Canal Regulation Works

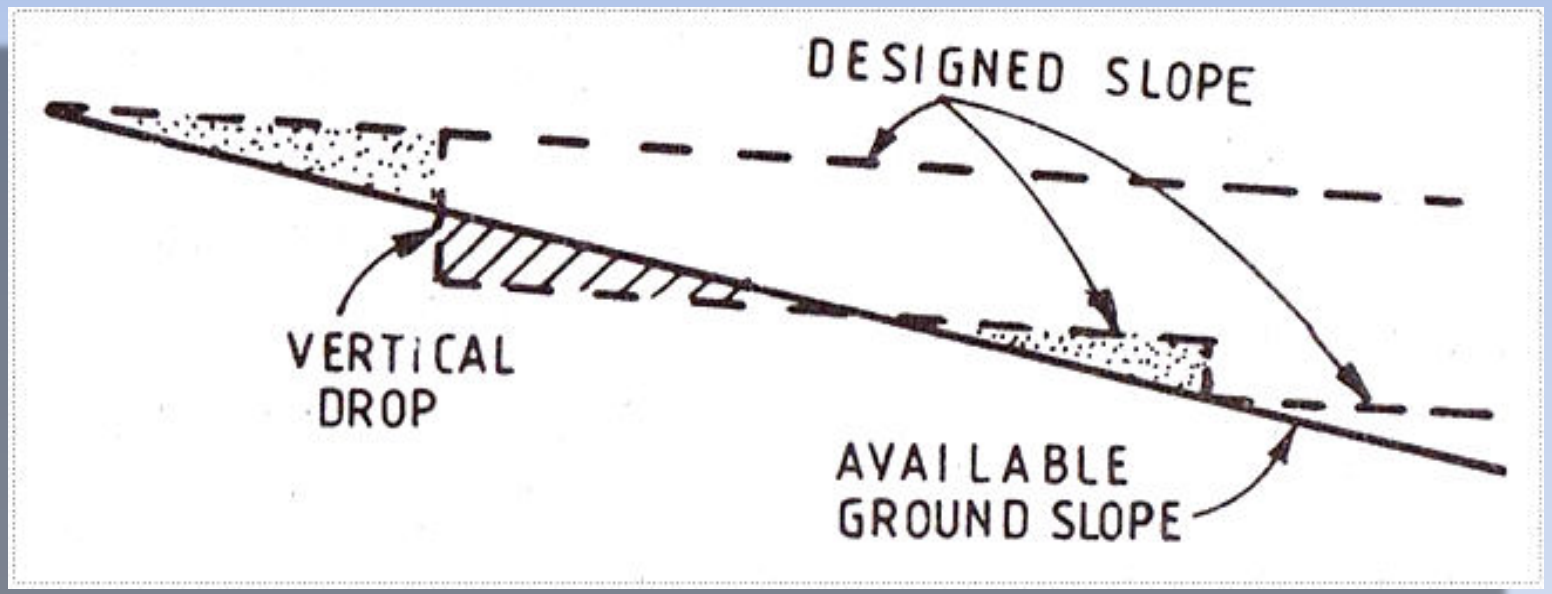
Syllabus

- **Canal Regulation Works:**
- Canal Fall- Necessity and Location- Types of Falls- Cross Regulator and Distributory Head Regulator- Their Functions, Silt Control Devices, Canal Escapes- Types of Escapes.

What is Canal Fall?

- Whenever the available natural ground slope is steep than the designed bed slope of the channel, the difference is adjusted by constructing vertical 'falls' or 'drops' in the canal bed at suitable intervals, as shown in figure below. Such a drop in a natural canal bed will not be stable and, therefore, in order to retain this drop, a masonry structure is constructed. Such a structure is called a Canal Fall or a Canal drop.

Canal Fall



Canal Fall

Irrigation canals are designed for a prescribed bed slope so that velocity becomes non silting or non scouring. But if the ground topography is such that in order to maintain the canal designed slope, indefinite filling from falling ground level is to be made. This indefinite filling is avoided by constructing a hydraulic structure in the place of sudden bed level. This hydraulic structure is called canal fall or drop. Beyond the canal fall, canal again maintains its designed slope.

