Hydraulic Engineering and Machines, [KCE-403]

Q1. SECTION - 1

Ans Specific Energy:

1. The total energy of a channel flow referred to a datum is given by,

$$H = Z + Y\cos\theta + a(V^2/2g)$$

2. If the datum coincides with the channel bed at the section the resulting expression is known as specific energy and is denoted by E. Thus,

$$E = Y\cos\theta + a(V^2/2g)$$

$$\cos\theta \doteq 1 \quad \text{and} \quad a = 1$$

$$E = Y + (V^2/2g)$$

3. Hence specific energy of flowing liquid is defined as energy per unit weight of the liquid with respect to the bottom of the channel.

Critical Flow Condition:

1. For given discharge the condition for minimum specific force can be obtained by different equation of specific force with respect to Y and then considering it as $dF/dy = 0$.

$$F = Q^2/gA + A\bar{Z} \quad \text{--- (i)}$$

2. Differentiate of Eq. (1) with respect to, we get

$$\frac{dF}{dY} = -\frac{Q^2}{gA^2}\frac{dA}{dY} + \frac{d(A\bar{Z})}{dY} = 0 \quad \text{--- (ii)}$$

3. Since Q is constant and both A and $\bar{z}$ are the function of depth, As shown in fig (1) with have a change dy in the depth, the corresponding change $d(A\bar{z})$ in the moment of the cross-section area about the free surface may be expressed as, $\frac{d(A\bar{z})}{dy} = (A(\bar{z} + dy) + T dy \frac{dy}{2}) - A\bar{z}$

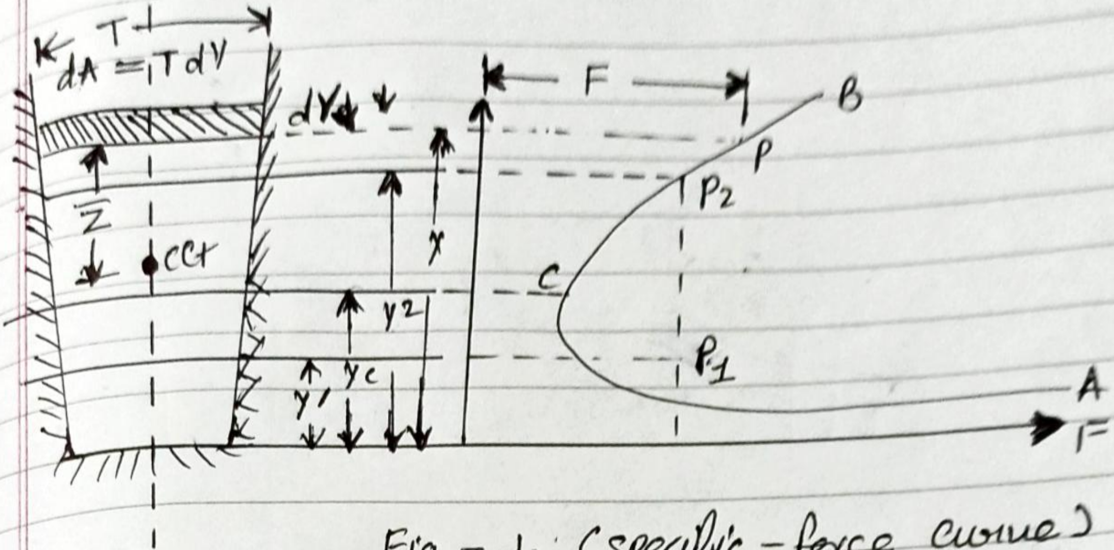

Fig - 1. (specific-force curve)

4. Neglecting smaller term, $\frac{T(dy)^2}{2}$ we get

$$d(A\bar{z}) = A dy$$

6. Substituting $(dA/dy) = T$, the above equation reduces.

or $$\frac{Q^2 T}{g A^3} = 1 \qquad \left[\because \frac{dA}{dy} = T\right]$$

5 Substituting smaller term of $d(A\bar{z})$ in eq. (2), we get

$$\frac{dF}{dy} = \frac{Q^2}{gA} \frac{dA}{dy} + \frac{A dy}{dy} = 0$$

7. The above condition is critical flow condition. Thus it can be said that at critical depth, specific force attains minimum value.