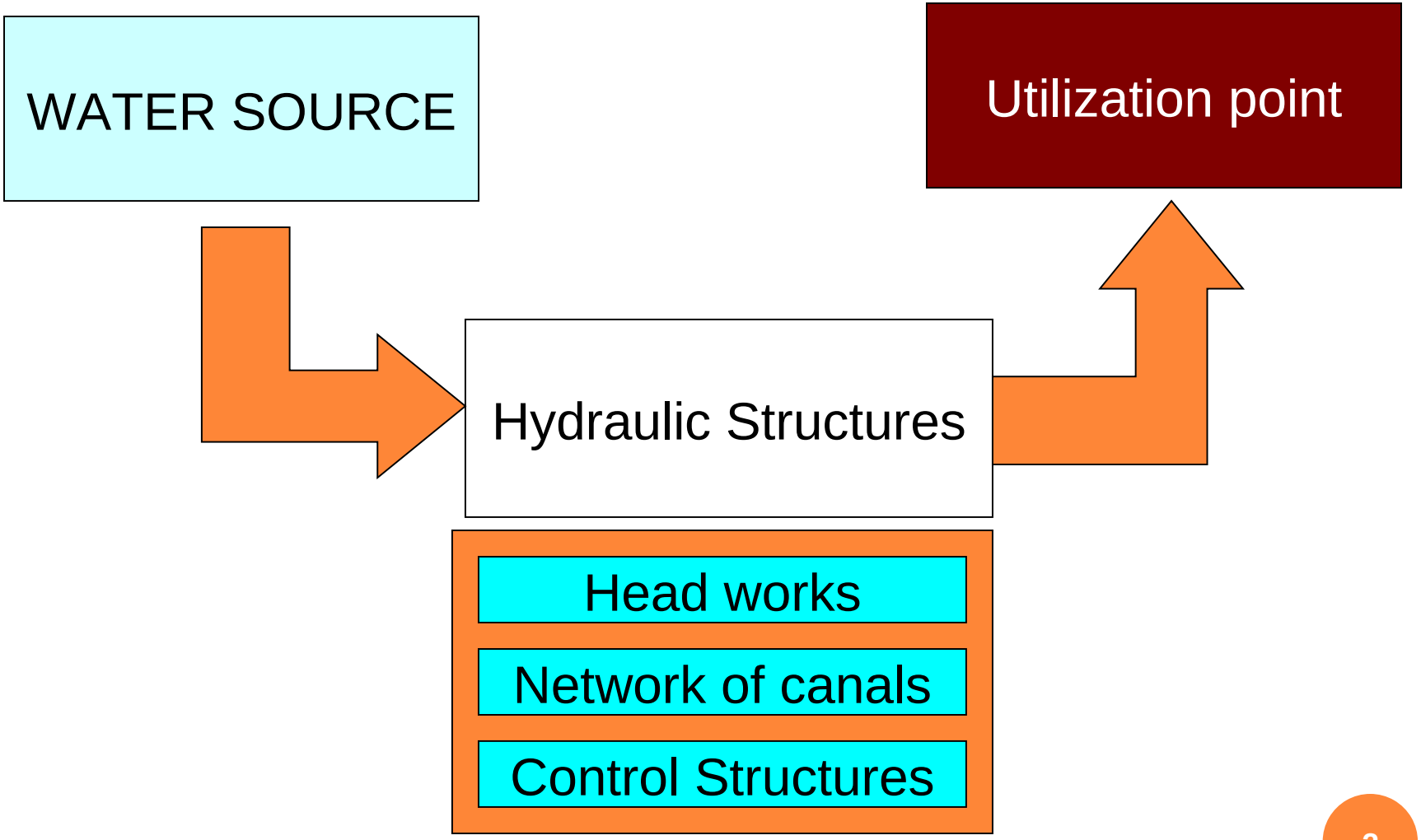
Chapter 3

DIVERSION HEAD



General:


WATER SOURCE
Utilization point
Hydraulic Structures
Head works
Network of canals
Control Structures

Introduction

- Any hydraulic structure which supplies water to the off-taking canal/conveyance structure is called a *headwork.*
- Headwork may be

  1. Storage headwork.
  2. Diversion headwork.

- A Storage headwork comprises the construction of a dam on the river. It stores water during the period of excess supplies and releases it when demand overtakes available supplies.

A diversion headwork serves to divert the required supply to canal from the river

Introduction

- **Headwork:** structures and hydro-mechanical equipment located at the upstream end of a water diversion system
- **Diversion works:** structures and hydro-mechanical equipment designed to divert and control the required discharge from the river. Eg. Dam,wier,barrage

In general;

- River diversion headwork is constructed at the head of the canal to divert the river water towards the canal, so as to ensure a regulated continuous supply of silt-free water with a certain minimum head into the canal.
- It usually provides a small storage capacity.

PURPOSES OF DIVERSION HEADWORK

- It raises the water level in the river so that the commanded area is increased
- It regulates the supply of water into the canal
- It provides storage of water for a short period
- It controls the entry of silt into the canal
- It reduces the fluctuations in the level of supply in the river.

SELECTION OF ACTUAL SITE FOR CANAL HEAD WORKS

- As far as possible a narrow, straight, well defined channel confined b/n banks not submerged by the highest flood.
- It should be possible to align the off taking canal in such a way that the command of its area is obtained without excessive digging.
- The material of construction such as stone, sand, etc. should be available in the vicinity of the site.
- The site should be accessible by road. And there should be (enough) workers available in the vicinity of project site.

