EXAMPLE

1. Water flows uniformly in a 2m wide rectangular channel at a depth of 45cm. The channel slope is 0.002 and n=0.014. Find the flow rate in cumecs.
2. At what depth will water flow in a 3m wide rectangular channel if n=0.017, S=0.00085 and Q=4cumecs.
3. A rectangular channel 10m wide carries 8cumecs when flowing 1m deep, what is the specific energy? Is the flow sub-critical or supercritical

ASSIGNMENT

A rectangular channel 3m wide carries $10m^3/s$ (a) Tabulate depth of flow against specific energy for depths 0.3 to 2.4m (b) Determine the minimum specific energy (c) What type of flow exists when the depth is 0.6m and when it is 2.4m? (d) When n=0.013 what slopes are necessary to maintain the depths I (c)

CRITICAL DEPTH IN NON-RECTANGULAR CHANNELS

The theory presented dealt with only channels of rectangular section but such channels are not common in practice.

In natural rivers the waterway may have a most irregular section.

The trapezoidal section being often preferred in the interest of economy and bank stability

$$E = y + \frac{V^2}{2g}$$

To explore the dependence of E on y we can no longer use the discharge per unit width q, since it has lost its specific meaning.

$E = y + \frac{Q^2}{2gA^2}$ where Q is the total discharge and A is the whole cross section.

We can find the condition of minimum specific energy by differentiation

$$\frac{dE}{dy} 1 - \frac{Q^2 dA}{gA^3 dy}$$

$$\frac{dE}{dy} = 1 - \frac{Q^2 B}{gA^3} = 0$$

condition for E minimum or Critical flow or depth is

$$Q^2 B = gA^3$$
$$V_c^{\ 2} A^2 B = gA^3$$
$$V^2{}_c = \frac{gA}{B}$$
$$V_c = \sqrt{\frac{gA}{B}}$$

EXAMPLES

1. An open channel conveying water is of trapezoidal cross section, the base width is 1.5m and side slopes are at 60 degrees to the horizontal. The channel is 1in 400 and the depth is constant at 1meter. Calculate the discharge in m^3/s. If the Chezy C is calculated from Basin relationship as shown below.

$C = \frac{87}{1 + \frac{0.2}{\sqrt{R}}}$ $Q = AC\sqrt{RS_o}$ R= hydraulic Radius

2. A trapezoidal channel has a bottom width of 6m side slopes of 2H 1V is to carry a flow of $25m^3/s$. Calculate the critical depth and velocity.

1. A trapezoidal channel has a bottom width of 6m and side slopes of 2H:1V. When the depth of water is 1m, the flow is $10m^3/s$. What is the specific energy, is the flow sub critical or super critical?

NON-UNIFORM FLOW

There are two types of non-uniform flow:

(i) Gradually varied flow i.e. the condition changes over a long distance

(ii) Rapidly varied flow – the change takes place abruptly

DETAIL DISCUSSION IN THE CLASS AFTER THE READING ASSIGNMENTS.

COMPUTING THE GRADUALLY VARIED FLOW PROFILE

There are several methods of solution; (i) a case of uniform x-section and slope (ii) natural channels having irregular x-section and slope

METHODS AVAILABLE

(i) The numerical methods i.e Standard Step method, distance calculated from depth

(ii) Direct integration methods

(iii) Graphical methods

STANDARD STEP METHOD

As demonstrated in the last lecture

$$y_1 + \frac{V_1^2}{2g} = y_2 + \frac{V_2^2}{2g} + (S - S_0)L$$

$$E_1 = E_2 + (S - S_0)L$$

$$L = \frac{E_1 - E_2}{S - S_0} = \frac{\Delta E}{S - S_0}$$

Which means that $\frac{\Delta E}{\Delta x} = S - S_0$

$\frac{\Delta E}{S - S_0} \Delta x$ distance

EXAMPLE

1. A rectangular channel 3.5m wide n=0.014 runs on a slope of 0.001 from a lake whose surface level is 3.5m above the channel bed at the lake outlet. A free overfall is to be located at some downstream section, how far should it be from the lake outlet so as to make the depth at the outlet 1% less than it would have been if no overfall were present.
2. Water flows uniformly at a steady rate of 0.4m3/s in a very long triangular flume which has a side slopes of 1:1. The bottom of the flume is on a slope of 0.006 and n=0.012. Is the flow sub-critical or supercritical?
3. A channel has a trapezoidal cross section with a base width of 0.6m and sides sloping at 45^o. When the flow along the channel is $20m^3$/minute determine the critical depth.
4. A smooth transition is to be made from a trapezoidal channel with bottom width 2m and side slope 2H:1V, to a rectangular channel 2m wide. The flow rate is 18m3/s and the depth in the trapezoidal channel is 2m. Calculate the change in bottom elevation of the rectangular channel to avoid choking. Neglect energy losses.
5. (a) A storm water drainage channel is 12m wide and has steep banks (assume rectangular) it slopes 1:2500 in the direction of flow, if Chezy C=50 for the channel boundary and its design discharge equals $35m^3$/s what is the corresponding depth of flow? (b) A broad crested weir 3m high with ann 18.5m crest length is built across the channel what would be it's effect on the water surface elevation 4km upstream from the weir. Weir formula $Q = 1.85BH^{3/2}$

6. A trapezoidal drainage channel have the following characteristics.b=6m, side slopes 2H:1V, So=0.0016, n=0.025, Q=12m3/s, $\alpha = 1.1$. A dam backs the water up to a depth of 1.5m immediately behind the dam. Calculate the distance upstream from the dam to a point where the depth of flow is 1% greater than normal depth, note that $\frac{\alpha V^2}{2g} = \frac{1.1V^2}{2g}$.