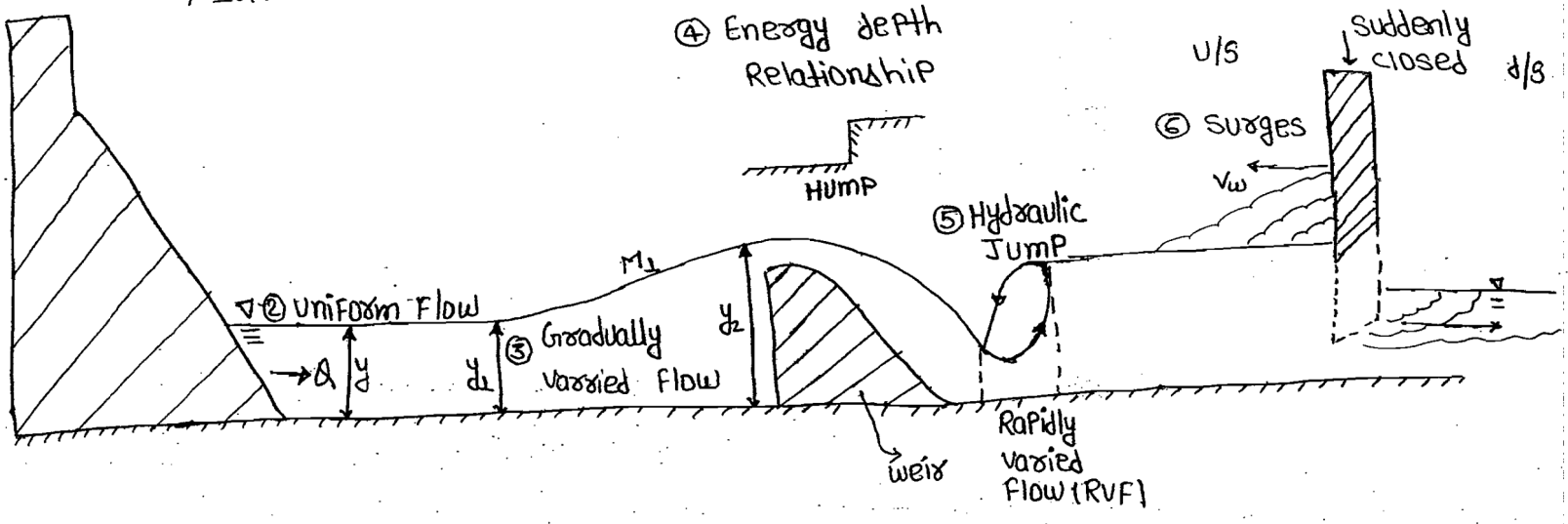
Open Channel Flow

1) Introduction

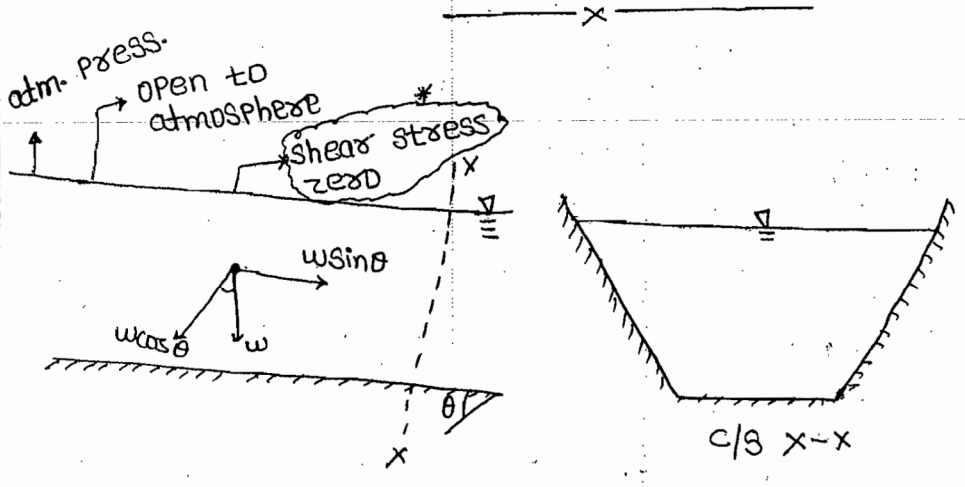


* OCF में हम lined Canal के बारे में पढ़ते हैं यानि Rcc dam not ~~gates~~ the earthem dam. (gravitational dam)