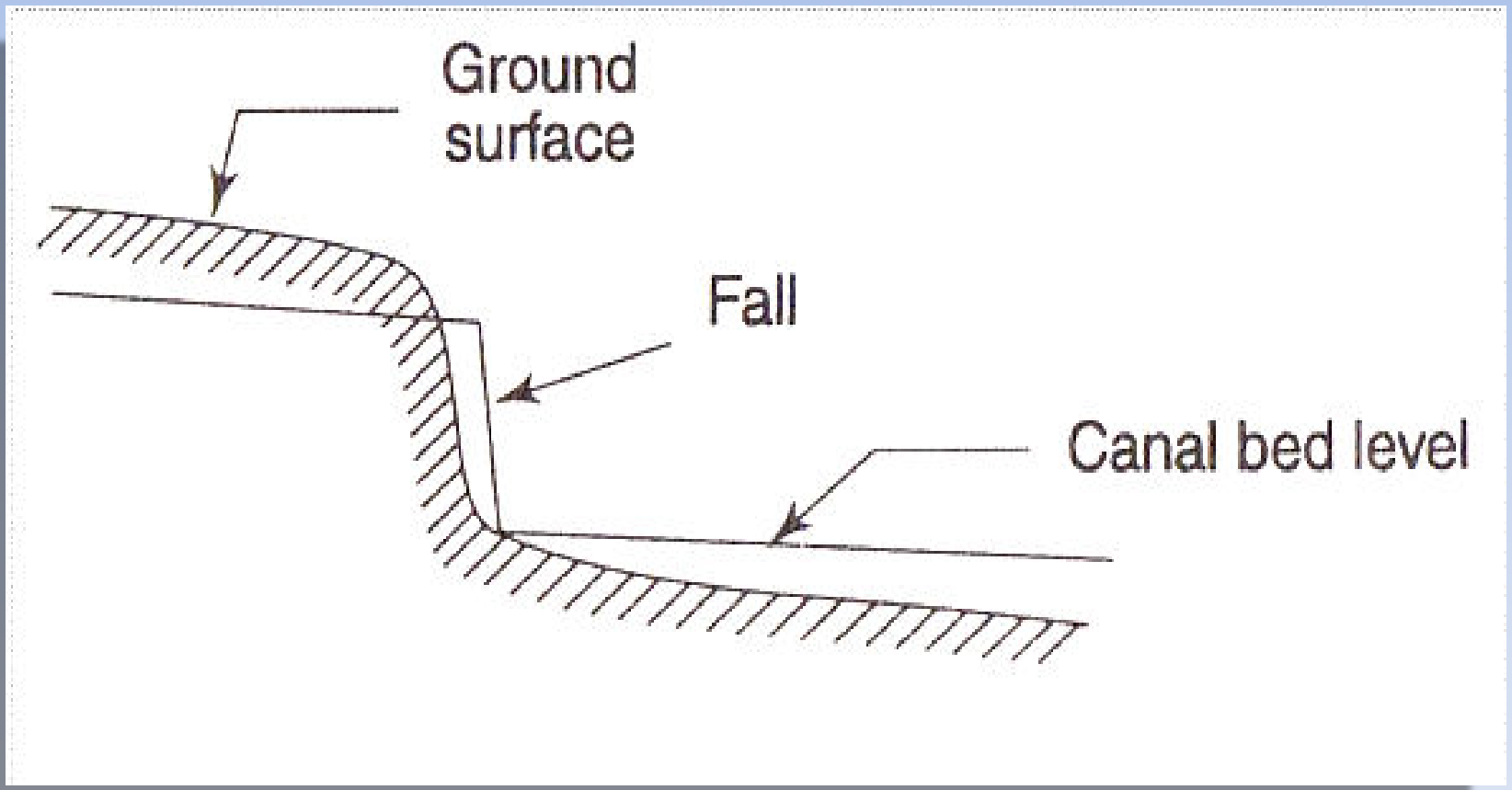
Canal Fall

- Thus, a canal fall or drop is an irrigation structure constructed across a canal to lower down its bed level to maintain the designed slope when there is a change of ground level to maintain the designed slope when there is change of ground level. This falling water at the fall has some surplus energy. The fall is constructed in such a way that it can destroy this surplus energy.

