

Module1: Open Channel Flow

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1	Classification, types and regimes in Open channel flow.
2	Channel geometry.
3	Velocity distribution in open channel, Wide-open channel.
4	Specific energy and Critical flow.
5	Computation of critical flow.
6	Momentum in open channel flow, Specific force.

Lecture 1

Types of open channel flow and regimes

TYPES OF OPEN CHANNEL

- Open channels are natural or manmade conveyance structures which have a free surface at atmospheric pressure. For example, flow in rivers, streams, flow in sanitary and storm sewers flowing partially full.

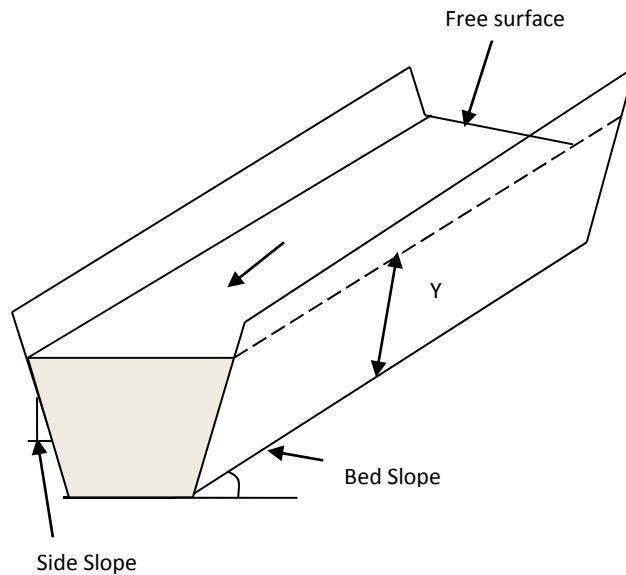


Figure 1.1: - A trapezoidal shaped open channel

- *Flume* is the channel made of wood, metal, concrete or masonry usually supported on or above to carry out water across a depression.
- A chute is a channel having steep slopes.
- A drop is similar to chute but the change in the elevation is effected in a short distance.
- A culvert when partially full is a covered channel installed to drain water through highways or railways embankment.

PRISMATIC AND NON-PRISMATIC CHANNELS:

- A channel in which the cross sectional shape, size and the bottom slope are constant is termed as *prismatic channel*.
- All natural channels generally have varying cross section and consequently are *non-prismatic*.
- Most of the man made channels are prismatic channels over long stretches. The rectangle, trapezoid, triangle and circle are commonly used shapes in manmade channels.

RIGID AND MOBILE BOUNDARY CHANNELS:

- *Rigid channels* are those in which the boundary is not deformable. The shape and roughness magnitudes are not functions of flow parameters. For example, lined canals and non erodible unlined canals.
- In Rigid channels the flow velocity and shear stress distribution will be such that no major scouring, erosion or deposition will take place in the channel and the channel geometry and roughness are essentially constant with respect to time.
- When the boundary of the channel is mobile and flow carries considerable amounts of sediment through suspension and is in contact with the bed. Such channels are classified as *mobile channels*.
- In the mobile channel, not only depth of flow but also bed width, longitudinal slope of channel may undergo changes with space and time depending on type of flow.
- The resistance to flow, quantity of sediment transported and channel geometry all depends on interaction of flow with channel boundaries.
- A general mobile boundary channel can be considered to have four degree of freedom. In rigid channel we have one degrees of freedom.

FLOW REGIMES

STEADY AND UNSTEADY FLOWS

- A *steady flow* occurs when the flow properties, such as the depth or discharge at a section do not change with time.
- If the depth or discharge changes with time, the flow is termed *unsteady*.
- Flood flows in rivers and rapidly varying surges in canals are some examples of unsteady flow.

UNIFORM AND NON-UNIFORM FLOWS

- If the flow properties, say the depth of flow, in an open channel remain constant along the length of the channel, the flow is said to be *uniform*.
- A flow in which the flow properties vary along the channel is termed as *non-uniform flow*.
- A prismatic channel carrying a certain discharge with a constant velocity is an example of uniform flow.
- In uniform flow, the gravity force on the flowing liquid balances the frictional force between the flowing fluid and inside surface of the channel, which is in contact with the fluid. In case of non-uniform flow, the friction and gravity force are not in balance.

