Problem VI:

A stream with the cross-section shown in the previous figure has a flow rate of 5m3/s. The stream has a longitudinal slope of 0.002 m/m and a natural stony bottom (n=0.05, stations 0 to 8).

a- Using Manning's equation, what is the water surface elevation of the stream?

b- What is the maximum capacity of the channel?

c- How would the capacity of the channel be affected if you were to pave the center of the channel (n=0.013) between stations 3 and 5?

Solution:

a. 1.69 m
b. 7.63 m^3/s
c. 8.49 m^3/s.

Problem VII:

A rectangular concrete channel with a width of 1 m and a height of 0.5m is on a slope of 0.008m/m. Design a concrete circular channel for which the depth is half of the diameter and the flow area is the same as that of the rectangular channel. Which channel is more efficient and by how much?

Solution:

Rectangular channel:

Wetted Area: 0.5 m^2

Flow: 1.37 m^3/s

Circular Channel:

In order to find the right diameter, half of the total area of the circular channel must be equal to the wetted perimeter mentioned above: $\frac{\pi R2}{2}$ = 0.5 ➔ R= 0.56 m ➔ D= 1.12 m.

Problem VIII:

A weir was placed in a rectangular channel to measure the flow. The discharge from the rectangular channel enters a trapezoidal channel with a stony bottom. The trapezoidal channel is 0.5m wide at the base with 2:1 (H: V) equal side slopes. The weir is sharp-crested, v-notch weir with a crest 0.43 m above the channel bottom, a weir coefficient of 0.58, and a notch angle of 1.57 radians. The height of the water above the weir is 0.7m, and the depth of water in the trapezoidal channel is measured to be 0.40m.

What is the flow rate? What is the slope of the trapezoidal channel (using Manning's formula)? If the discharge is increased until the elevation of the water surface in the trapezoidal channel reaches 0.61m, what will the headwater elevation be at the weir?

Solution:

- Flow Rate: 0.56 m^3/s (Head water elevation = 0.7+0.43)
- Slope of the Trapezoidal channel: 1.024%
- Q=1.43 m3/s ,h =1.45m

Problem IX:

The outlet structure on a pond is used to regulate the flow out of the pond for different storm events. An outlet structure must be designed to discharge 2.20 m^3/min when the water surface elevation in the pond reaches 1.52m, and 6.29 m^3/min when the water surface elevation reaches 2.60m. The outlet structure will be a circular orifice and a sharp-crested rectangular weir combination, with the centroid of the orifice at an elevation of 0.9m and the weir crest at an elevation of 2.50m. Both will discharge to free outfall conditions.

Assume an orifice coefficient of 0.6. Find the orifice diameter needed to supply the correct discharge when the water surface reaches the first specified elevation. What will the discharge from the orifice be when the water surface reaches the second specified elevation? Find the width of the weir needed to supply the extra discharge necessary to meet the requirement. Use Manning's formula where necessary.

Solution:

- D=0.15 m
- the discharge increases to 3.64 m^3/s
- When the water surface elevation reaches 2.6 m, the remaining discharge left to handle is 6.29 - 3.64 = 2.5 m^3/s and with a weir coefficient of 1.84 the crest length is equal to 0.76m.

Problem X:

An approximately trapezoidal, clean, natural stream carries the discharge from a pond down a 0.001 slope. The maximum depth in the channel is 0.5m. The channel has equal side slopes of 3.0 (H: V) and a bottom width of 1.0m. The pond discharges water through a circular orifice into the channel. The centroid of the orifice is located 1.0m above the bottom of the channel.

Assume an orifice coefficient of 0.6. Design the orifice to discharge the maximum flow rate possible without exceeding the maximum allowed depth in the channel when the water surface in the pond reaches 4.6 m above the channel bottom. Use Manning's formula when necessary.

Solution:

- In the trapezoidal channel the discharge calculated was 0.59 m^3/s.
- To find the orifice diameter, the maximum flow that the orifice could discharge is 0.59 m^3/s, after calculation we found that the correct diameter would be equal to 0.39 m.