* In OCF में हम यह पढ़ते हैं कि कोई dam से ~~पता~~ uniform flow हो रहा है। यानि ~~depth~~ time के साथ depth change नहीं हो रहा कुछ distance पर weir आगर रहता है तो पानी o उसके पर से Smothly rise करता है। यानि uniform से Gradually varried flow होता है। जब पानी weir से नीचे जाता है तो high energy से low energy में जाता है। तो पानी का flow rapidly varied करता है। और ~~उसमे~~ hydraulic Jump देखते हैं। इसी में हम Energy और depth का Relationship find करते हैं। और जब यह पानी आगे जाता है। एक gate provide किया जाता है to control the flow of water. अगर इस gate को close करते हैं तो वहाँ पर Surges develop होता है। due to high flow & also in the downstream side. So इसे OCF में यही सब पढ़ना होता है।

Chapter:-1

Introduction



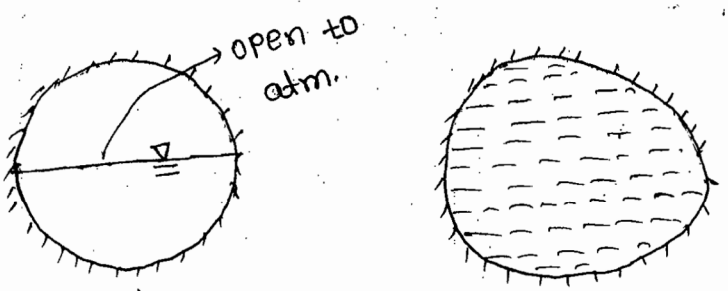
→ Open channel flow means a flow through channel that is open to atmosphere & has a free surface. In open channel driving force is gravity.

→ Flow takes place through the higher elevation to lower elevation.

→* Shear stress at the surface is zero.

Note:- A flow takes places through open channel or through pipe (Partially ~~fie~~ filled) then top surface is at atm. pressure hence it is reffered as open channel flow.

→ If liquid flows under pressure through and conduit without having a free surface is called pipe flow



Open channel flow

Pipe flow

Important terms in open Channel :-

① Base width (B)

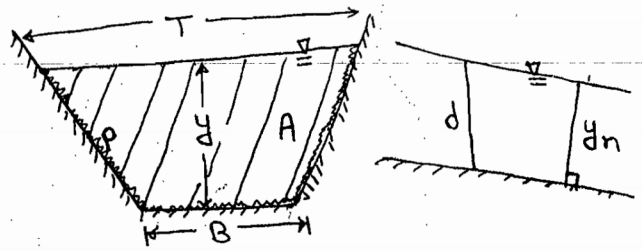
② Top width (T)

③ wetted Area (A)

④ wetted perimeter (P)

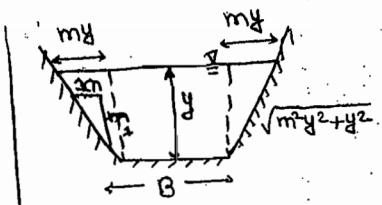
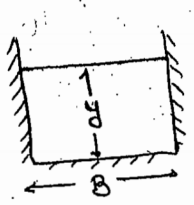
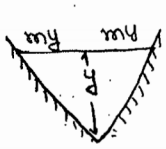
⑤ Normal depth of flow (y/yn)

⑥ vertical depth of flow (d)

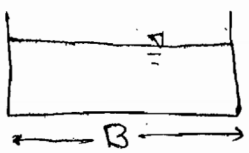


⑦ $$\text{Hydraulic Radius (R)} = \frac{\text{wetted Area (A)}}{\text{wetted perimeter (P)}}$$

⑧ $$\text{Hydraulic Depth (D)} = \frac{\text{wetted Area (A)}}{\text{Top width (T)}}$$

			
Area (A)	$By + 2\times\frac{1}{2} my \times y$ $\Rightarrow (By + my^2) = (B+my)y$	By	my^2
Perimeter (P)	$B + 2y\sqrt{1+m^2}$	$B + 2y$	$2y\sqrt{1+m^2}$
Top width (T)	$B + 2my$	B	$2my$

