Hydraulic Engineering and Infrastructures

Civil Engineering Department

Pressurized pipe flow

1 Pipes fueled by a tank †

From reservoir D, water must be supplied for irrigation to farms F1 and F2. The minimum flow rates to be supplied are 500 L/s and 200 L/s, respectively, with a minimum pressure of 50 m.w.c. (meters of water column) at both points.

By concession, the maximum flow rate that can leave reservoir D is 850 L/s.

Determine:

1. The commercial diameter that the BF2 pipe should have (available commercial diameters: 100, 125, 150, 200, 300, 400, 500, 700, 800, 900, 1000 mm) and the actual flow rate that will circulate through the pipe with the selected commercial diameter. To start, you can assume that Q_1 and Q_2 are at their minimum value.
2. For the selected commercial diameter of BF2, find the maximum and minimum levels that the water in reservoir D must reach so that the maximum and minimum operating flow conditions are satisfied, and calculate their values.
3. Draw the energy gradient lines for each pipe under both operating conditions.

	ϕ (mm)	L (m)	f
AB	800	10000	0.025
BF1	600	5000	0.025
BF2	?	3000	0.025

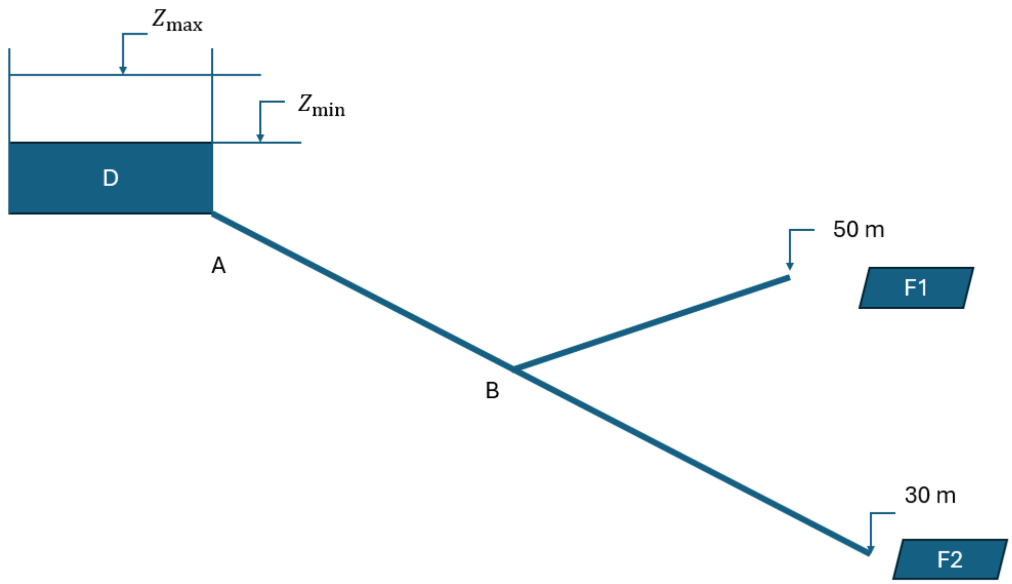

Figure 1: Tank fueling the two pipes.

2 Hardy cross †

Solve the following network using the Hardy Cross method, but instead of the Darcy–Weisbach equation (which gives the head loss as proportional to Q^2), apply the Hazen–Williams equation. This empirical relation expresses the head loss in pressurized pipes as

$$h_f = \frac{10.7L}{C_{HW}^{1.852} D^{4.87}} Q^{1.852}$$

where h_f is the head loss (m), L is the pipe length (m), D is the internal diameter (m), Q is the discharge (L/s), and C_{HW} is the Hazen–Williams roughness coefficient. Accordingly, the discharge correction in the Hardy Cross method changes to

$$\Delta Q = \frac{-\sum h_f}{1.852 \sum \frac{h_f}{Q}}$$

instead of the Darcy–Weisbach formulation with exponent 2. Use a Hazen–Williams factor of $C_{HW} = 100$.

Pipe	L	D
1	305 m	150 mm
2	305 m	150 mm
3	610 m	200 mm
4	457 m	150 mm
5	153 m	200 mm

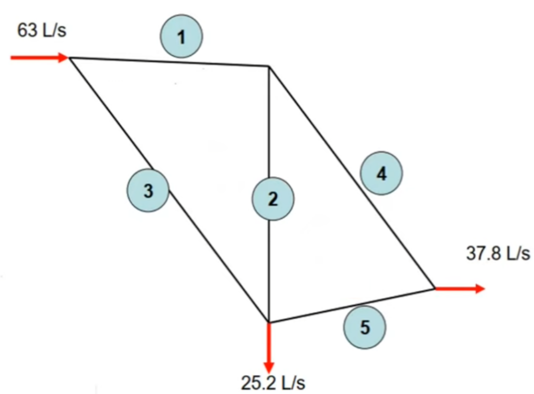

Figure 2: Pipeline system.