Diversion Headwork -Components

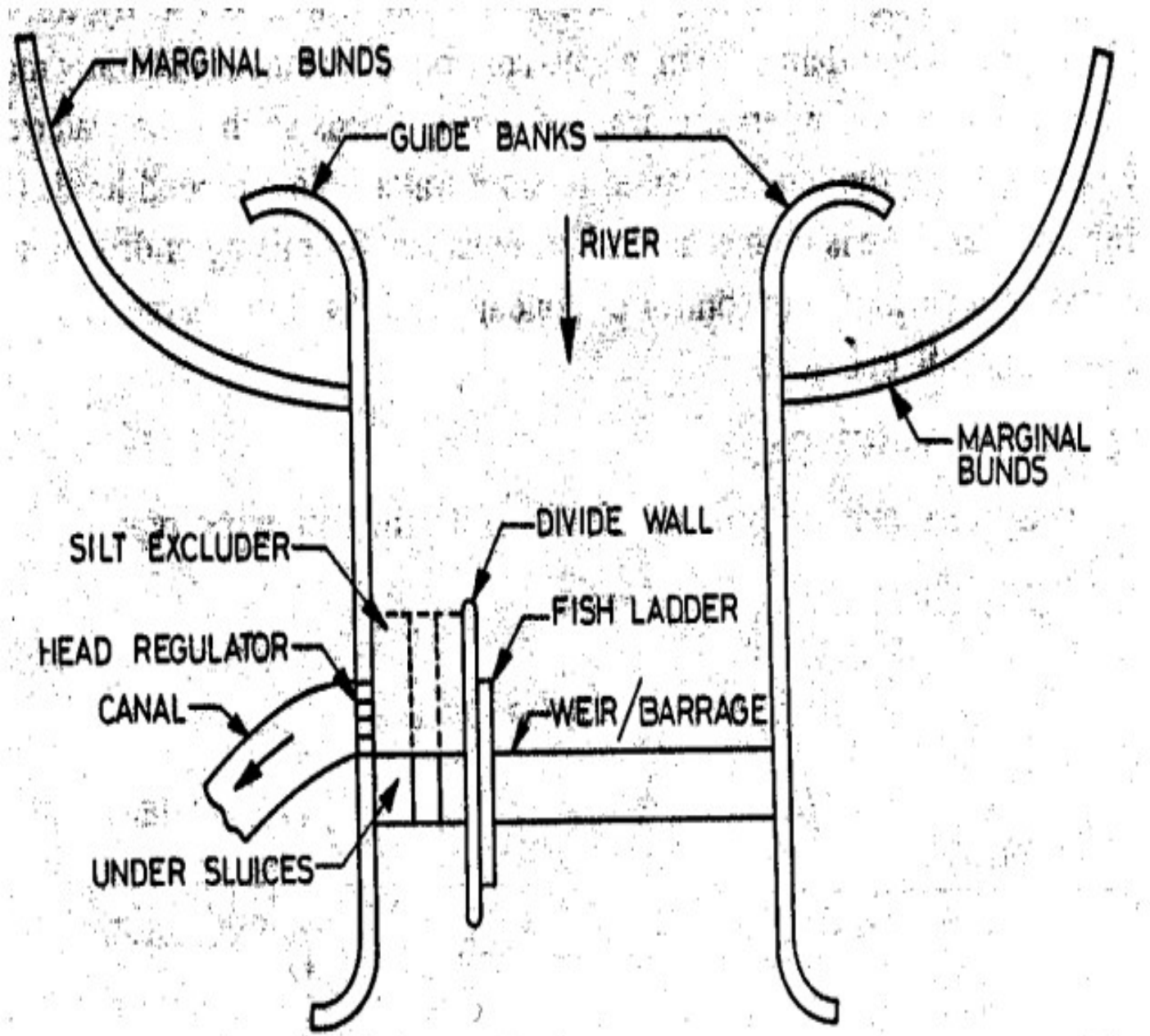
A typical diversion weir consists of:

1. Weir proper
2. Under sluices
3. Divide wall

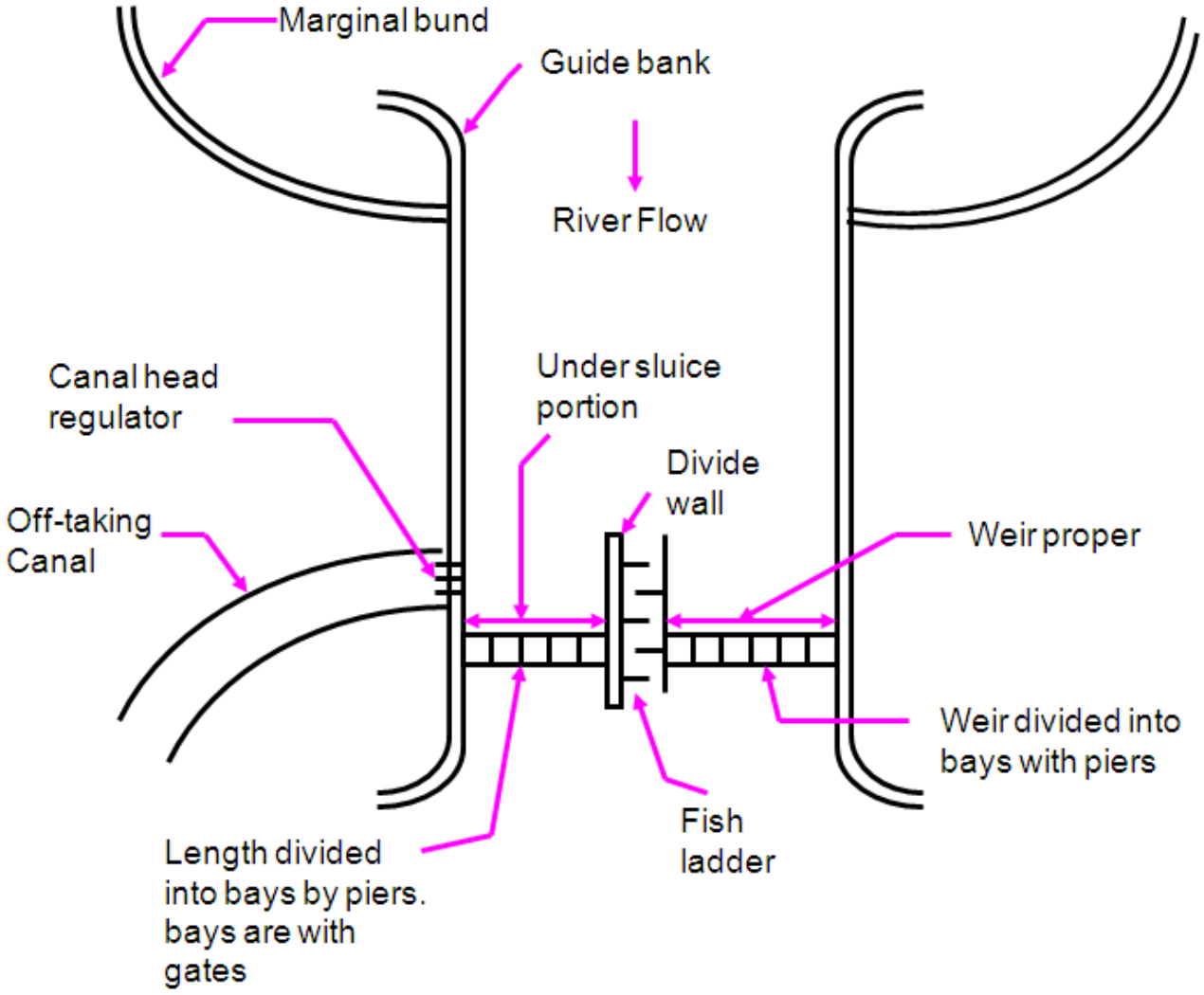
Main components

4. River training works –marginal bunds, guide banks, etc.
5. Fish ladder
6. Canal head regulator
7. Ancillary works – gates/shutters, etc.
8. Silt regulation works/silt excluder

