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Applied Fluid Mechanics Homework 07

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2018141521058

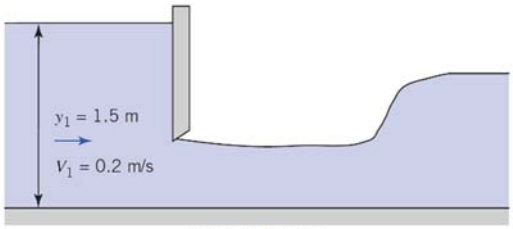
Applied Fluid Mechanics

Class Section 01

04/29/2021

Problem 11.24

11.24 Flow through a sluice gate is shown. Estimate the water depth and velocity after the gate (well before the hydraulic jump).



P11.24, P11.30

Solution:

$$y_1 b V_1 = y_2 b V_2$$

$$\Longrightarrow V_2 = \frac{y_1}{y_2} V_1$$

$$\frac{V_1^2}{2g} + y_1 = \frac{V_2^2}{2g} + y_2$$

$$\frac{V_1^2}{2g} + y_1 = \frac{\left(\frac{y_1}{y_2} V_1\right)^2}{2g} + y_2$$

$$\frac{V_1^2}{2g} + y_1 = \frac{y_1^2 V_1^2}{2g y_2^2} + y_2$$

$$\frac{(0.2\ \text{m/s})^2}{2 \times (9.81\ \text{m/s}^2)} + (1.5\ \text{m}) = \frac{(1.5\ \text{m})^2 \times (0.2\ \text{m/s})^2}{2 \times (9.81\ \text{m/s}^2) \times y_2^2} + y_2$$

Solving equation above yields that

$$y_2 = 0.056\ \text{m}$$

$$\Longrightarrow V_2 = \frac{y_1}{y_2} V_1 = \frac{(1.5\ \text{m})}{(0.056\ \text{m})} \times (0.2\ \text{m/s}) = 5.326\ \text{m/s}$$

$$Fr_2 = \frac{V_2}{\sqrt{g y_2}}$$

$$= \frac{(5.34\ \text{m/s})}{\sqrt{(9.81\ \text{m/s}^2) \times (0.056\ \text{m})}} = 7.16$$

Problem 11.30

11.30 Estimate the depth of water before and after the jump for the hydraulic jump downstream of the sluice gate of Fig. P11.24.

Solution:

$$\frac{y_3}{y_2} = \frac{1}{2}\left[\sqrt{1 + 8Fr_2^2} - 1\right]$$

$$= \frac{1}{2} \times \left[\sqrt{1 + 8 \times (7.16)^2} - 1\right] = 9.64$$

Therefore,

$$y_3 = 9.64 y_2 = 9.69 \times 0.056\ \text{m} = 0.543\ \text{m}$$

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