25.3 Example 25.1

A wide rectangular channel having a bottom slope of 0.001 is carrying a flow of 3 m^3/s/m. A control structure is built at the downstream end which raises the water depth at the downstream end to 4.5 m. Determine the distance from the control structure at which the flow depth is equal to 3.8 m. Manning n for the channel is 0.012.

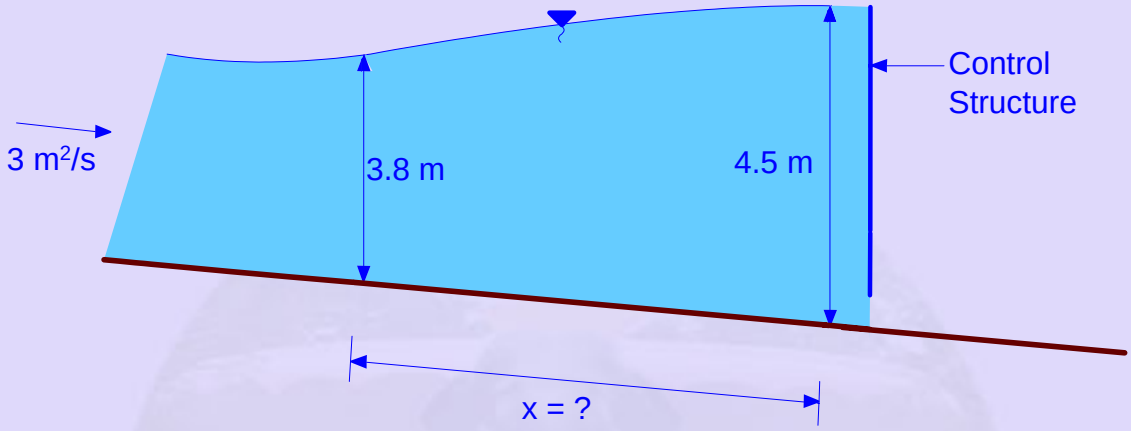

Fig. 25.2: Definition sketch for Example 25.1

Solution

- Divide the distance into two reaches as shown in Fig. 25.3. The flow depths at sections 1, 2 and 3 are 3.8 m, 4.0 m and 4.5 m, respectively. Distances Δx_1 and Δx_2 are determined as follows.

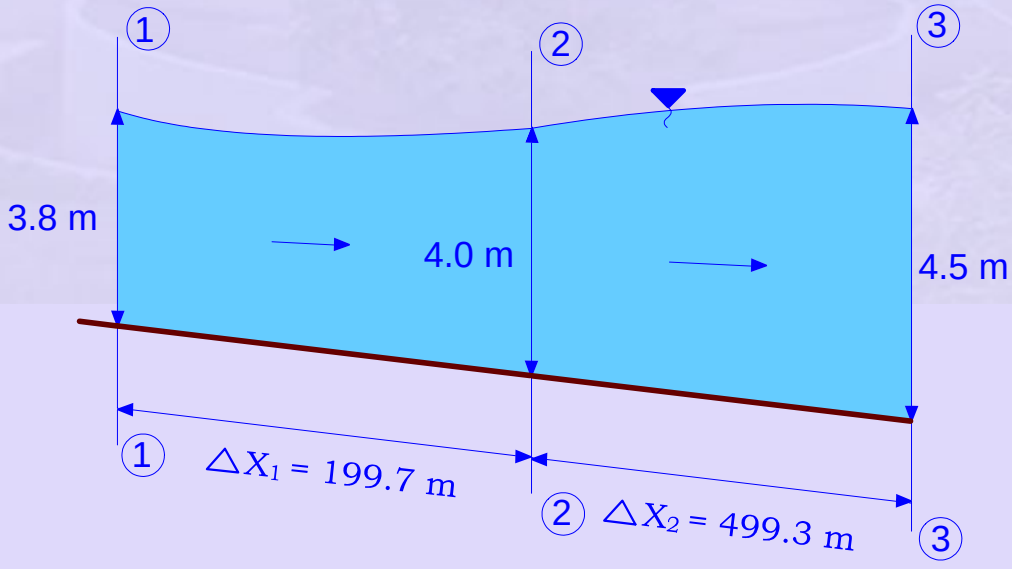

Fig. 25.3: Solution for Example 25.1

- Apply Equation 25.8 between sections 2 and 3. Here,

  $\Delta X_2 = X_3 - X_2;\ Y_3 = 4.5\ m;\ Y_2 = 4.0\ m;\ S_0 = 0.001;\ n = 0.012\ and\ q = 3.0\ m^2/s$. Y_2 is taken as upstream depth while Y_3 is taken as downstream depth.

  $$\boxed{\Delta X_2 = 499.3\ m}$$

- Apply Equation 25.8 between sections 1 and 2. Here

  $\Delta X_1 = X_2 - X_1; Y_2 = 4.0\,m;\ Y_1 = 3.8\,m$; Y_1 and Y_2 are taken as upstream and downstream depths, respectively.

  $$\boxed{\Delta X_1 = 199.7\ m}$$

- Either Equation 25.8 for a wide channel or Equation 25.5 for any general prismatic channel can be applied in the above step by step manner to determine the entire water surface profile behind a control structure.
- In this example, Y_n = Normal depth = 1.08 m. Therefore, flow depth varies from 4.5 m (Behind the structure) to 1.08 m (far upstream of the structure). Procedure given in the earlier steps can be used to determine the extent to which the control structure is affecting the water surface profile, by computing the location where a flow depth of 1.08 m occurs.