Note:- Very wide Rectangular Channel



$B >>> y$

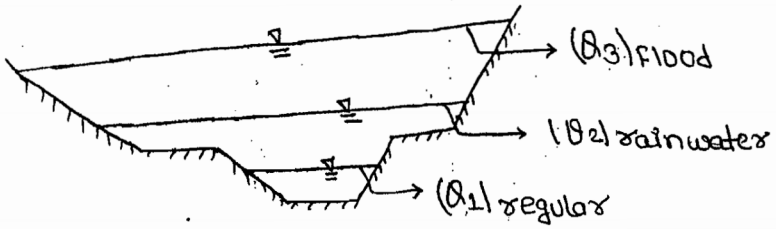
$B + 2y \sim B$

$$R = \frac{A}{P} = \frac{By}{B+2y} \simeq \frac{By}{B} = y$$

Classification of Channel based upon Channel characteristics

- Shape
- Slope & C/S
- Boundary
- Natural / Artificial

A) Classification based upon shape :-



Composite channel

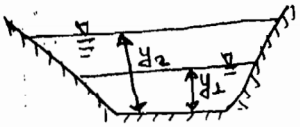
B) Classification based upon change in slope & C/s

- **Prismatic channel** :- Slope & C/S of Channel is same in the dirⁿ of flow.

- **Non-prismatic channel** :- slope & C/S changes.

C) Classification based upon boundary :-

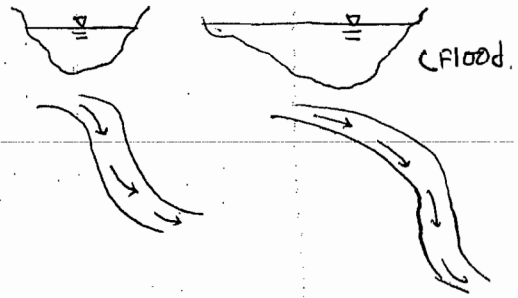
- **Rigid boundary**



  - Lined Canal (1 freedom)
    ↓
    only depth (y) changes

- Mobild boundary

- River (depth, c/s Area, slope, layout)
  ⇓
  4° freedom

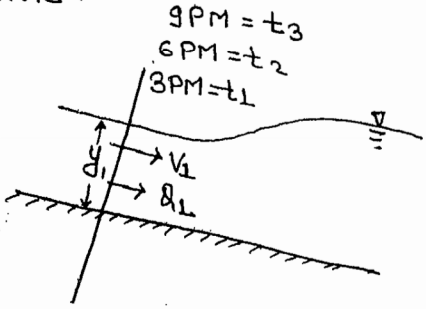


Classification of open channel flow based upon flow characteristics:-

① variation of flow parameters w.r.t time
② " " " " " space
③ Based upon turbulence
④ Based upon critical flow
⑤ Based upon direction of flow (1D, 2D, 3D flow)

① variation of flow parameters w.r.t time:-

Ⓐ **Steady flow:-** Flow parameters at a section do not changes with time.



$$\frac{dy}{dt} = 0 \qquad \frac{dV}{dt} = 0 \qquad \frac{dQ}{dt} = 0$$

Ⓑ **Unsteady Flow:-** Flow parameter at a section changes with time.

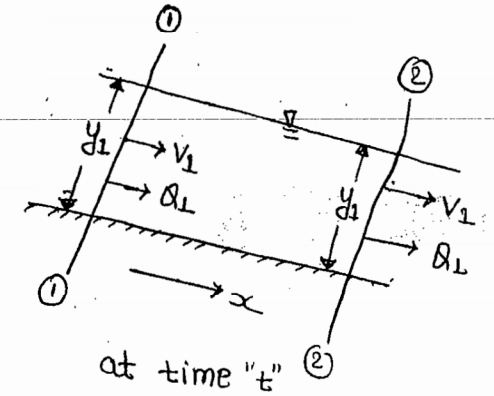
$$\frac{dy}{dt} \neq 0 \qquad \frac{dV}{dt} \neq 0 \qquad \frac{dQ}{dt} \neq 0$$

② Variation of Flow Parameters in Space :-

Ⓐ Uniform Flow :-

→ Flow Parameters at a time do not changes in space

$$\frac{dy}{dx}=0 \quad \frac{dv}{dx}=0 \quad \frac{dQ}{dx}=0$$

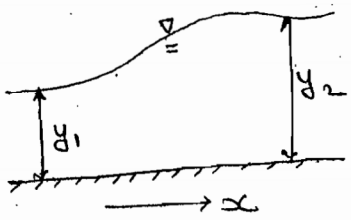


at time "t"

