EAH 225 HYDRAULICS –Open Channel Hydraulics Assignment 2

SOLUTIONS

1. Determine the normal depth and critical depth in a trapezoidal channel with a bottom width of 12 m, side slopes of 1:3, and a bed slope of 0.002. The Manning's n value is 0.025 and the discharge is 85 m^3/s.

SOLUTION

Rearrange Manning's equation and solve for the normal depth:

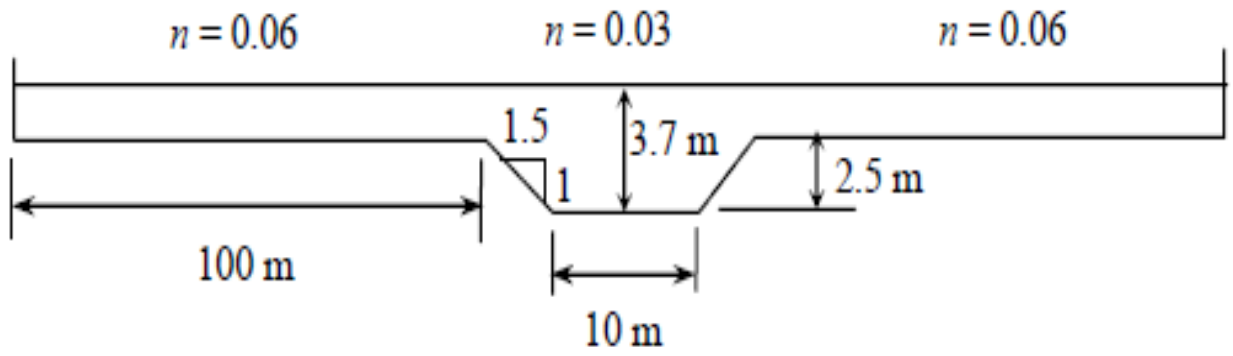
$$AR^{2/3} = nQ / S^{1/2}$$

with the result, y_o = 2.01 m. The critical depth is obtained from equating the Froude number squared to one:

$$\mathbf{F}^2 = \frac{Q^2 B_c}{g A_c^3} = 1.0$$

from which y_c = 1.50 m. Therefore, this is a subcritical flow because $y_o > y_c$.

2. A compound channel has symmetric floodplains (*fp*), each of which is 100 m wide with Manning's n = 0.06, and a main channel (*mc*), which is trapezoidal with a bottom width of 10 m, side slopes of 1:1.5, a bank-full depth of 2.5 m, and a Manning's n of 0.03. If the channel slope is 0.001 and the total depth is 3.7 m, compute the uniform flow discharge.



SOLUTION

Given a Manning's n = 0.03 for the main channel and n = 0.06 for the floodplains, calculate area and wetted perimeter for the floodplains (*fp*) and main channel (*mc*):

$$A_{mc} = 2.5(10 + 1.5 \times 2.5) + (10 + 2 \times 1.5 \times 2.5)(1.2) = 55.4\,\text{m}^2$$

$$P_{mc} = 10 + 2(2.5)\sqrt{1 + 1.5^2} = 19\,\text{m}$$

$$A_{fp} = 100 \times 1.2 = 120\,\text{m}^2$$

$$P_{fp} = 100 + 1.2 = 101.2\,\text{m}$$

Then from Manning's equation, the discharge is given by:

$$Q = 2 \times \frac{1}{n_{fp}} A_{fp} R_{fp}^{2/3} S^{1/2} + \frac{1}{n_{mc}} A_{mc} R_{mc}^{2/3} S^{1/2}$$

$$Q = \frac{2}{0.06} \times 120 \times \left(\frac{120}{101.2}\right)^{2/3} \times 0.001^{1/2} + \frac{1}{0.03} \times 55.4 \times \left(\frac{55.4}{21.4}\right)^{2/3} \times 0.001^{1/2}$$

Thus,

Q = 141.7 m^3/s + 119.2 m^3/s = 261 m^3/s.