22.6 Examples

Design a triangular lined channel section with rounded bottom as prescribed by CBI&P given Q =30 m^3s^{-1}, n=0.015, bed slope S_0 1:1800, side slope m = 1.25.

Solution :

The side slope of the channel m =1.25,

i.e., $\cot\theta = 1.25$,

$\therefore \quad \theta = 0.6747$ radian $= 38.6598^\circ$

Area of the channel $A = y^2(\theta + \cot\theta)$

$= 1.9247\, y^2$

Perimeter of the channel $P = 2y(\theta + \cot\theta) = 2y(0.6747+1.25)$

Hydraulic radius $R = A/P$

$= y/2$

therefore $AR^{2/3} = 1.9247y^2 * (y/2)^{2/3} = \dfrac{1.9247y^{8/3}}{2^{2/3}} = 1.2125y^{8/3}$ ---->1

and $\dfrac{nQ}{\sqrt{S_o}} = \dfrac{0.015 * 30}{\sqrt{1/1800}} = 19.092$ ---->2

Equating equations 1 and 2

$\therefore \quad y = \left(19.092/1.2125\right)^{3/8}$

$= (15.7458)^{3/8}$

$y = 2.81$ m

therefore, Area of the cross section of the channel $A = 1.9247 * (2.81)^2$

$= 15.197\ m^2$

and a free board = 34 cm

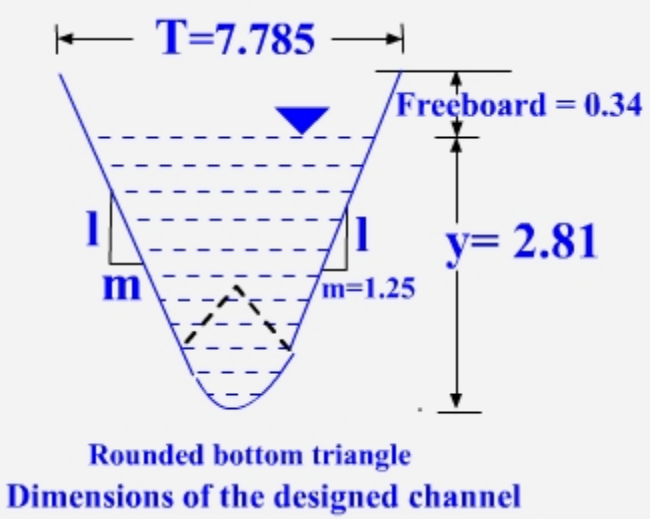
therefore the total height of the channel section H = 2.81 +0.34 = 3.15 m

Top width of the channel $T = 2 * m * H$

$= 2 * 1.25 * 3.15 = 7.875$ m

Perimeter of the channel $P = 2H\sqrt{1+m^2}$

$= 10.085$ m



Dimensions of the designed channel

2. Design a lined channel to carry Q =125 m^3s^{-1} , n = 0.015, bed slope S_0 1:2500, side slope m = 1.25. Maximum permissible velocity is 2.5ms^{-1}

Solution:

The side slope of the channel m = 1.25,

$$\text{i.e.,} \quad \cot\theta = 1.25,$$

$$\text{therefore} \quad \theta = 0.6747 \text{ radian}$$

$$\text{Area of the channel } A = y^2(\theta + \cot\theta) + by$$

$$= 1.9247\,y^2 + by \quad \text{-->1}$$

$$\text{and Area} \quad A = Q/V$$

$$= 125/2.5 = 50\ m^2$$

$$= 50\ m^2. \quad \text{--->2}$$

Equating equations 1 and 2

$$50 = 1.9247\,y^2 + by \quad \text{--->A}$$

$$\text{Perimeter of the channel } P = 2y(\theta + \cot\theta) + b \quad \text{--->3}$$

$$= 3.8494y + b$$

$$R = \frac{A}{P} = \frac{1.9247y^2 + by}{3.8494y + b}$$

$$2.5 = \frac{1}{0.015} R^{2/3} \sqrt{1/2500}$$

$$\therefore \ R = \left[\frac{0.015 * 2.5}{\left(1/2000\right)^{0.5}} \right]^{3/2} = \left(\frac{0.0375}{0.02236} \right)^{1.5}$$

$$= 2.1719$$

$$P = \frac{A}{R} = \frac{50}{2.1719} = 23.0213 \text{ m}$$

Equating equations 3 and 4

$$23.0213 = 3.8494y + b$$

$$\text{therefore } B = 23.0213 - 3.8494y \quad \text{--->5}$$

put equation 5 in equation A, then

$$50 - 1.9247\,y^2 + (23.0213 - 3.8494y) * y = 0 \quad \text{--->B}$$

Solving the equation B one obtains

b = 12.04 m and

y = 2.8527 m

add free board = 0.6473 m

therefore the total height of the channel H =2.8527 + 0.6473 = 3.5 m and the top width of the channel $T = b + 2 * m * H$

$$= 12.04 + 2(1.25*3.5) = 20.79 \text{ m}$$

T = 20.8 m (approximately)

3. Design the lined canal to carry Q = 100 m^3/s, with n = 0.013, bed slope S_0 = 1:2500, V = 2 m/s, side slope m = 1.25, and hydraulic radius R = 1.48.

4. Design a triangular lined channel section with rounded bottom given Q = 300 m^3/s, n = 0.014, bed slope S_0 = 0.0016, side slope m = 1.25.