CVG 3116 Fall 2017

Hydraulics – Tutorial 5
October 17, 2017

University of Ottawa

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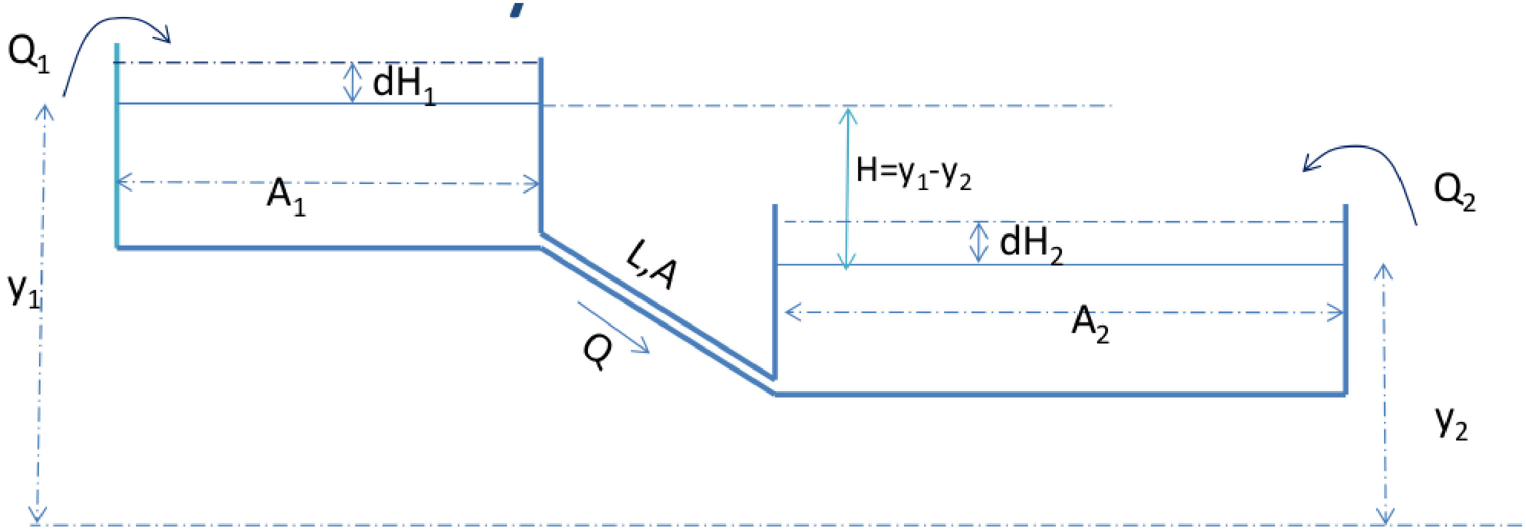
Lecture 7: Unsteady Flows



- Two Reservoirs

$$dt = \frac{dH}{\left[\frac{Q_1}{A_1} - \frac{Q_2}{A_2} - K\,H^{0.5}\left(\frac{1}{A_1} + \frac{1}{A_2}\right)\right]} \qquad K = \frac{A\sqrt{2g}}{\sqrt{\left(\lambda \frac{L}{D} + \sum k_{Li}\right)}} \qquad Q = KH^{0.5}$$

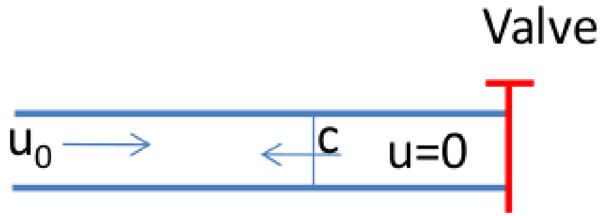
- Release into the atmosphere

$$dt = \frac{dH}{\left[\frac{Q_1}{A_1} - K\,H^{0.5}\left(\frac{1}{A_1}\right)\right]} \qquad K = \frac{A\sqrt{2g}}{\sqrt{\left(\lambda \frac{L}{D} + \sum k_{Li}\right)}} \qquad Q = KH^{0.5}$$

See Case 3- Orifice (Slide 6, Lec. 7)

Lecture 7: Water Hammer

If a valve is suddenly closed, a shock wave is generated and moves back in the pipe (in the upstream direction).

