MILITARY INSTITUTE OF SCIENCE & TECHNOLOGY

CE 362
Open Channel Flow Sessional
Experiment No. 09
Determination of Change in Water Level Due to Raised Channel Bottom

9.1 General:

A transition can be defined as a change in direction or slope or cross-section (i.e. change in bed level and/or width) of a channel that produces a change, either temporary or permanent, in the state of the flow in the channel. The concept of specific energy and critical depth are very useful in the analysis of problems connected with transitions. This experiment deals with determination of change in water level due to a change in the bed level.

9.2 Theory:

Consider a horizontal, frictionless rectangular channel of width B carrying a subcritical flow with discharge Q at depth y_1 (depth of section (1) of fig. 9.1).

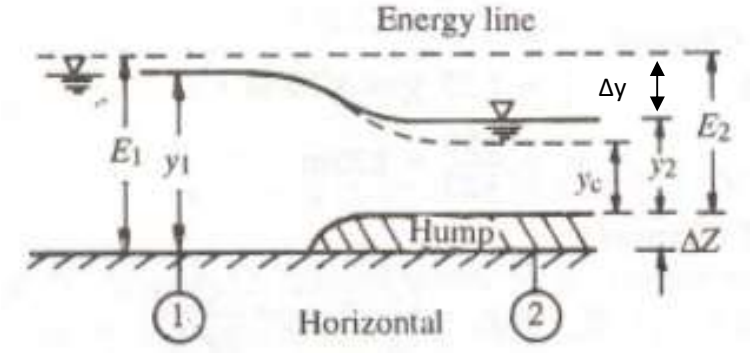


Fig. 9.1: Channel transition with a hump

At another section (2) (Fig. 9.1) a smooth hump of height △z is built on the channel floor. Since there are no energy losses between sections (1) and (2), and construction of a hump causes the specific energy at section (2) to decrease by △z. Thus the specific energies at sections (1) and (2) are given by

$$E_1 = y_1 + \frac{v_1^2}{2g} \tag{9.1}$$

$$E_2 = y_2 + \frac{v_2^2}{2g} \tag{9.2}$$

Where, V_1 and V_2 are the mean velocities at section (1) & (2). Since the flow at section (1) is subcritical, the water surface may drop due to decrease in the specific energy at section (2).

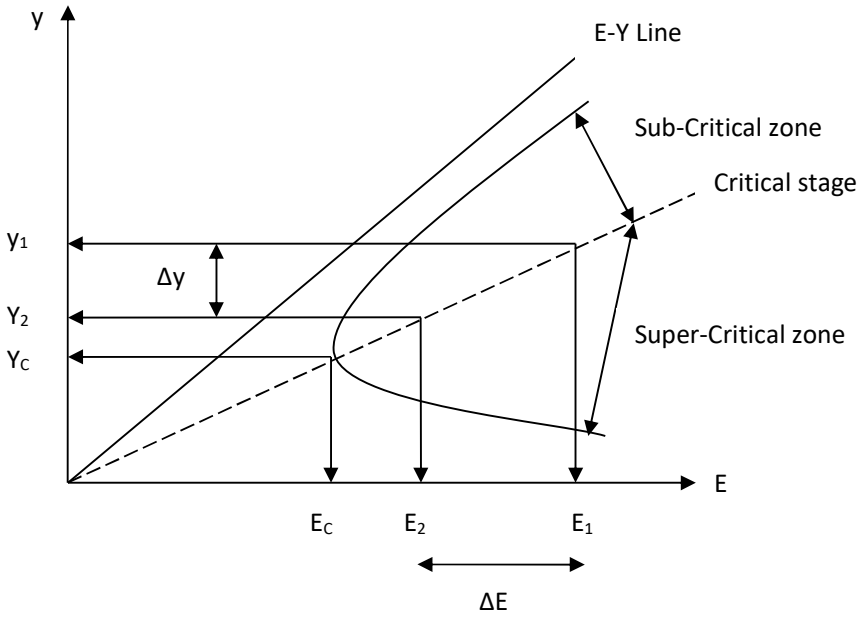


Fig. 9.2: Specific energy curve

Change in Energy, $\triangle z = E_1 - E_2$ (9.3)

and, change in water level, $\triangle y = y_1 - y_2 - \triangle z$ (9.4)

Critical depth y_c gives an idea about the state of flow on the hump. If the flow depth y_2 is less than y_c, the flow on the hump will be supercritical and if the flow depth y_2 is more than y_c, the flow will be subcritical.

$$y_c = \sqrt[3]{\frac{Q^2}{gB^2}} \quad (9.5)$$

9.3 Objectives:

1. To observe the flow profile above the hump.
2. To determine state of flow at a cross-section of the hump.
3. To determine change in water surface above the hump.