Necessity of Canal Falls

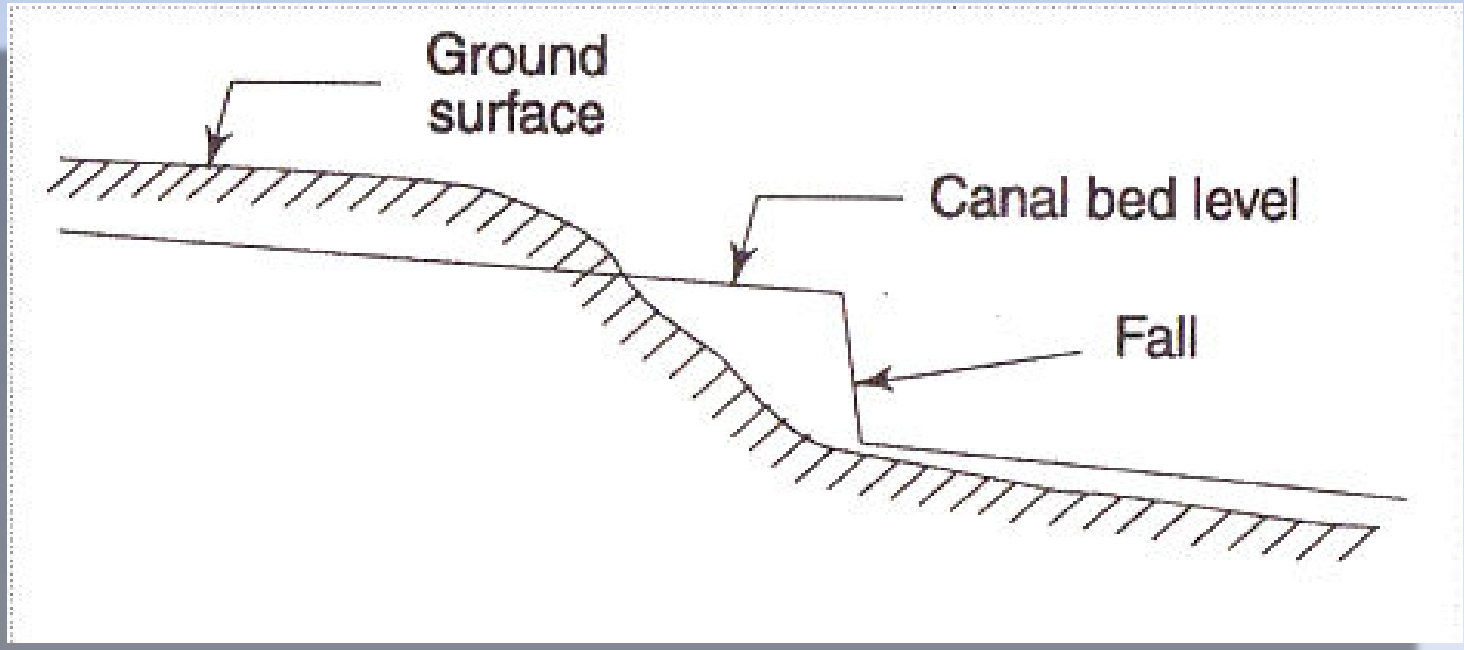
- When the slope of the ground suddenly changes to steeper slope, the permissible bed slope can not be maintained. It requires excessive earthwork in filling to maintain the slope. In such a case falls are provided to avoid excessive earth work in filling

