FREDERICK UNIVERSITY

Department of Mechanical Engineering

Hydraulic Jump Depth Ratio

Objective: Under certain conditions, if the flow in a channel is supercritical a hydraulic jump will form. The purpose of this experiment is to use an apparatus as shown in the figure to determine the depth ratio, y_2 / y_1 across the hydraulic jump as a function of the Froude number upstream of the jump, Fr_1.

Equipment: Water channel (flume) with a pump and a flow control valve; sluice gate; point gage; adjustable tail gate.

Experimental Procedure: Position the sluice gate so that the distance, a, between the bottom of the gate and the bottom of the channel is approximately 3 cm. Adjust the flow control valve to produce a flowrate that causes the water to back up to the desired depth, upstream of the sluice gate. Carefully adjust the angle, of the tail gate so that a hydraulic jump forms at the desired location downstream from the sluice gate. Note that if θ is too small, the jump will be washed downstream and disappear. If is too large, the jump will migrate upstream and will be swallowed by the sluice gate. With the jump in place, use the point gage to determine the depth upstream from the sluice gate, y_0 the depth just upstream from the jump, y_1 and the depth downstream from the jump, y_2. Repeat the measurements for various flowrates (i.e., various y_0 values).

Calculations: For each data set, use the Bernoulli and continuity equations between points (0) and (1) to determine the velocity, V_1, and Froude number, $\mathrm{Fr}_1 = V_1 / \sqrt{g y_1}$ just upstream from the jump

$$Q = z_2 b \sqrt{\frac{2g(z_1 - z_2)}{1 - \left(z_2 / z_1\right)^2}} .$$

Also use the measured depths to determine the depth ratio, y_2 / y_1, across the jump.

Graph: Plot the depth ratio, y_2 / y_1, as ordinates and Froude number, Fr_1, as abscissas.

Results: On the same graph, plot the theoretical depth ratio as a function of Froude number

$$\frac{y_2}{y_1} = \frac{1}{2}\left(-1+\sqrt{1+8\mathrm{Fr}_1^2}\right)$$