Hydraulics
Open Channel Flow - 1

04.04.11
Exercise-1

Q1. Water flows in a concrete rectangular open channel that is 12 m wide at a depth of 2.5m. The channel slope is 0.0028. Find the water velocity and the flow rate.

\[ V = \frac{1}{n} \cdot R^{2/3} \cdot s^{1/2} \]

\[ n = 0.013 \]

\[ R = \frac{A}{P_w} = \frac{(12 \times 2.5)}{(2.5 + 12 + 2.5)} = 1.765m \]

\[ V = \frac{1}{0.013} \times (1.765)^{2/3} \times (0.0028)^{1/2} = 5.945 \text{m/s} \]

\[ Q = A \cdot V = (12 \times 2.5) \times 5.945 = 178 \text{m}^3/\text{sec} \]
Exercise -2

Q2. For each of the channel cross sections shown in following, compute the area, wetted perimeter and hydraulic radius.

(a) Circle

(b) Rectangular

(c) Trapezoidal
Exercise - 2

\[ A = \frac{1}{2} \left[ \frac{\pi (4)^2}{4} \right] = 6.283 \text{m}^2 \]

\[ P_w = \frac{1}{2} x \pi x 4 = 6.283 \text{m} \]

\[ R = \frac{A}{P_w} = \frac{6.283}{6.283} = 1 \text{m} \]
Exercise - 2

\[ A = 5 \times 2.5 = 12.5 \text{m}^2 \]

\[ P_w = 2.5 + 5 + 2.5 = 10 \text{m} \]

\[ R = \frac{A}{P_w} = \frac{12.5}{10} = 1.25 \text{m} \]
Exercise - 2

\[
A = (5 \times 1.2) + \left[ 2x \left( \frac{1}{2} \right) \times 1.2 \times 1.2 \right] = 7.44 \, m^2
\]

\[
P_w = 5 + \left( 2 \times 1.2 \times \sqrt{2} \right) = 8.394 \, m
\]

\[
R = \frac{A}{P_w} = \frac{7.44}{8.394} = 0.886 \, m
\]
Q3. Calculate the discharge in steady flow through the channel and floodway of figure; take $s = 0.001$ and $y = 2.438$ m.

$$Q = A \cdot \frac{1}{n} \cdot R^{2/3} \cdot s^{1/2}$$
Exercise - 3

\[ A_1 = 12x(5 + 2.438) + (5 + 2.438)x(5 + 2.438) - (2.438 \times 2.438 / 2) = 141.6m^2 \]

\[ P_{wl} = \sqrt{(5 + 2.438)^2 + (5 + 2.438)^2} + 12 + \sqrt{5^2 + 5^2} = 29.59m \]

\[ Q_1 = 141.6 \times (1/0.025) \times \left( \frac{141.6}{29.59} \right)^{2/3} \times 0.001^{1/2} = 508.6m^3 / sec \]
Exercise - 3

\[ A_2 = (120 \times 2.438) + (2.438^2 / 2) = 295.5 \, m^2 \]

\[ P_{w2} = 120 + \sqrt{(2.438)^2 + (2.438)^2} = 123.4 \, m \]

\[ Q_2 = 295.5 \times (1/0.04) \times \left(\frac{295.5}{123.4}\right)^{2/3} \times 0.001^{1/2} = 418.1 \, m^3 / \text{sec} \]

\[ Q = Q_1 + Q_2 = 926.7 \, m^3 / \text{sec} \]