**Problem 8.1:** A trapezoidal irrigation channel excavated in silty sand having a critical tractive force on the horizontal of $\tau_{cb} = 2.4 N/m^2$, and angle of friction $\phi = 30^0$, and n=0.02 is to be designed to convey a discharge of 10 $m^3$/s on the slope of 1/10000. The side slopes will be 1(vertical): 2(horizontal).

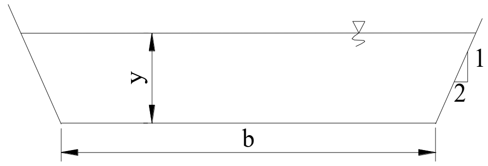



Figure 8.1

**Problem 8.2:** Flow rate in a trapezoidal channel is 12 $m^3$/s. Channel is covered by concrete and n=0.02. Bottom slope is $J_0 = 0.003$.

a) If channel base width is four times the depth, determine dimensions of the channel.

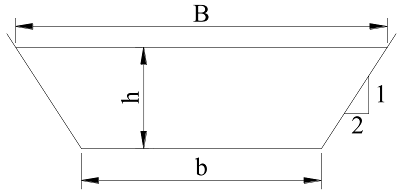



Figure 8.2a

b) Same discharge flows in a triangular and rectangular, determine the dimensions.

c) Same discharge flows in a circular pipe with n=0.016 and internal diameter D=1 m under pressure, how many pipes are necessary for pipe length; L=500 m and friction loss; 5 m.

d) Same discharge flows in a circular concrete channel, how many channel are necessary.

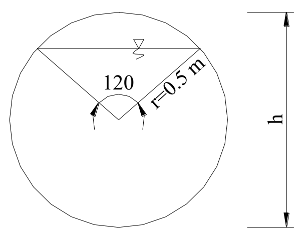



Figure 8.2b

e) Find the regime for case (a) using general equation of critical flow. Calculate critical slope and velocity.

f) Find the regime for cases (a) and (b) using Fr number.

g) Determine dimensions as hydraulically economic for case (a).

h) Determine the regime for case (g).

**Problem 8.3:** At the cross-section of the flow in a river during a flood was shown in Fig.p8.3. Assuming the roughness coefficient for the side channel and main channel n= 0.025. Bed slope is 0.0007.Calculate the discharge in the channel.

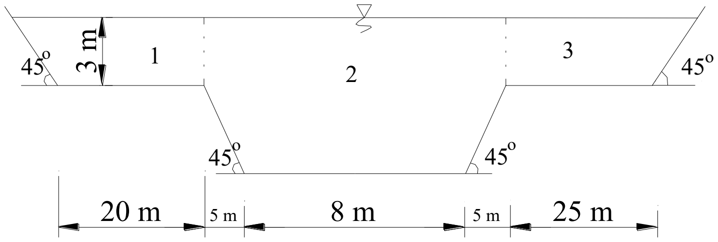



Figure 8.3

**Problem 8.4:** At the cross-section of the flow in a concrete channel was shown in Fig.8.4. Assuming the roughness coefficient for the channel n= 0.012. Bed slope is 2m/km. Calculate the discharge in the channel.

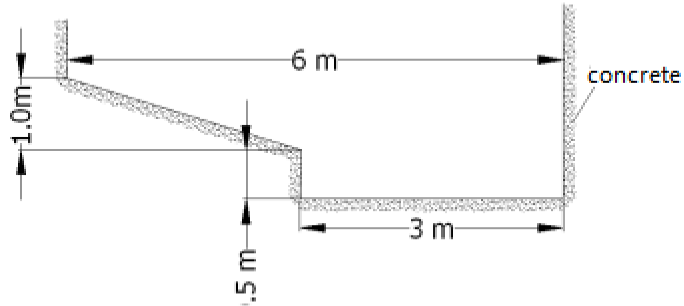



Figure 8.4

**Problem 8.5:** Flow rate is Q = 15 $m^3/s$

a) Draw specific energy diagram using given data.

b) Explain the diagram and determine critical depth.

c) Define specific energy, total head and write the relation between them. What are the unit definitions for both concepts? Define the critical regime for two different ways. Show a discharge will be found for two different depths with existing specific energy using for Q=constant, E=E(y) or for E= constant, Q=Q(y) , and critical regime will be found for their limit cases.

d) When specific energy is constant for uniform flow in a rectangular channel, is it possible energy loss through the channel? Explain.