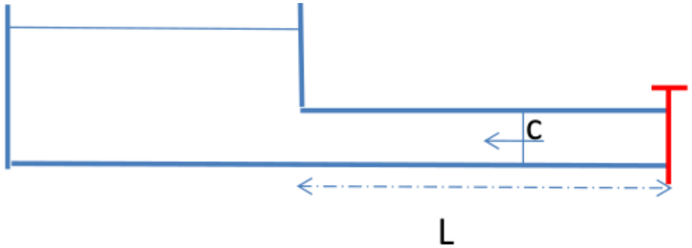


Shock wave speed, $c = \sqrt{\dfrac{1/\rho}{(1/K)+(D/Ee)}}$

Rigid pipe, E – infinite, thus $c = \sqrt{K/\rho}$

Increase in pressure, $\Delta p = \rho c u_0$

Transmission time , $T = \dfrac{L}{c}$



Lecture 7: Water Hammer

Note: the time for a round trip of the shock wave is $\dfrac{2L}{c}$

Condition for reduction of pressure change: $t_c > \dfrac{2L}{c}$

- Pressure rise due to water hammer

Case 1: $t_c < \dfrac{2L}{c}$ $\quad \Delta p = \rho c u_0$

Case 2: $\dfrac{2L}{c} \leq t_c < \dfrac{20L}{c}$ $\quad \Delta p = \dfrac{2L\rho u_0}{t_c}$

Case 3: $\dfrac{20L}{c} \leq t_c$ $\quad \Delta p = \dfrac{L\rho u_0}{t_c}$

Lecture 8: Open Channel Flow

- Manning`s Equation

$$Q=\frac{1}{n}\frac{A^{5/3}}{P^{2/3}}S_0^{1/2}$$

$$V=\frac{1}{n}R^{2/3}S_0^{1/2}$$

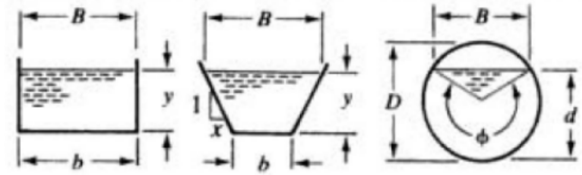
Q=VA

$$Q=\frac{A}{n}R^{2/3}S_0^{1/2}$$

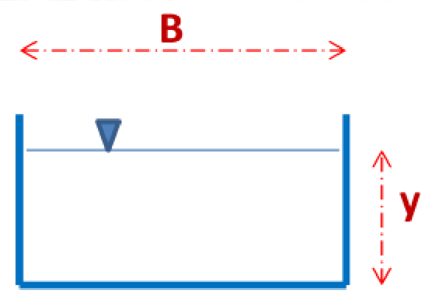
- Hydraulic Radius, R

$$R=\frac{A}{P}$$

Table 5.1 Geometric properties of some common prismatic channels.



	Rectangle	Trapezoid	Circle
area, A	by	$(b+xy)y$	$\frac{1}{8}(\phi-\sin\phi)D^2$
wetted perimeter, P	$b+2y$	$b+2y\sqrt{1+x^2}$	$\frac{1}{2}\phi D$
top width, B	b	$b+2xy$	$\left(\sin\frac{\phi}{2}\right)D$
hydraulic radius, R	$\frac{by}{b+2y}$	$\frac{(b+xy)y}{b+2y\sqrt{1+x^2}}$	$\frac{1}{4}\left(1-\frac{\sin\phi}{\phi}\right)D$
hydraulic mean depth, D_m	y	$\frac{(b+xy)y}{b+2xy}$	$\frac{1}{8}\left(\frac{\phi-\sin\phi}{\sin(1/2\phi)}\right)D$



$$P=B+2y$$

See geometric properties for other cross sections – Slide 8, Lecture 8