TYPICAL LAYOUT OF DIVERSION HEADWORK



Diversion Head Work - Components



Typical Layout of a diversion head work

1.Weir and barrage

- If the major part or the entire ponding of water is achieved by a raised crest and a smaller or nil part of it is achieved by the shutters then this barrier is known as a ***weir.*** on the other hand most of the ponding is done by gates and a smaller or nil part of it is done by the raised crest then this barrier is known as ***barrage***. *Weirs and barrages are permanent river diversion works* and are relatively low dams constructed across a river to raise the river level sufficiently, to divert the flow in full/ in part into a supply canal or conduit for the purpose of irrigation, power generation, domestic and industrial uses, etc

1.Weir and barrage

- *Weirs are with or without gates, whereas barrages are always gate controlled.*

The Purpose is:

- To obstruct and divert the river flow into the canal
- To raise the water level in the river locally at the canal take-off point and helps in maintaining gravity flow Thus, reduces excessive cutting of the canal in the head ditch.
- To reduce the fluctuation in the water level of the river
- To enable diversion of silt-free water into the canal system

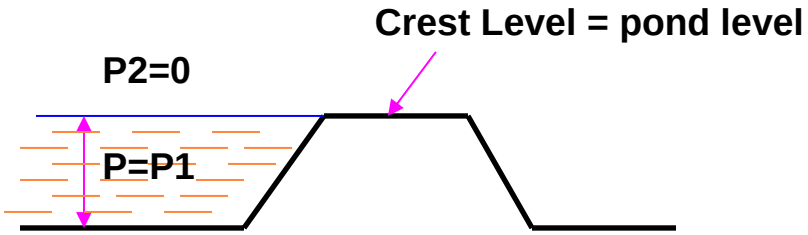
WEIR PROFILE



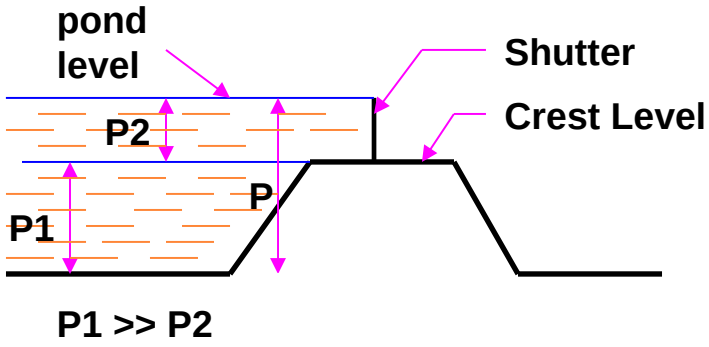
Barrage without raised crest



Weir and Barrage:

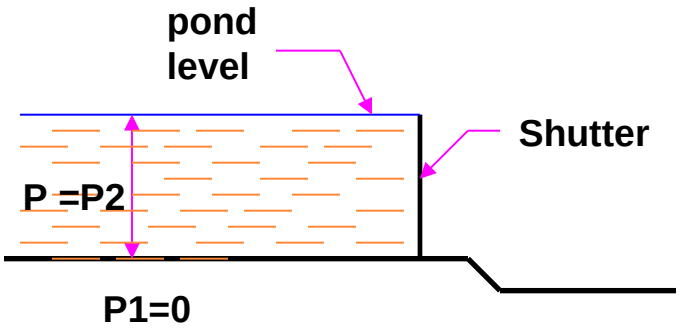


a) Without shutter

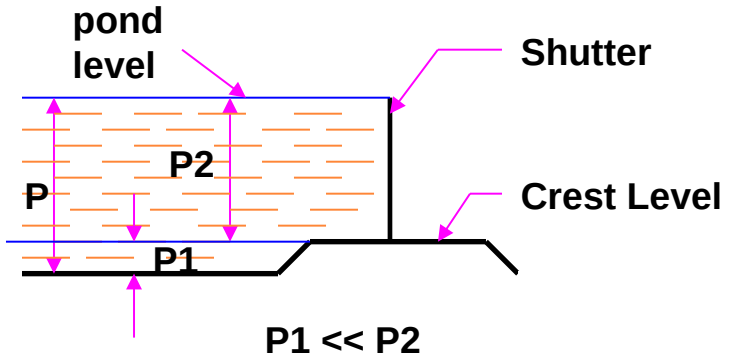


b) With shutter

Weir



a) Without crest



b) With crest

Barrage

Key: P = total ponding ; P1= Ponding by crest; P2= Ponding by shutter

Weir and Barrage:

Weir

- Most of the ponding of water is by a raised crest
- Has a small shutter or none
- The afflux during high flood is high
- Less control of river flow at times of flood.
- Not possible to construct road way
- Relatively cheap

Barrage (shuttered weir)

- Most of the ponding is by gates
- Has a small crest or none
- The afflux during high flood is nil or minimum
- A better control of river flow by manipulating gates
- a road way can be constructed
- Relatively expensive

WEIR AND BARRAGE

A weir maintains a constant pond level on its upstream side so that the water can flow into the canals with the full supply level.

✓If the difference between the pond level and the crest level is less than 1·5 m or so, a weir is usually constructed.

✓On the other hand, if this difference is greater than 1·50 m, a gate-controlled barrage is generally more suitable than a weir.

✓ In the case of a weir, the crest shutters are dropped during floods so that the water can pass over the crest.

✓During the dry period, these shutters are raised to store water upto the pond level.

✓Generally, the shutters are operated manually, and there is no mechanical arrangement for raising or dropping the shutters.