Ⓑ Non Uniform / Varied Flow :-

→ Flow Parameters Changes in space

$$\frac{dy}{dx}\neq 0 \quad \frac{dv}{dx}\neq 0 \quad \frac{dQ}{dx}\neq 0$$



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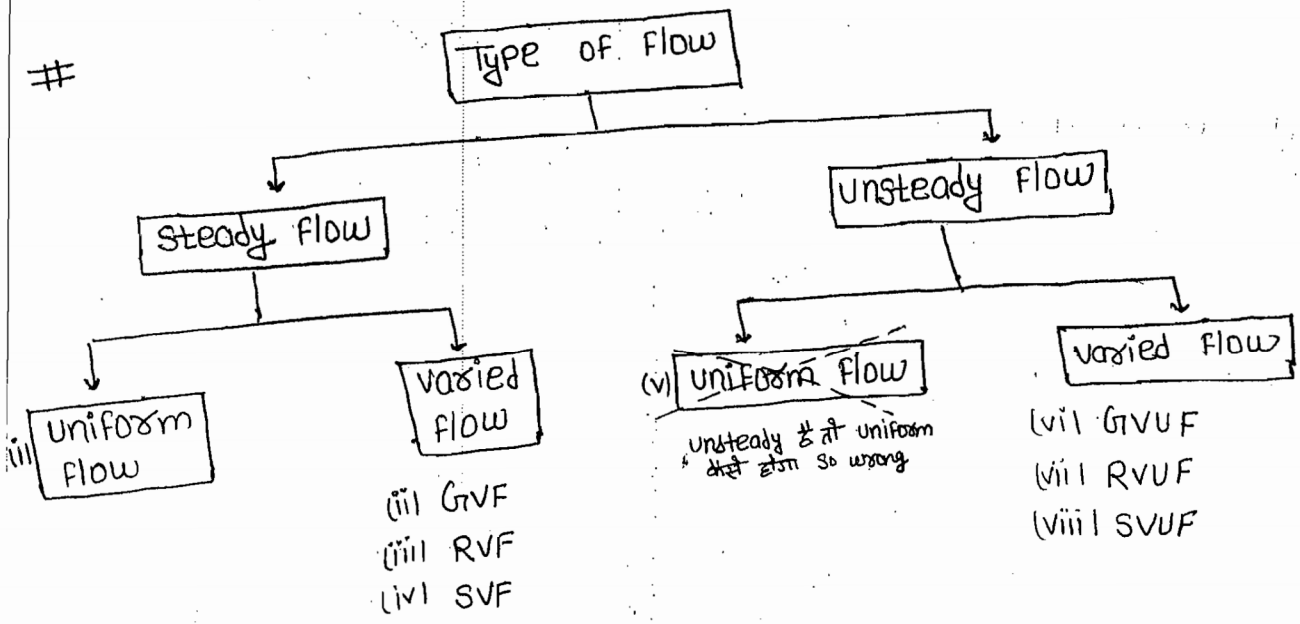
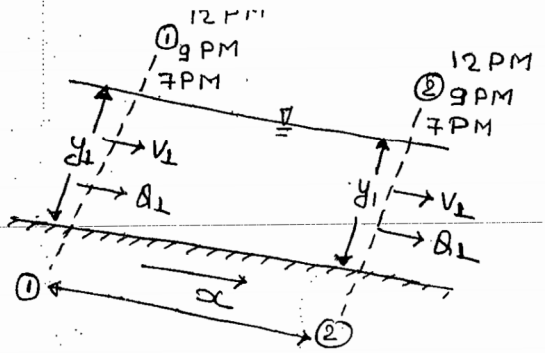


① Uniform Flow :- Flow parameter do not changes in space & time

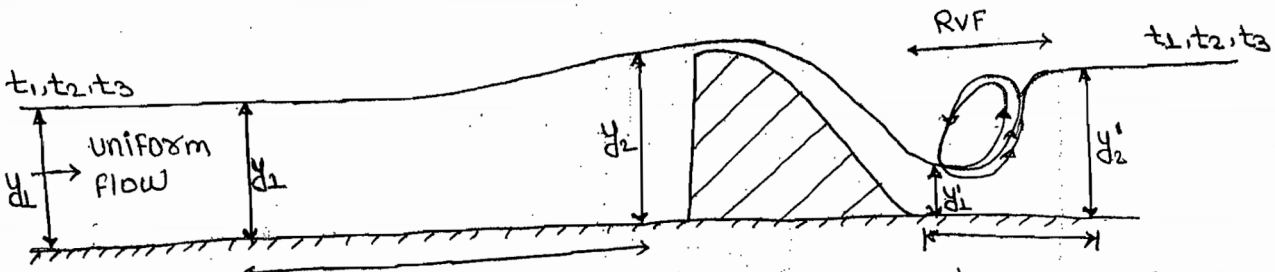
- Uniform flow will be steady also.

