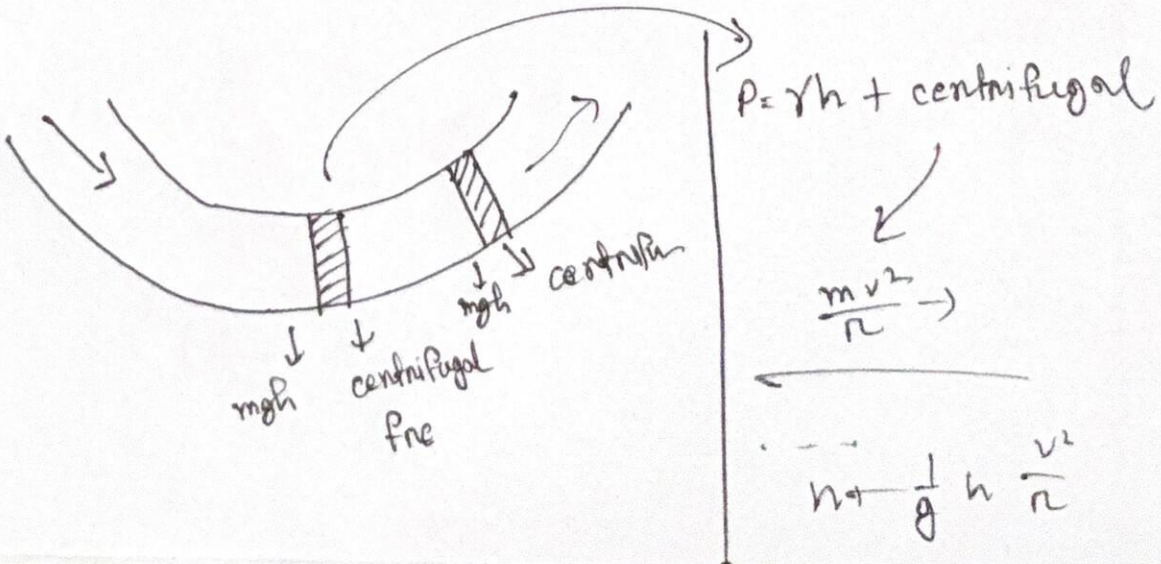
Hydrostatic pressure distribution

$$W = mg$$
$$= \rho V \times g$$
$$= \rho g \times V$$
$$= \gamma \times h \Delta A$$
$$= \dots$$

$$p = \gamma h$$

$$\frac{p}{\gamma} = h$$

Pressure distribution on concave flow



Ex 1.6

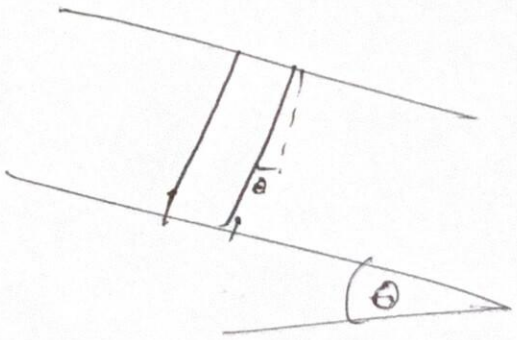
do if inclined

$Q = AV$

$q = hv$

$\Rightarrow V = \frac{q}{h} = 22 \text{ m/s}$

$P = \gamma h \left(1 + \frac{v^2}{g r_c}\right)$



$P = \gamma d \cos\theta$

$= \gamma h \cos\theta \times \cos\theta$

$= \gamma h \cos^2\theta$