✓On the other hand, in the case of a barrage, the control of pondage and flood discharge is achieved with the help of gates which are mechanically operated

ADVANTAGES AND DISADVANTAGE OF WEIR

Weirs

- *Advantages*
  - **The initial cost of weirs is usually low.**
- Disadvantages
  - **There is a large afflux during floods which causes large submergence**
  - **Because the crest is at high level, there is great silting problem.**
  - **The raising and lowering of shutters on the crest is not convenient. Moreover, it requires considerable time and labor.**
  - **The weir lacks an effective control on the river during floods.**

BARRAGE – ADVANTAGES AND DISADVANTAGES

Barrages

- Advantage
  - **The barrage has a good control on the river during floods. The out flow can be easily regulated by gates**
  - **The afflux during floods is small therefore the submerged area is less**
  - **There is a good control over silt entry in to the canal**
  - **There is a good control over flow conditions**
  - **There are better facilities for inspection & repairs of various structures.**
  - **It is possible to provide a roadway across the river at a relatively small additional cost.**
- Disadvantage
  - **The initial cost of the barrage is quite high**

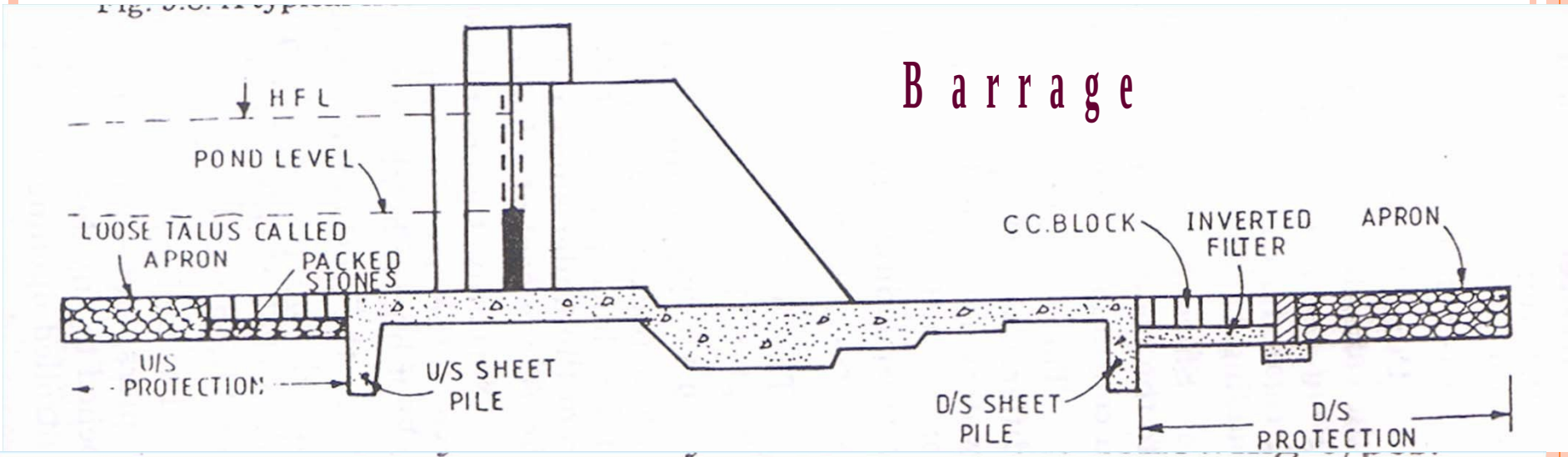


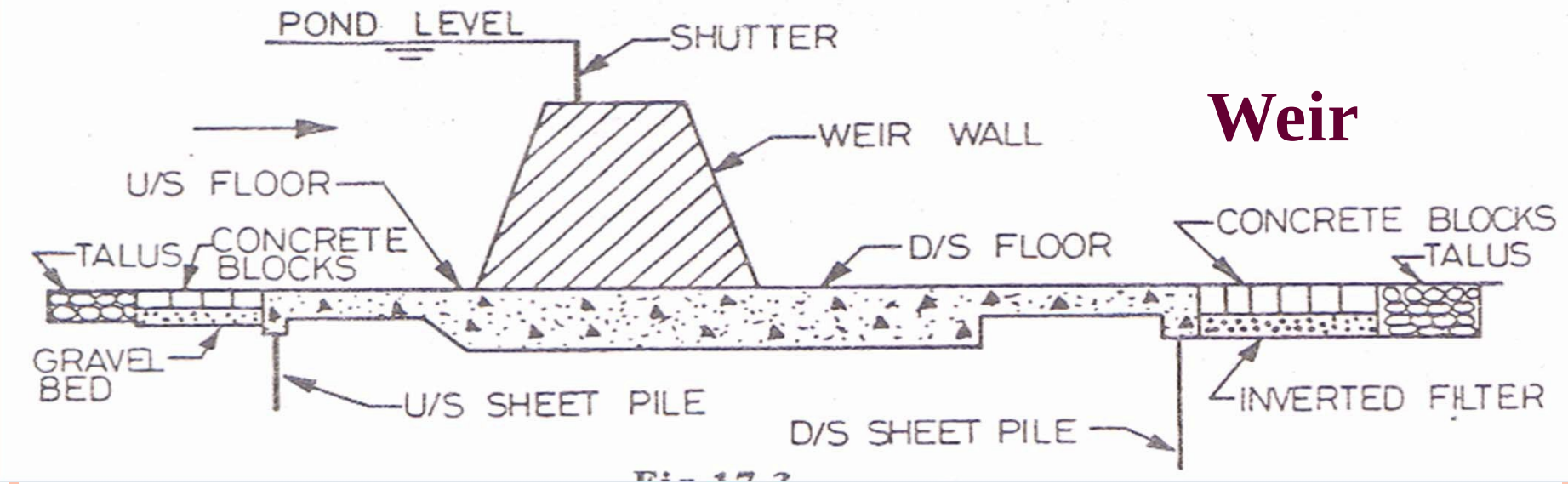
Small weir

Small barrage



WEIR AND BARRAGE



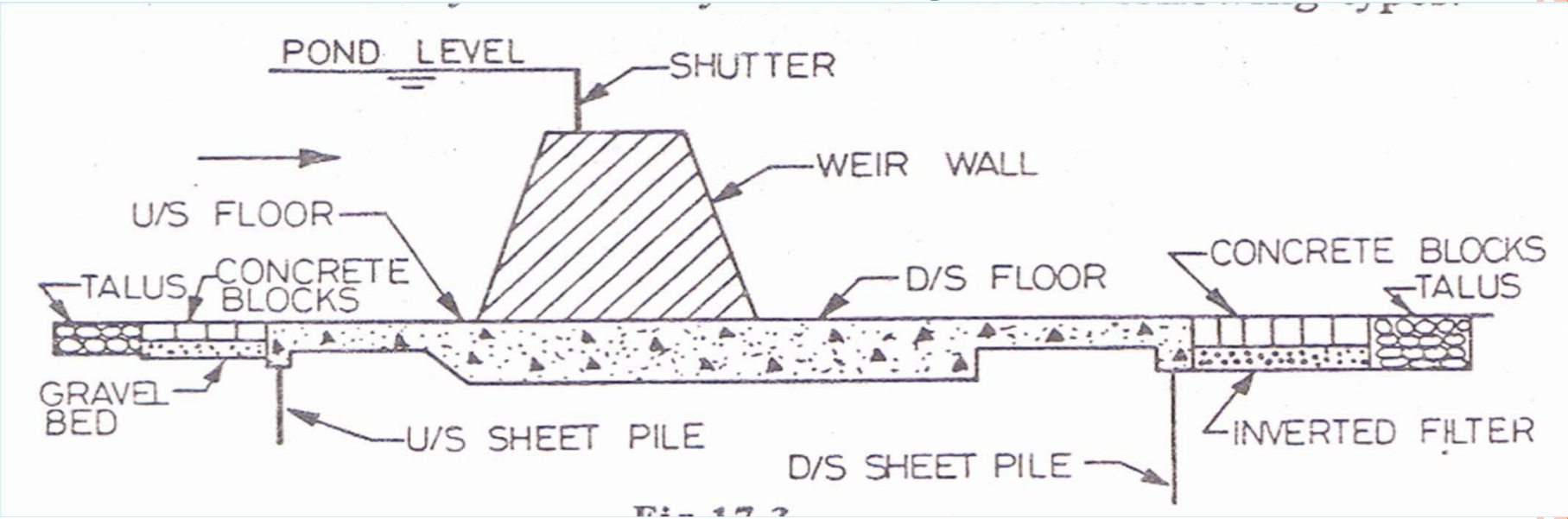


TYPES OF WEIR

- Vertical drop weirs
- Rock fill weirs.
- Concrete glacis or sloping weirs

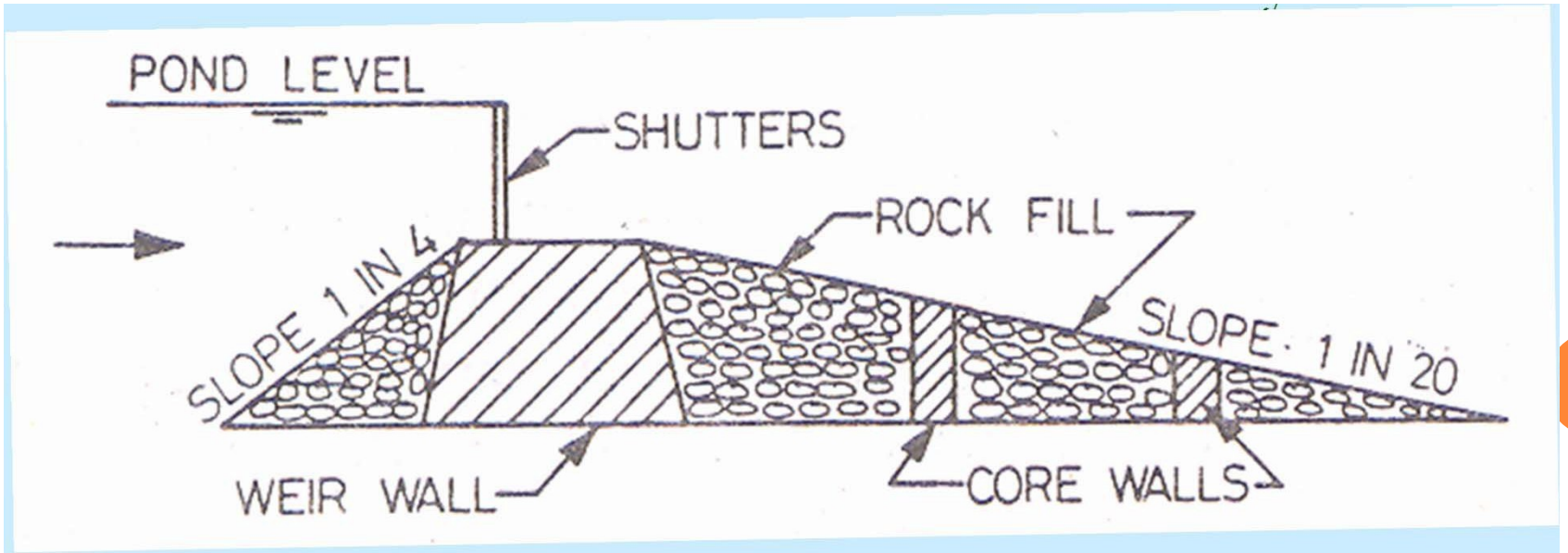
VERTICAL DROP WEIRS

- Wall type structure on a horizontal concrete floor.
- Shutters are provided at the crest, which are dropped during floods so as to reduce afflux.
- Water is ponded upto the top of the shutters during the rest of the period.
- Vertical drop weirs were quite common in early diversion headworks, but these are now becoming more or less obsolete



ROCK FILL WEIRS

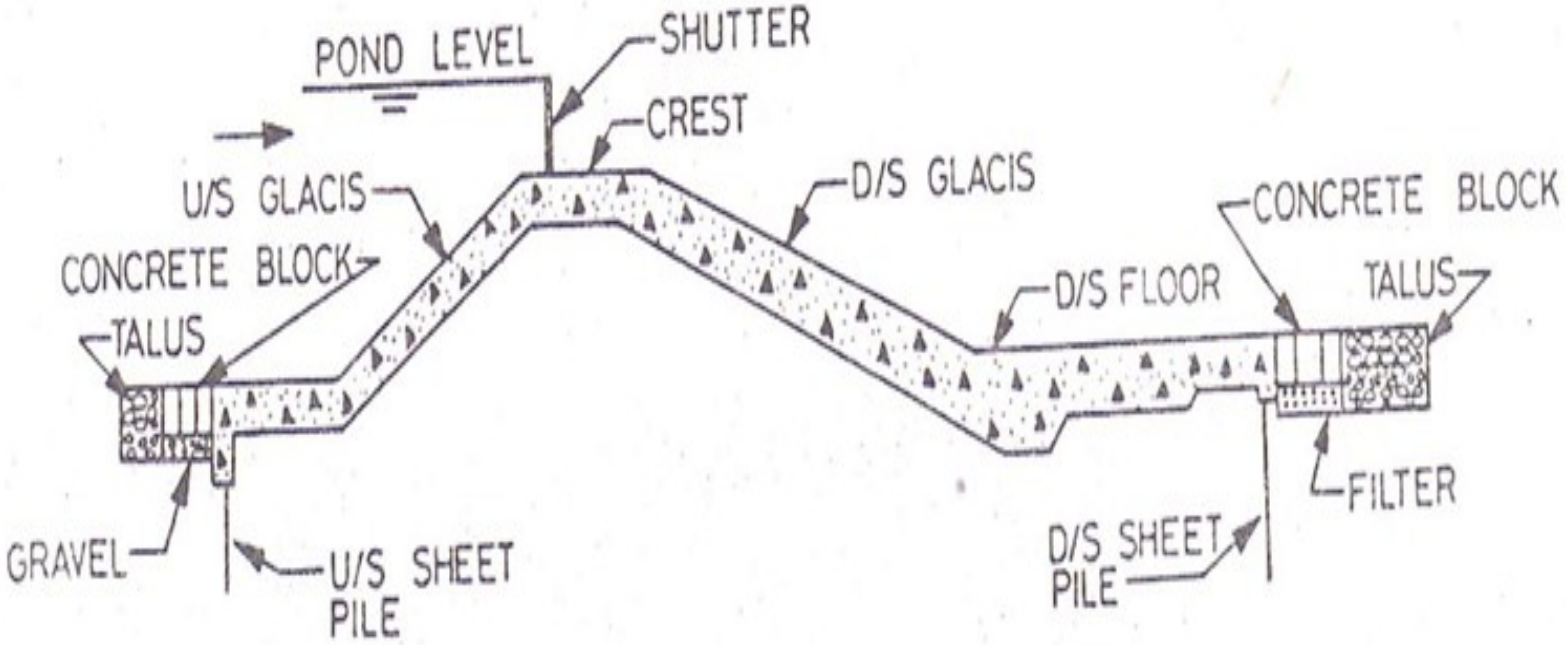
- In a rockfill type weir, there are a number of core walls. The space between the core walls is filled with the fragments of rock.
- A rockfill weir requires a lot of rock fragments and is economical only when a huge quantity of rockflll is easily available near the weir site.
- It is suitable for fine sand foundation. The old Okhla Weir across the Yamuna river is a rockfill weir.
- Such weirs are also more or less obsolete these days