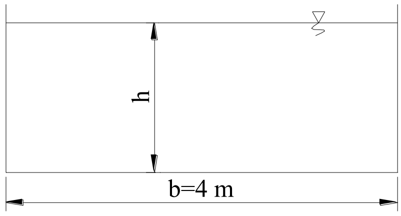



Figure p8.5

**Problem 8.6:** Uniform flow depth is 3m, velocity is 2m/s and assume the channel is wide.

a) Determine the flow regime.

b) A sill constructed on the bed has 25cm height. Show, is it possible the flow past over the sill? What is the water depth on the sill?

c) What is maximum (critical) height of the sill?

**Problem 8.7:** Determine flow depth and energy level at upstream of the sill of 1m height constructed on channel bed for previous problem. Draw the water surface profile.

**Problem 8.8:** Uniform flow depth and velocity are $y_0$=1 m and V=5 m/s respectively;

a) Determine the flow regime

b) If a sill constructed on the channel bed has 10 cm height, does discharge flow over the sill with existing energy? Determine the water depth over the sill?

c) What is critical height of the sill?

d) If height of the sill constructed on the channel bed is 40 cm, calculate the water depth at upstream section of the sill.

**Problem 8.9:** Discharge flows in a channel with 10m width. Depth is 3 m and flow velocity is 2 m/s.

a) Determine the flow regime

b) Determine the minimum channel width with existing energy?

c) Draw the water profile.

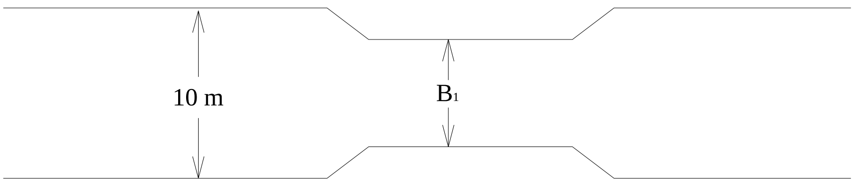



Figure 8.9

**Problem 8.10:** 15 m$^3$/s flowrate flows in a channel shown in Fig. 8.10. Assuming the roughness coefficient for the side channel and main channel n= 0.035. Side slopes are 1:2 and width of the channel is 5 m. Calculate the discharge in the channel. Bed slope is 10 m/km at the upstream section and it changes to 50 m/km at the downstream section.

**(a)** Find uniform water depth at the upstream and downstream section.

**(b)** Find the critical water depth at the upstream and downstream section.

**(c)** Find the Froude number at the upstream and downstream section. Determine the regimes.

**(d)** Draw water surface level.

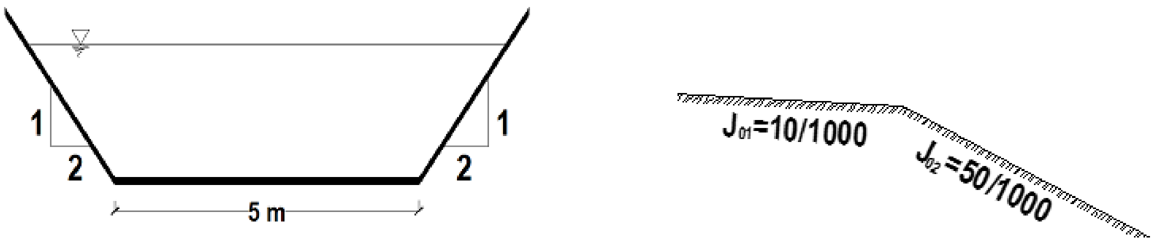
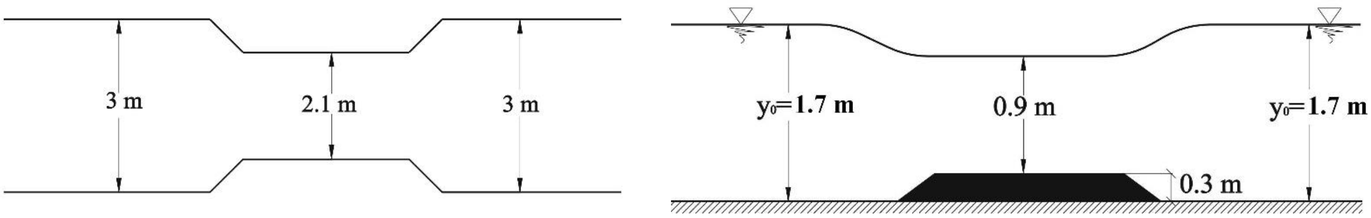