9.4 Apparatus:

Rectangular flow channel (Fig 9.3), Broad-crested weir (Fig 9.4), Instrument carriage (Fig. 9.5).



Fig 9.3: Rectangular flow channel.

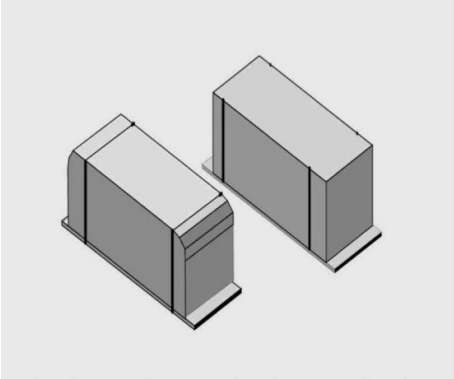


Fig 9.4: Broad-crested weir.

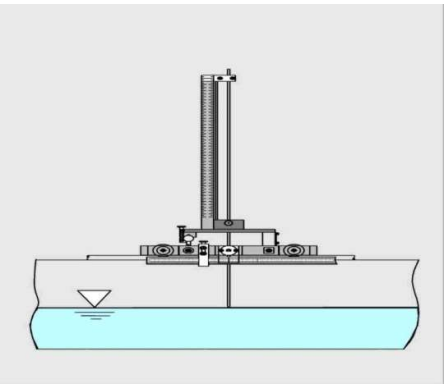


Fig 9.5: Instrument carriage.

9.5 Procedure:

1. Measure the depths of flow at section (1) and section (2) by point gauge.
2. Take the reading of discharge from water meter.
3. Calculate velocities at both sections.
4. Calculate E_1 and E_2 for both sections, using Eq. 9.1 and Eq. 9.2, and determine the hump height $\triangle z$ by using Eq. 9.3.
5. Calculate the change in water level using Eq. 9.4
6. Calculate the critical depth, y_c, using Eq. 9.5.

1.6 Data Sheet:

Determination of change in water level
due to raised channel bottom

Flume width, B = Actual discharge, Q =

Critical depth, y_c =

Table 9.1: Determination of drop in water surfacedue to raised channel bottom.

Section	Depth of flow, y (m)		Velocity of flow, v (m/s)	Velocity head, $\frac{v^2}{2g}$ (m)	Specific energy, $E=y+\frac{v^2}{2g}$ (m)	Hump height, $\triangle z$ (m)	Change in water level, $\triangle y$ (m)	State of flow
1 (Before hump)								
2 (Above hump)								

Name : Group :

Roll : Date :

Signature of Teacher



9.7 Calculations and Results:

9.7.1 Detailed Calculations:

9.7.2 Final Results:

9.8 Discussions:

9.8.1 Comments on Results:

9.8.2 Sources of Errors and Precautions:

9.9 Assignments:

1. Water flows at a velocity of 1 m/s and a depth of 1.5 m in a long rectangular channel 3 m wide. Compute the change in water level produced by (i) a smooth upward step of 0.45 m (ii) a smooth upward step of 0.80 m. In all cases neglect energy losses.

2. A rectangular channel 2.5 m wide carrries 6.0 m^3/s of flow at a depth of 0.50 m. Calculate the height of a flat topped hump required to be placed at a section to cause critical flow. The energy loss due to obstruction of the hump can be taken as 0.1 times the upstream velocity head.

9.10 References:

1. Subramanya, K. (1998): Flow in Open Channels, Chapter–2 (Energy depth relationship)

2. Halim, M. A. (2008): Open channel flow, Chapter–3 (Specific energy and critical flow).


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