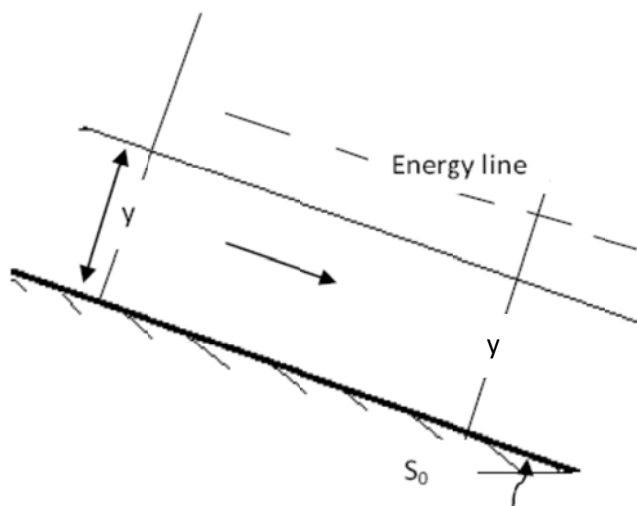


Figure 1.2 :- Uniform flow through open channel

GRADUALLY VARIED AND RAPIDLY VARIED FLOW

- The non-uniform flow can be classified as gradually varied flow (GVF) and rapidly varied flow (RVF).
- Varied flow assumes that no flow is externally added to or taken out of channel system. The volume of water in a known time interval is conserved in the channel system
- If the change of depth in a varied flow is gradual so that the curvature of streamlines is not excessive, such a flow is said to be gradually *varied flow (GVF)*. Figure 1.3 shows water surface profile of a GVF; here y_1 and y_2 are the depth at section 1 and 2 respectively
- In GVF, the loss of energy is essentially due to boundary friction. Therefore, the distribution of pressure in the vertical direction may be taken as *hydrostatic*.
- If the curvature in a varied flow is large and the depth changes appreciably over short lengths, such a phenomenon is termed as *rapidly varied flow*.

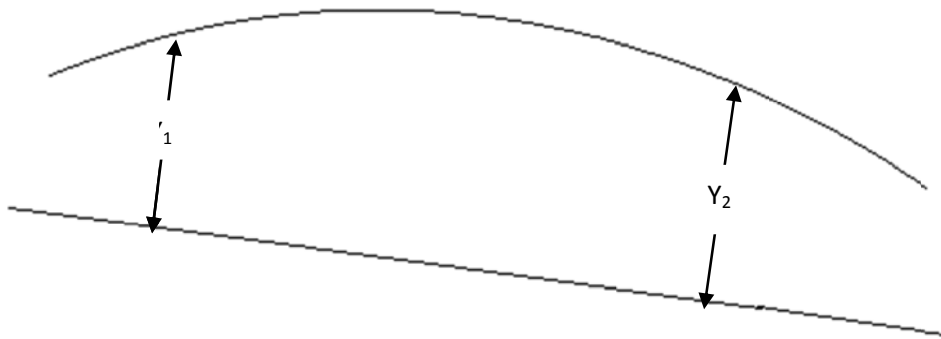


Figure1.3: Gradually varied flow through Open channel

SPATIALLY VARIED FLOW (SVF)

- If some flow is added to or subtracted from the system, the resulting varied flow is a spatially varied flow.
- SVF can be steady or unsteady. In steady SVF, the discharge while being steady varies along the channel length. The flow over a side weir is an example of steady flow.

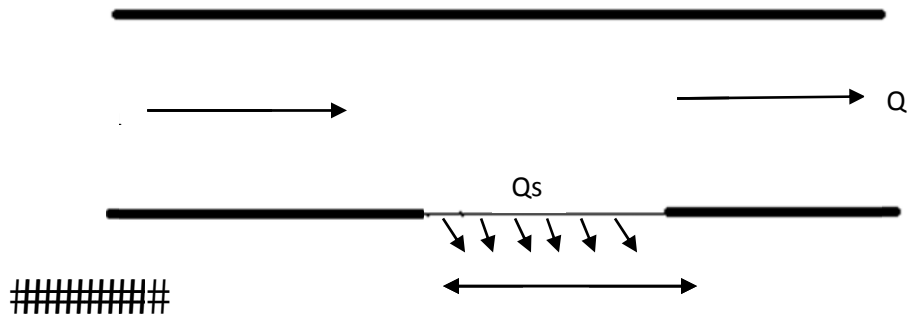


Figure 1.4: Spatially varied flow through Open channel