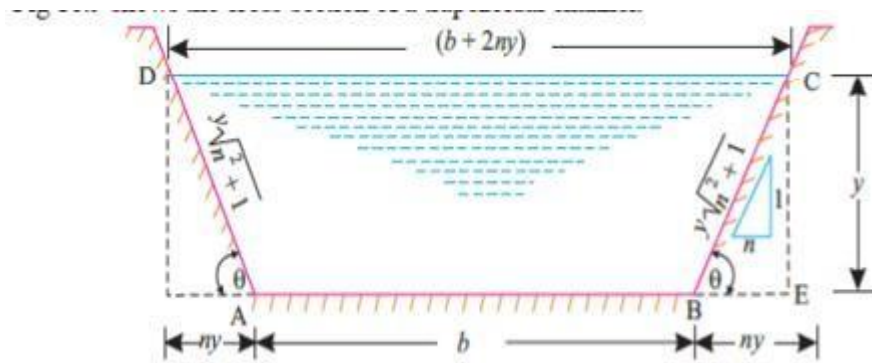


# MOST ECONOMICAL TRAPEZOIDAL CHANNEL



Let  $b$  = Base width of the channel,  
 $y$  = Depth of flow, and  
 $\theta$  = Angle made by the sides with horizontal.  
 Side slope = 1 vertical to  $n$  horizontal.

$$\text{Area of flow, } A = \left( \frac{AB + CD}{2} \right) \times y = \frac{b + (b + 2ny)}{2} \times y = (b + ny) y \quad \dots(i)$$

$$\therefore \frac{A}{y} = b + ny$$

$$\text{or, } b = \frac{A}{y} - ny \quad \dots(ii)$$

$$\begin{aligned} \text{Wetted perimeter, } P &= AD + AB + BC = AB + 2BC \quad (\because AD = BC) \\ &= b + 2\sqrt{BE^2 + CE^2} \\ &= b + 2\sqrt{n^2 y^2 + y^2} \end{aligned}$$

$$\text{or, } P = b + 2y\sqrt{n^2 + 1} \quad \dots(iii)$$

Substituting the value of  $b$  from eqn. (ii) in eqn. (iii), we get:

$$P = \frac{A}{y} - ny + 2y\sqrt{n^2 + 1} \quad \dots(iv)$$

The section of the channel will be *most economical* when its wetted perimeter ( $P$ ) is *minimum*,

$$\text{i.e. } \frac{dP}{dy} = 0$$

$$\text{or, } \frac{d}{dy} \left[ \frac{A}{y} - ny + 2y\sqrt{n^2 + 1} \right] = 0$$

$$\text{or, } -\frac{A}{y^2} - n + 2\sqrt{n^2 + 1} = 0 \quad (\because n \text{ is constant})$$

$$\text{or, } \frac{A}{y^2} + n = 2\sqrt{n^2 + 1}$$

Substituting the value of  $A$  from eqn. (i), in the above equation, we get:

$$\frac{(b + ny)y}{y^2} + n = 2\sqrt{n^2 + 1}$$

$$\text{or, } \frac{(b + ny)}{y} + n = 2\sqrt{n^2 + 1}$$

$$\text{or, } \frac{b + ny + ny}{y} + 2\sqrt{n^2 + 1} \quad \text{or} \quad \frac{b + 2ny}{y} = 2\sqrt{n^2 + 1}$$

$$\text{or, } \frac{b + 2ny}{2} = y\sqrt{n^2 + 1} \quad \dots(16.14)$$

[i.e. Half of top width = One of the sloping sides ... Fig 16.9]

**Hydraulic radius,  $R$ :**

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

$$A = (b + ny) \times y \quad [\text{From eqn. (i)}]$$

$$P = b + 2y\sqrt{n^2 + 1} \quad [\text{From eqn. (iii)}]$$

$$\text{But, } 2y\sqrt{n^2 + 1} = b + 2ny \quad [\text{From eqn. (16.14)}]$$

$$\therefore P = b + (b + 2ny) = 2(b + ny)$$

$$\therefore \text{Hydraulic radius, } R = \frac{(b + ny)y}{2(b + ny)} = \frac{y}{2} \quad \dots(16.15)$$

i.e., The hydraulic radius equals half the flow depth.