Section - 4

Ans 2

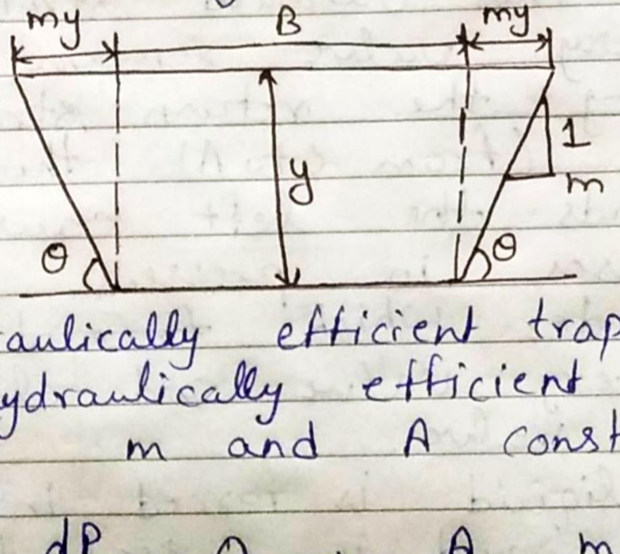
(i) Let, Bottom width $= B$ and Side Slope $= m:1 = (H:V)$

(ii) Area, $A = (B + my)y = \text{Constant}$ —— ①

$$B = \frac{A}{y} - my \quad \text{—— ②}$$

(iii) Wetted perimeter, $P = B + 2y\sqrt{m^2+1}$

$$= \frac{A}{y} - my + 2y\sqrt{m^2+1} \quad \text{—— ③}$$



Hydraulically efficient trapezodial channel

(iv) For hydraulically efficient section keeping m and A constant.

$$\frac{dP}{dy} = 0 \Rightarrow -\frac{A}{y^2} - m + 2\sqrt{m^2+1} = 0$$

$$A = \left(2\sqrt{m^2+1} - m\right)y^2 \quad \text{—— ④}$$

(V) From eq. ② we get

$$B = \frac{A}{y} - my = 2\left(\sqrt{m^2+1} - m\right)y \quad \text{—— ⑤}$$

(vi) From eq. ③ we get

$$P = B + 2y\sqrt{m^2+1} = 2y\left(2\sqrt{m^2+1} - m\right) \quad \text{—— ⑥}$$

(vii) Hydraulic means radius, $R = \frac{A}{P}$

$$= \frac{(2\sqrt{1+m^2} - m)y^2}{2(2\sqrt{1+m^2} - m)y} = \frac{y}{2}$$

(viii) for most efficient channel.

$$\therefore \frac{dP}{dm} = 0 \Rightarrow 2y\left[2 \times \frac{1}{2}(1+m^2)^{-1/2} \times 2m - 1\right] = 0$$

$$\frac{2m}{\sqrt{1+m^2}} - 1 = 0 \Rightarrow m = \frac{1}{\sqrt{3}} \quad (\because y \neq 0)$$

$$1/\tan\theta = 1/\sqrt{3}$$

$$\Rightarrow \tan\theta = \sqrt{3} = \tan 60^\circ \Rightarrow \theta = 60^\circ$$

(ix) Put the value of m in eq ④, eq ⑤ & eq. ⑥, we get

$$A = \left(2\sqrt{1+\frac{1}{3}} - \frac{1}{\sqrt{3}}\right) y^2 = \sqrt{3}y^2$$

$$B = 2y\left(\sqrt{1+\frac{1}{3}} - \frac{1}{\sqrt{3}}\right) = \frac{2}{\sqrt{3}}y$$

$$P = 2y\left(2\sqrt{1+\frac{1}{3}} - \frac{1}{\sqrt{3}}\right) = 2\sqrt{3}y$$

(X) If L = Length of the inclined side of the Channel, then

$$L = \frac{P-B}{2} = \frac{2}{\sqrt{3}}y = B$$

(xi) Hence the conditions for the most economical trapezoidal section are:

- Hydraulic mean radius, $R = y/2$
- Angle of the inclined sides of the channel from the bed $\theta = 60^\circ$.
- Thus the hydraulically most efficient trapezoidal section is one half of a regular hexagon.