SLOPING/GLACIS WEIRS

- Concrete sloping weirs (or glacis weirs) are of relatively recent origin.
- The crest has glacis (sloping floors) on u/s as well as d/s. There are sheet piles driven upto the maximum scour depth at the u/s and d/s ends of the concrete floor.
- Sometimes an intermediate pile is also driven at the beginning of the u/s glacis or at the end of d/s glacis.
- The main advantage of a sloping weir over the vertical drop weir is that a hydraulic jump is formed on the d/s glacis for the dissipation of energy.
- Therefore, the sloping weir is quite suitable for large drops

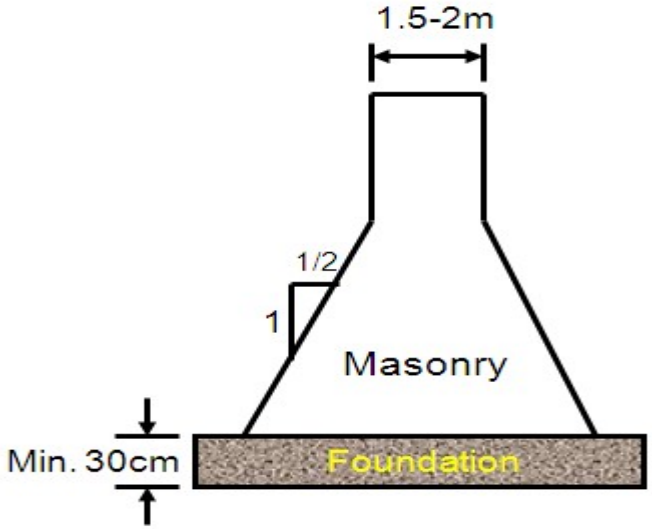
SLOPING/GLACIS WEIRS



Diversion Head Work - Components

1.Divide wall …

- a long solid wall which divides the river water into two portions – the weir proper and the under sluice portion.
- Divide wall constructed of stone masonry or concrete.
- Top width usually varies from 1.5 to 2m
- Extends from the weir body to a little beyond the length of the head regulator



Diversion Head Work - Components

2.Under sluice portion…

- a portion from which the main canal takes off water
- helps to reduce turbulence of flow near the canal head regulator.
- crest of the under sluice is made lower than the crest of the canal head regulator to divert silt free water.
- sluices controlled by gate to remove silt deposited in front of the head regulator.

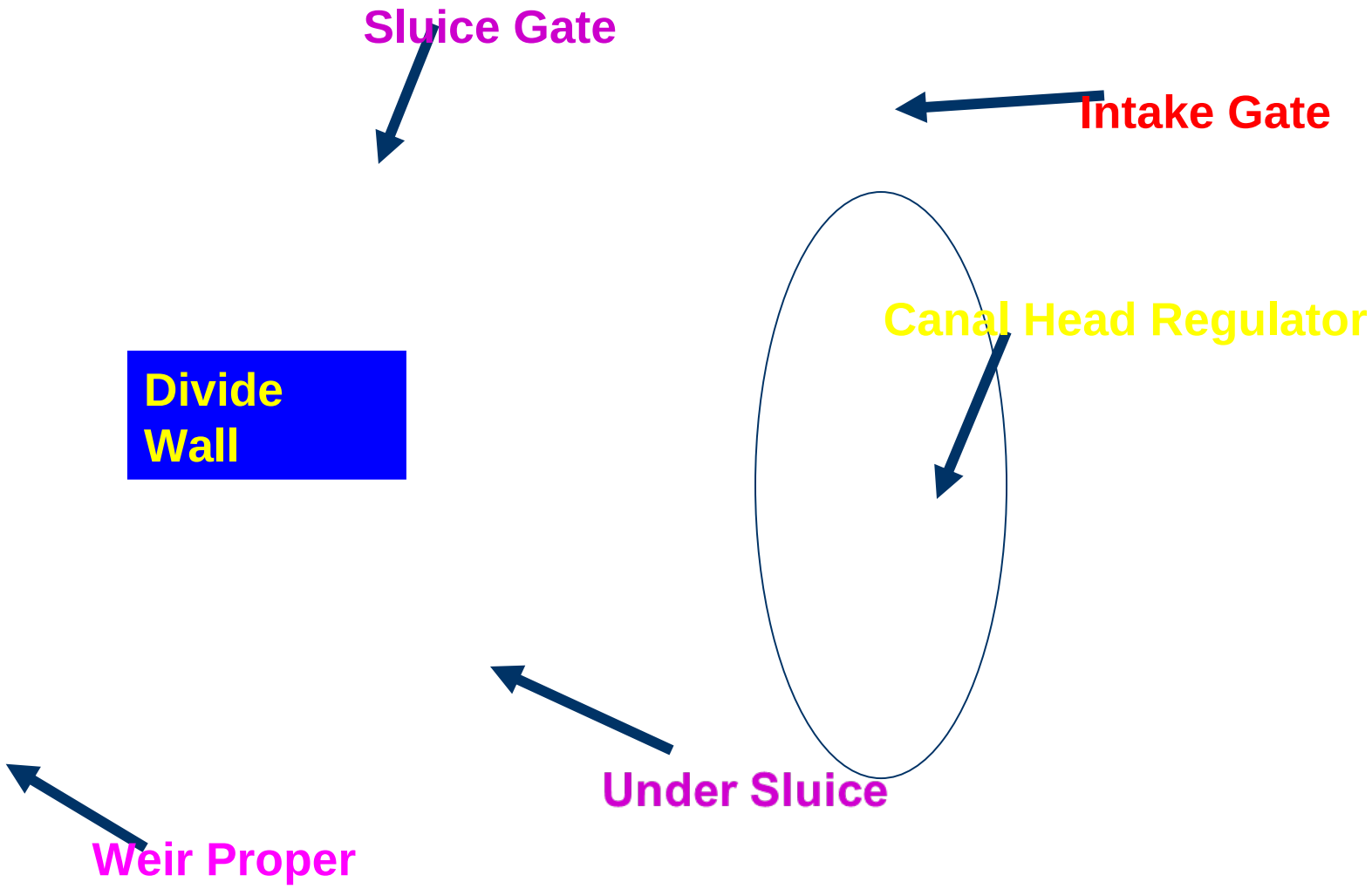
3.silt excluder:-to clean the silt deposition to the downstream so that only clear water enters into the canal through head regulator.

