SECTION – 4

Q2 Ans

1. let, Bottom width = B and side slope = m : 1 (H:V)

$$A = (B + my)y = \text{Constant} \quad \text{—— (i)}$$

2. Area,

$$B = \frac{A}{y} - my \quad \text{—— (ii)}$$

3. Wetted perimeter, $P = B + 2y\sqrt{m^2+1}$

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

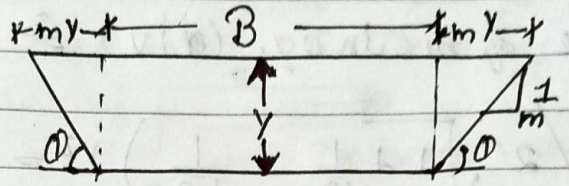

Fig 1: Hydraulically efficient trapezoidal channel.

4. For hydraulically efficient section, keeping m and A constant.

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

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

5. from eq. (ii), we get

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

6. from eq. (iii), we get

$$P = B + 2y\sqrt{m^2+1} = 2y(2\sqrt{m^2+1} - m) \quad \text{(vi)}$$

7. Hydraulic mean radius, $R = \frac{A}{P} = \frac{2y\sqrt{1+m^2} - my}{2(2\sqrt{1+m^2} - m)y}$

$= \frac{y}{2}$

8. for most efficient channel,

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

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

9. Put the value of m in eq. (iv) & (v) and (vi),

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

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

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

10. If L = length of the inclined side of the channel, then

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

11. Hence the condition for the most economical trapezoidal section are:

(i) Hydraulic mean radius, $R = y/2$

(ii) Angle of the inclined sides of the channel from the bed, $\theta = 60°$

(iii) trapezoidal section is one half of a regular hexagon.