Figure 8.10

**Problem 8.11:** 7.2 m$^3$/s flowrate flows in a rectangular channel shown in the Figure below. Is water surface level shown in the cross-section possible?. Calculate the water level.




Plan Cross-section

**Problem 8.12:** A vertical sluice gate constructed in a rectangular channel with 6 m width, 0.0004 bottom slope and n=0.015. If discharge is 8 m$^3$/s and opening cause a hydraulic jump, calculate jump depths and force on the gate (neglect energy loss).

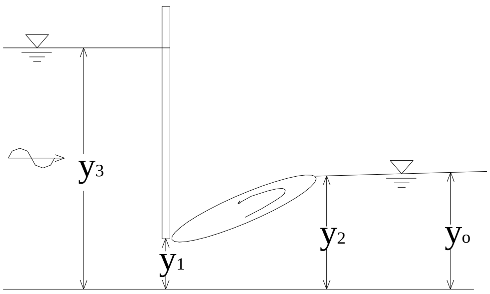



Figure 8.12

**Problem 8.13:** Discharge 20m$^3$/sn flows in a rectangular channel with 2.5 m of height. Width is 8 m, n=0.025 and bottom slope is 0.0004. Determine the depths far from1 and 2 km.

**Problem 8.14:** In a river; q=1.8 m$^2$/sn C=45 m$^{1/2}$/sn $J_0=10^{-4}$. At the control section of river x=0 (downstream of the river), 0.5 m of water level is above the uniform water depth. Calculate the water levels for different sections (x≠0).

$$\Delta x = x_2 - x_1 = \frac{y_0}{J_0}\{(\eta_2\eta_1) - \gamma[\psi(\eta_2) - \psi(\eta_1)]\}, \qquad \gamma = 1 - \frac{C^2 J_0}{g}, \qquad \eta = \frac{y}{y_0}, \qquad J_{kr} = \frac{g}{C^2},$$

$$y_o = \sqrt[3]{\frac{q^2}{C^2 J_o}},$$ $\psi(\eta)$: Bresse function

**Problem 8.15:** A trapezoidal channel of base width 6.1 m and side slopes 1.5(horizontal)/1(vertical) is laid on a slope 0.001 and carries a discharge of 28.4 m$^3$/sn. The channel terminates in a free overflow and it is desired to explore the "drawdown" to the overflow and the extent to which velocities are thereby increased. For this it is required to compute and plot the flow profile upstream from the overflow over the region where the velocity is at least 10 percent greater than at uniform flow. The Manning n=0.025.

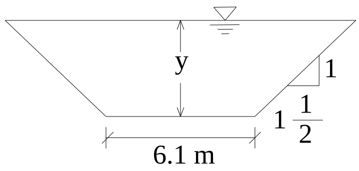



Figure 8.15

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## MODEL THEORY

**Problem 8.16:** Define Reynolds and Froude models. Is it possible to achieve both Reynolds and Froude models at the same time? Explain.

**Problem 8.17:** In a tidal model, the horizontal scale ratio is 1/500, the vertical scale is 1/50.

a) What model period would correspond to a prototype period of 12 hours 15 minutes?

b) If the horizontal scale ratio is 1/50000, the vertical scale is 1/500. What model period would correspond to a prototype period of 12 hours 15 minutes?

**Problem 8.18:** A model study of a fresh water breakwater that is proposed to be built in laboratory. This model's stability should test against wave forces. Model structure made of 1kg concrete blocks and this model has no damage for smaller wave height than 0.3 m. If prototype structure resists against 6m wave height, calculated the required block weight used in the prototype. (Ignore difference in fluid density between model and prototype, assume same block type is used both for prototype and model structure).