4.Head Regulator…

- a structure constructed at the entrance of the canal take off.
- used as a meter for measuring discharge.
- regulates and prevents excessive silt entry.

5.Fish ladder:- a structure provided for allowing free passage to the fishes, if present in the river.

COMPONENTS OF WEIR




Temporary Diversion
Wing Wall
Divide Wall
Weir Proper
End Sill
D/S Launching Apron

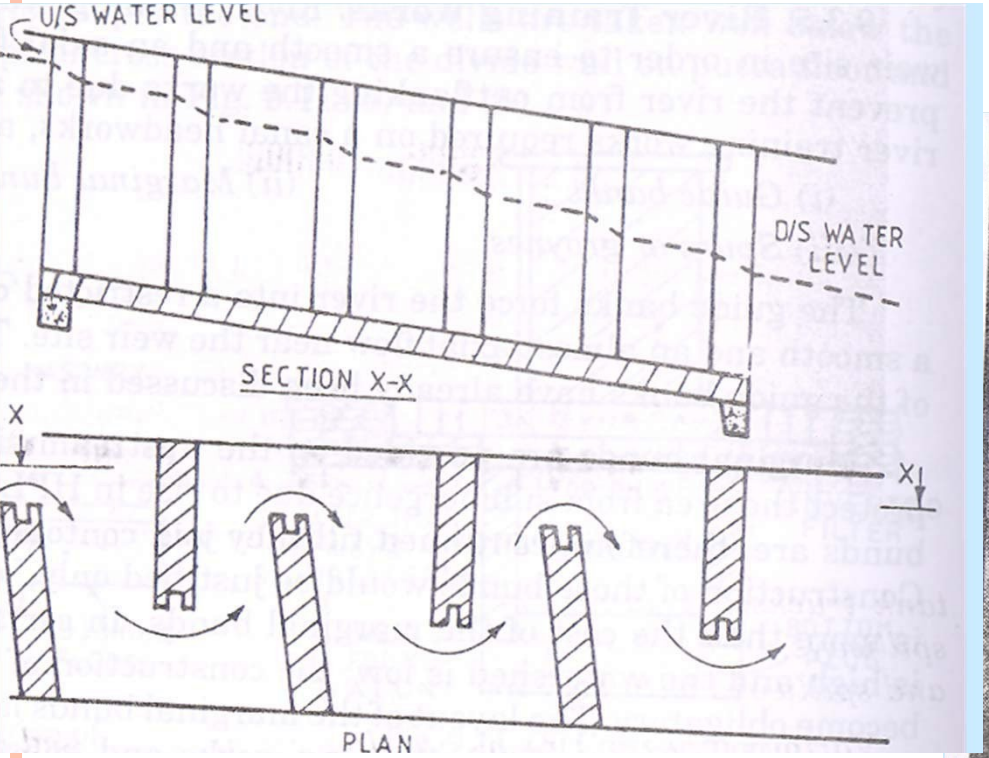

Divide Wall
Weir Proper
U/S
Launching
Apron
Under Sluice



PROFILE OF BARRAGE



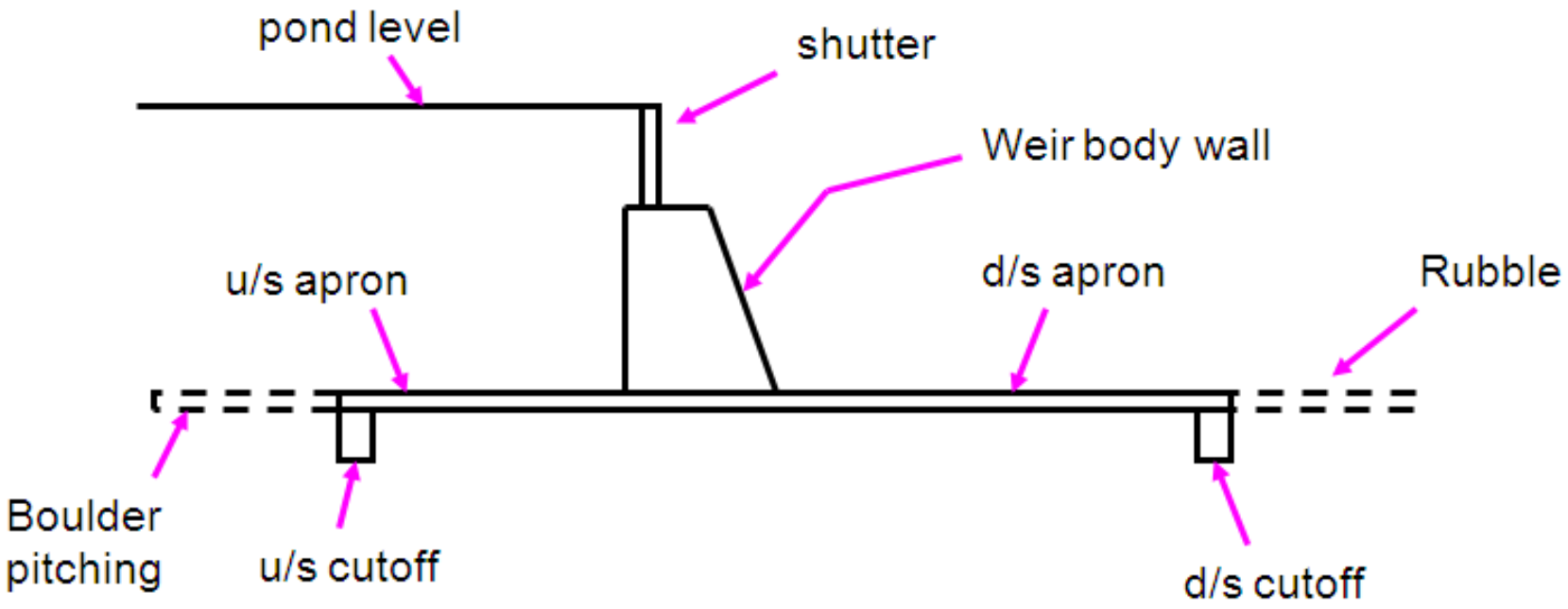
FISH LADDER





Diversion Head Work - Design

- It is essential to know various parts of a weir before actually designing it.