Necessity of Canal Falls



Necessity of Canal Falls

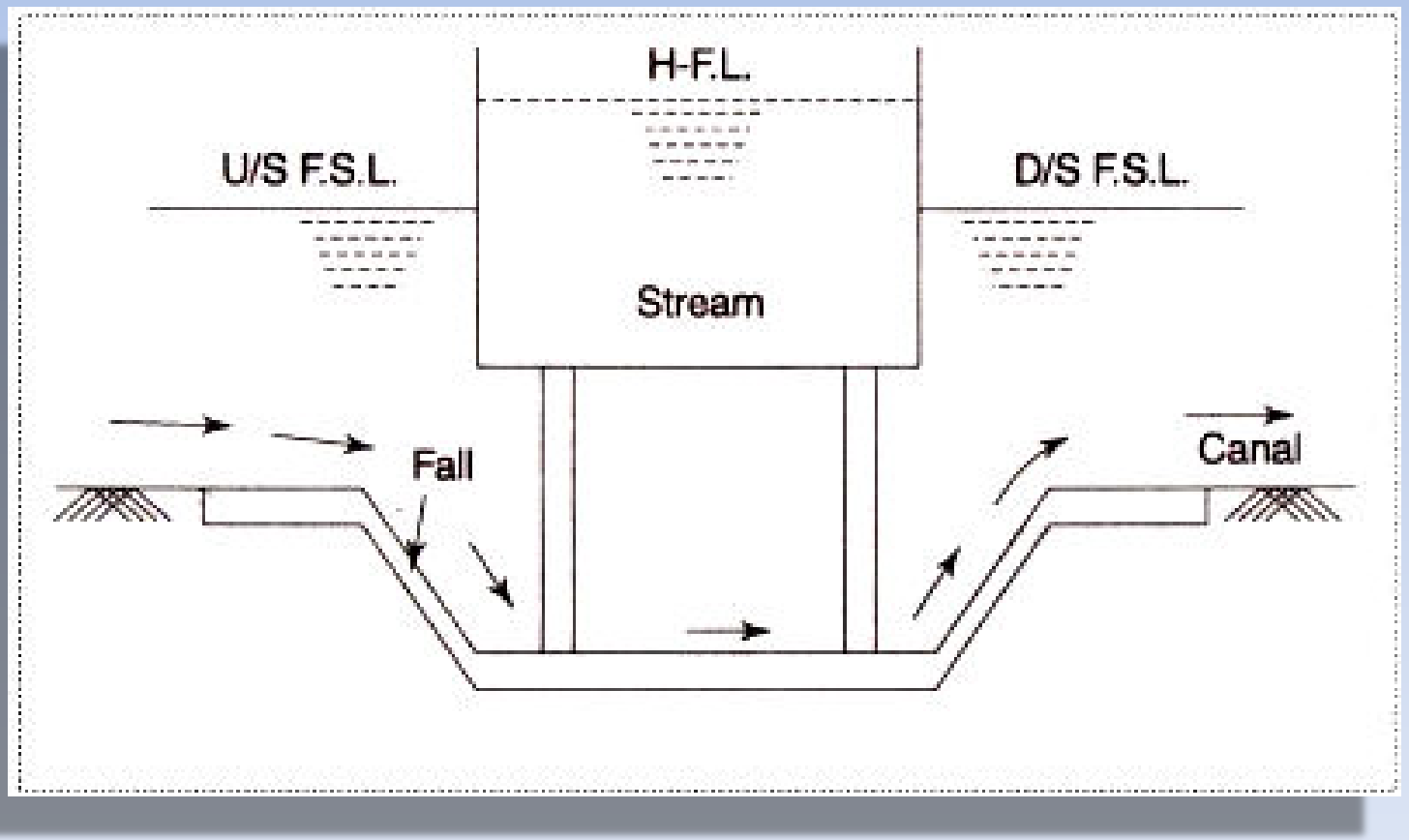
- When the slope of the ground is more or less uniform and the slope is greater than the permissible bed slope of canal.



Necessity of Canal Falls

- In cross-drainage works, when the difference between bed level of canal and that of drainage is small or when the F.S.L of the canal is above the bed level of drainage then the canal fall is necessary to carry the canal water below the stream or drainage.

Necessity of Canal Falls



Types of Canal Fall

- Depending on the ground level conditions and shape of the fall the various types of fall are:

Ogee Fall

- The ogee fall was constructed by Sir Proby Cautley on the Ganga Canal. This type of fall has gradual convex and concave surfaces i.e. in the ogee form. The gradual convex and concave surface is provided with an aim to provide smooth transition and to reduce disturbance and impact. A hydraulic jump is formed which dissipates a part of kinetic energy. Upstream and downstream of the fall is provided by Stone Pitching.

