JME 3700
April 25, 2017

Homework #13

1. (10 pts) Water flows at $Q = 0.9 m^3/s$ in a rectangular channel having a width of $w = 1.5\, m$. The flow encounters a smooth vertical rise of $0.06\, m$ (Fig. 1). Calculate the downstream depth y_2 if the upstream depth is $y_1 = 0.8\, m$.

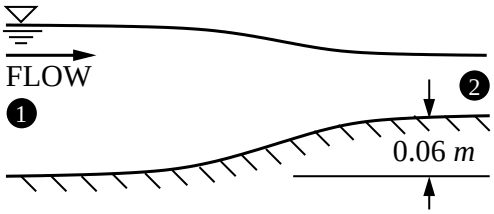

Fig. 1: *Contracting flow.*

2. (10 pts) Determine the upper bound for the depth y of a super–critical open–channel flow if the channel is rectangular with a width of $w = 2\, m$ and has a volumetric flow rate of $Q = 40\, m^3/s$.

3. (10 pts) A flume has a rectangular cross seciton of $2L$ wide by L deep, but has a very thin vertical board in its middle (Fig. 2) Assuming the Manning formula applies, find the ratio of the flow rate for this configuration, Q_1, versus the flow rate if the middle board were removed, Q_2, and comment on the cause of any observed difference. Both configurations have the same slope, S_0, and Manning coefficient, n.

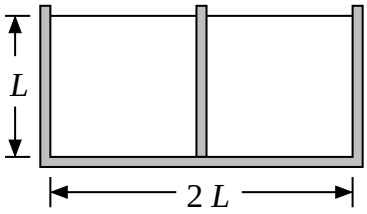

Fig. 2: *Rectangular flume.*

4. (10 pts) Roman engineer Flöwous Maximus is tasked with determining the maximum distance, D, that an outpost can be built outside the main city, given that its only water supply will be via aquaduct from the city's water aquafier. The maximum vertical fall between the aquafier and the surrounding countryside is $h = 2\, m$ and the duct itself would be a right–triangle section of finished brick, having $n = 0.015\, s/m^{1/3}$ (Fig. 3). Find D in units of km if the aquaduct's design size is $w = 2\, m$ and the outpost's anticipated peak consumption is $Q = 2\, m^3/s$.

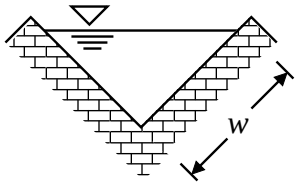

Fig. 3: *Aquaduct channel.*

5. (10 pts) Suppose that, at certain times, the aquaduct in Problem 4 has to be shut off for maintenance. However, the outpost has be notified in advance so they can store water ahead of time. Flöwous has an idea that he can simply pass a message in a bottle via the aquaduct informing his deputies at the outpost of the shutoff. To the nearest hour, how long of a time, t, does it take Flöwous' message to reach his deputies?