Typical structural components of a weir

Diversion Head Work - Design

- Weir Design: The data required for design are:
  - Maximum flood discharge in the river.
  - stage-discharge curve
  - Cross-section of the river
  - Soil properties at the bed of the river
  - Pond level

- Design considerations:
  - *Piping or undermining* …hollow formation due to excessive percolation of water below the foundation.

  - *Failure due to uplift*…failure/rupture of apron, if not strong when the percolated water exerts excessive upward pressure

Diversion Head Work - Design

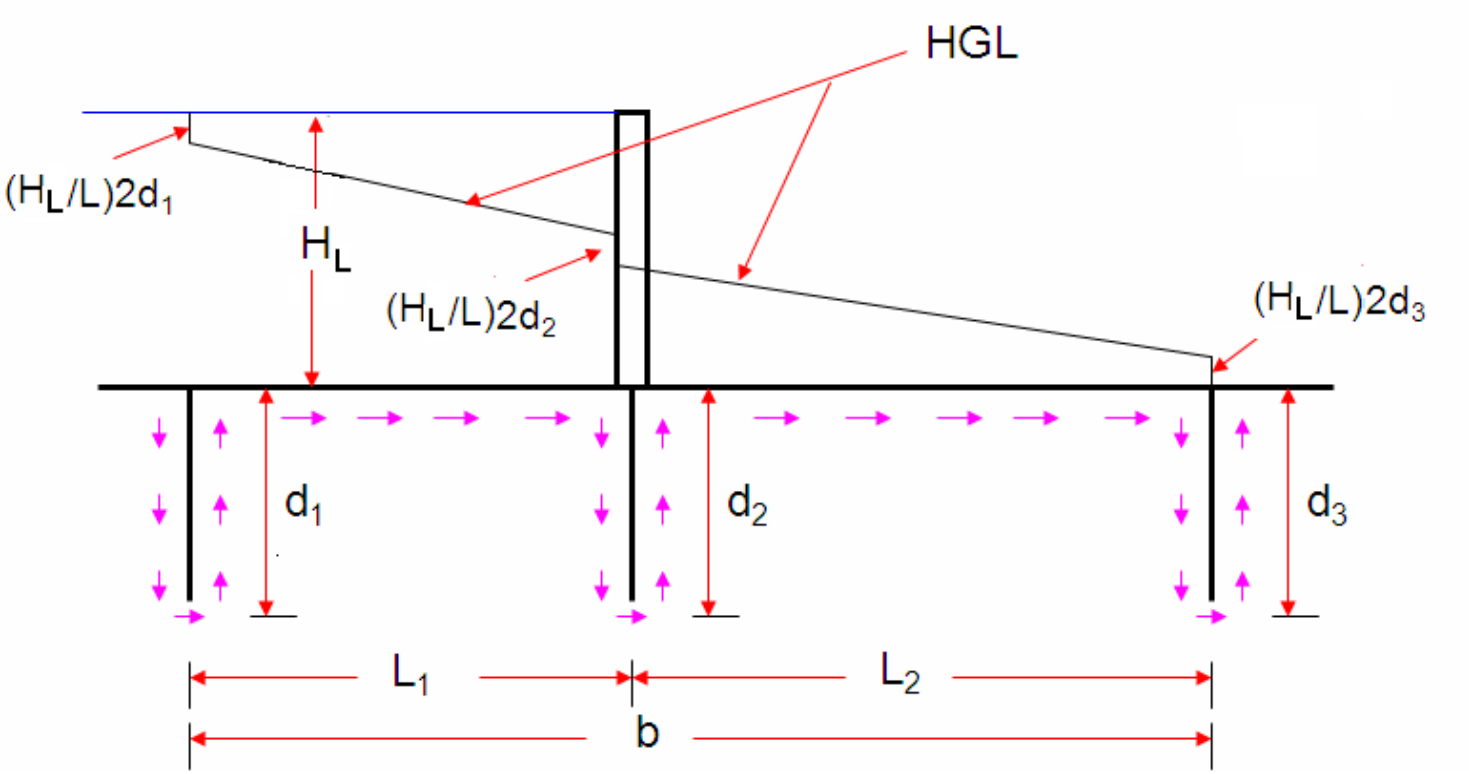
- Design Methods (Seepage Theories)
  1. Bligh's Creep theory
  2. Lane's creep theory
  3. Khosla's creep theory

1. Bligh's Creep theory … It states about

- The percolating water follows the outline of the foundation of the structure …. creep length, L.
- No distinction between horizontal and vertical creep.
- The loss of head is proportional to the length of the creep … the hydraulic gradient, G.

Creep length, L … the total length covered by the percolating water till it emerges out at the downstream end.

Diversion Head Work - Design



- Creep length, $L = b + 2d_1+2d_2+2d_3$
- Head loss per unit length or hydraulic gradient, $G = H_L/L$
- Head losses equal to $(H_L/L)2d_1$, $(H_L/L)2d_2$ and $(H_L/L)2d_3$ will occur respectively in the planes of three vertical cutoffs.

Diversion Head Work - Design

Lane's Creep theory …

- The horizontal creep is less effective in reducing uplift (or in causing loss of head) than the vertical creep.
- He suggested a weightage factor of 1/3 for the horizontal creep against the vertical creep. i.e.

$$L = 2d_1 + 1/3L_1 + 2d_2 + 1/3L_2 + 2d_3$$

- It is an improvement over Beligh's but not rationalized. Not used anywhere.

Khosla's Creep theory….

The seeping water does not creep along the bottom contour of the floor but moves along stream lines which is represented for steady seepage in homogenous soil by the Laplace equation as:

$$\frac{d^2\phi}{dx^2} + \frac{d^2\phi}{dy^2} = 0$$

Where, ϕ = flow potential =Kh; K= permeability and h=residual head

THANK YOU

