$y_2 = \frac{1}{2}\left(-1+\sqrt{1+8F_{r_2}^2}\right)_{+}$.

SECTION 3

Q2

Ans

A Channel of Constant Velocity:

The main features of uniform flow with constant velocity in an open channel are:

1. The depth of flow, wetted area, velocity of flow and discharge are constant at every line, water surface and channel bottom are all parallel to each other,

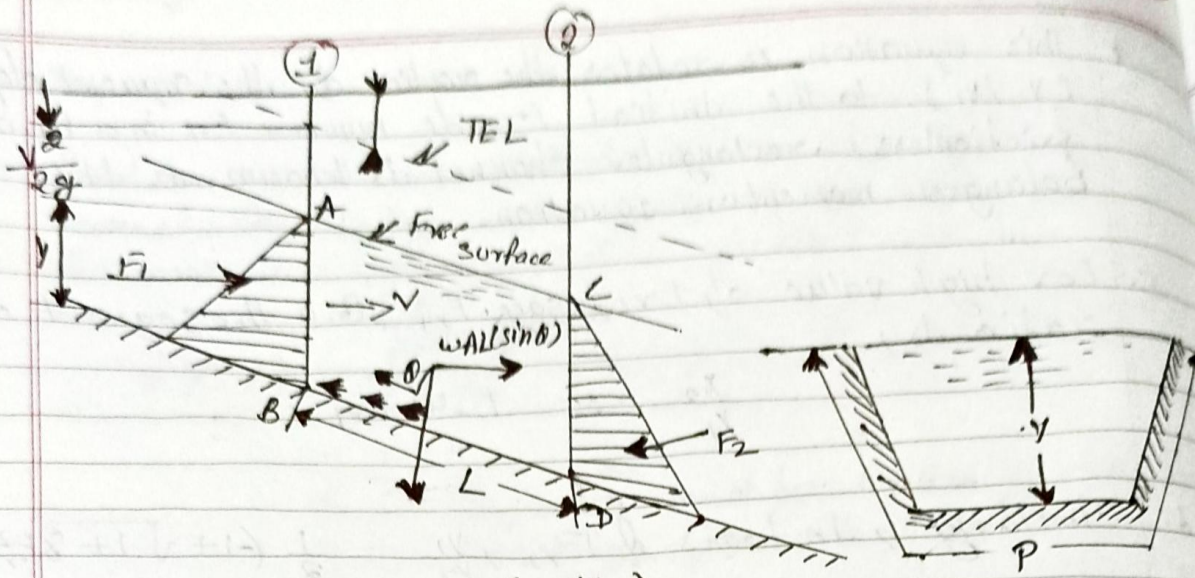
$$S_f = S_w = S_o = S$$

where,

S_f = Energy line slope

S_w = water surface slope

S_o = channel bottom slope.



$W = (w\Delta L)$

Force on a segment of channel having uniform flow.

DERIVATION:

Consider a small section of an open channel. The f acting on the free body of water ABCD in the direction of flow are as follows:

(i) Forces of hydrostatic water pressure F_1 and F_2 acting on the two ends of the free body.

$F_1 = F_2$ (∵ Depth of water at section 1 & 2 are same)

(ii) Component of weight of water in the direction of flow $= w\Delta L \sin\theta$

w = specific weight of water

A = wetted cross-sectional a

θ = Angle of inclination of channel bottom with horizontal

(iii) The resistance of flow exerted by wetted surface of channel.

P = Wetted perimeter of the channel.

τ_0 = Average shear stresses at the channel boundary.

$\therefore$ Total resistance to flow $= PL\tau_0$

2. According to Newton's second law of motion,

$$wAL\sin\theta - PL\tau_0 = 0 \Rightarrow \tau_0 = w\left(\frac{A}{P}\right)\sin\theta = wRS_0 \quad \text{---(i)}$$

Where, $R = \frac{A}{P}$ = Hydraulic radius,

$S_0 = \sin\theta$ = slope of channel bottom.

Note. we know that, $\tau_0 = \frac{f}{8}\rho V^2$ ---(ii)

4. From (i) & (ii)

$$wRS_0 = \frac{f}{8}\rho V^2 \Rightarrow V = \sqrt{\frac{8w}{\rho f}}\sqrt{RS_0} = \sqrt{\frac{8g}{f}}\sqrt{RS_0}$$

Where, $g = w/\rho$

$$V = C\sqrt{RS_0} \quad \text{---(iii)}$$

5. Discharge, $Q = AV = AC\sqrt{RS_0}$

where, $C = \sqrt{8g/f}$

* Eq. (iii) is known as chezy's equation for uniform velocity.

B. Characteristic of water turbine :-

1. Hydraulic machines are defined as those machine which convert either hydraulic energy into mechanical energy or mechanical energy into hydraulic energy.

2. The hydraulic machines, which convert energy into machine or mechanical energy are called turbine while the hydraulic machines which convert the mechanical energy into hydraulic energy are called pump.

3. This mechanical energy is used in running an electric generator which is directly coupled to the shaft of the turbine. Thus the mechanical energy is converted into electrical energy.