- $\frac{dy}{dt}=0$ $\frac{dv}{dt}=0$ $\frac{dQ}{dt}=0$

$\frac{dy}{dx}=0$ $\frac{dv}{dx}=0$ $\frac{dQ}{dx}=0$



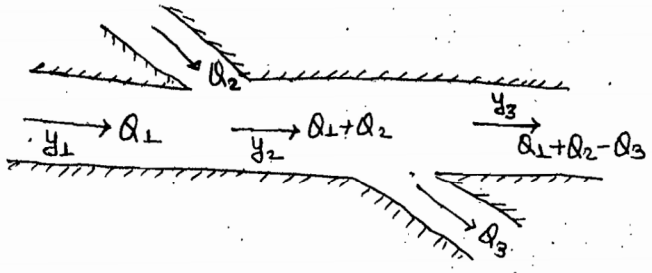
(iii) & (iii) Gradually varied flow (GVF) & Rapidly varied flow (RVF) :—



- change in long distance (km)
- water surface/curvature change in gentle/smooth

- change is in small distance (m)
- curvature change is sudden

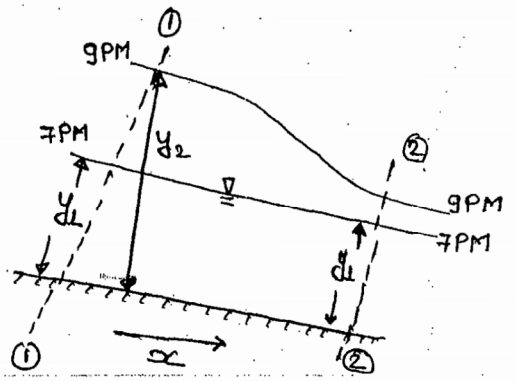
(iv) Spatially varied flow (SVF) :-



- Addition or extraction of discharge in main stream at constant rate

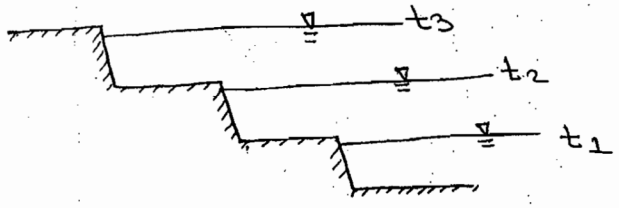
(v) Unsteady uniform flow :-

- Not found in natural condition.



- gF Flow Parameters are Changing with time at a section how it Can be same in Space.

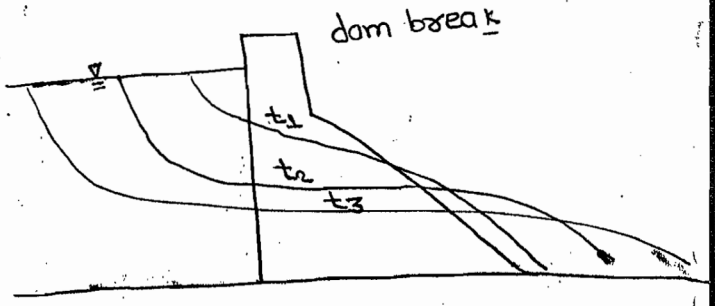
(vii) Gradually varied Unsteady Flow (GVUF) :-



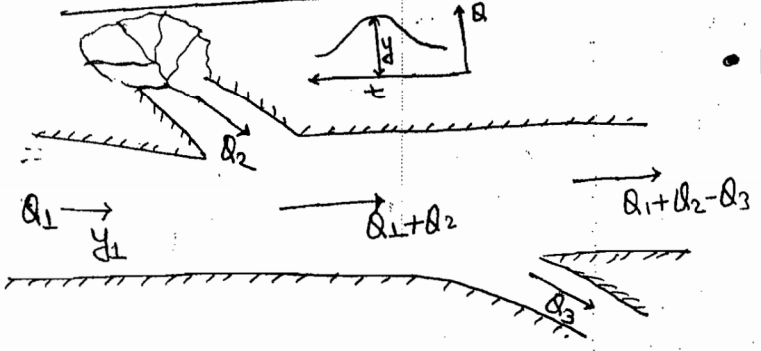
Flood

(viii) Rapidly varied Unsteady Flow (RVUF) :-

- Surges
- Tides / bore / afflux

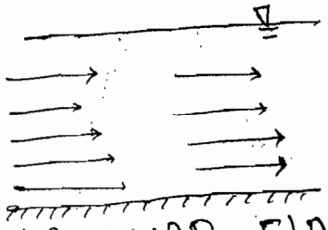


(viii) Spatially varied Unsteady Flow (SVUF) :-



- Addition (or) extraction of discharge at variable rate

(3) Variation of Flow based upon turbulence :-



LAMINAR FLOW

→ Flow in layers
→ NO mixing
→ Layers glide Smoothly over each other.