Ogee Fall

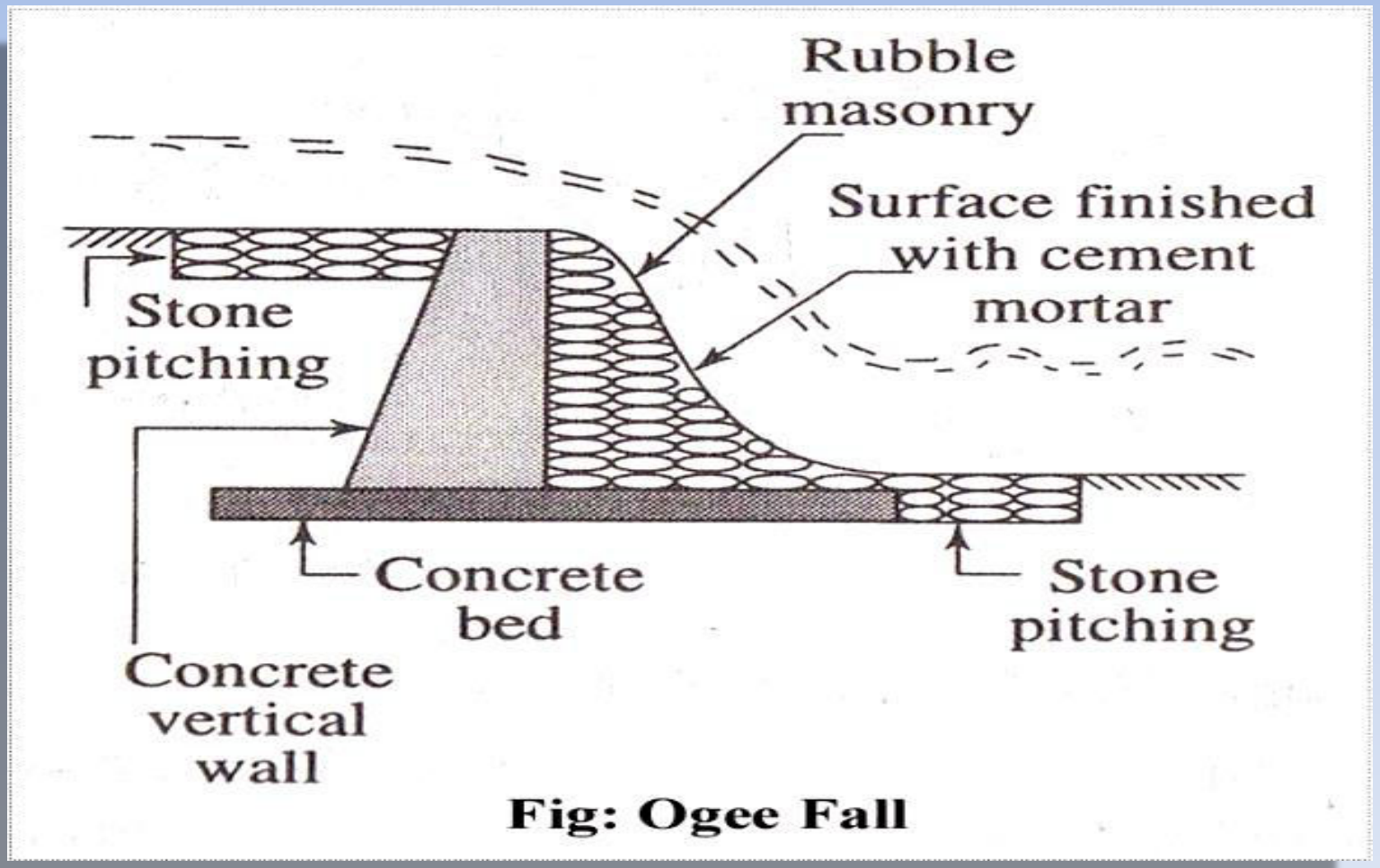


Fig: Ogee Fall

Types of Canal Fall

Stepped Fall

- It consists of a series of vertical drops in the form of steps. This steps is suitable in places where sloping ground is very long and require a long glacis to connect the higher bed level u/s with lower bed level d/s. it is practically a modification of rapid fall. The sloping glacis is divided into a number drops to bring down the canal bed step by step to protect the canal bed and sides from damage by erosion. Brick walls are provided at each drop. The bed of the canal within the fall is protected by rubble masonry with surface finishing by rich cement mortar.

Stepped Fall

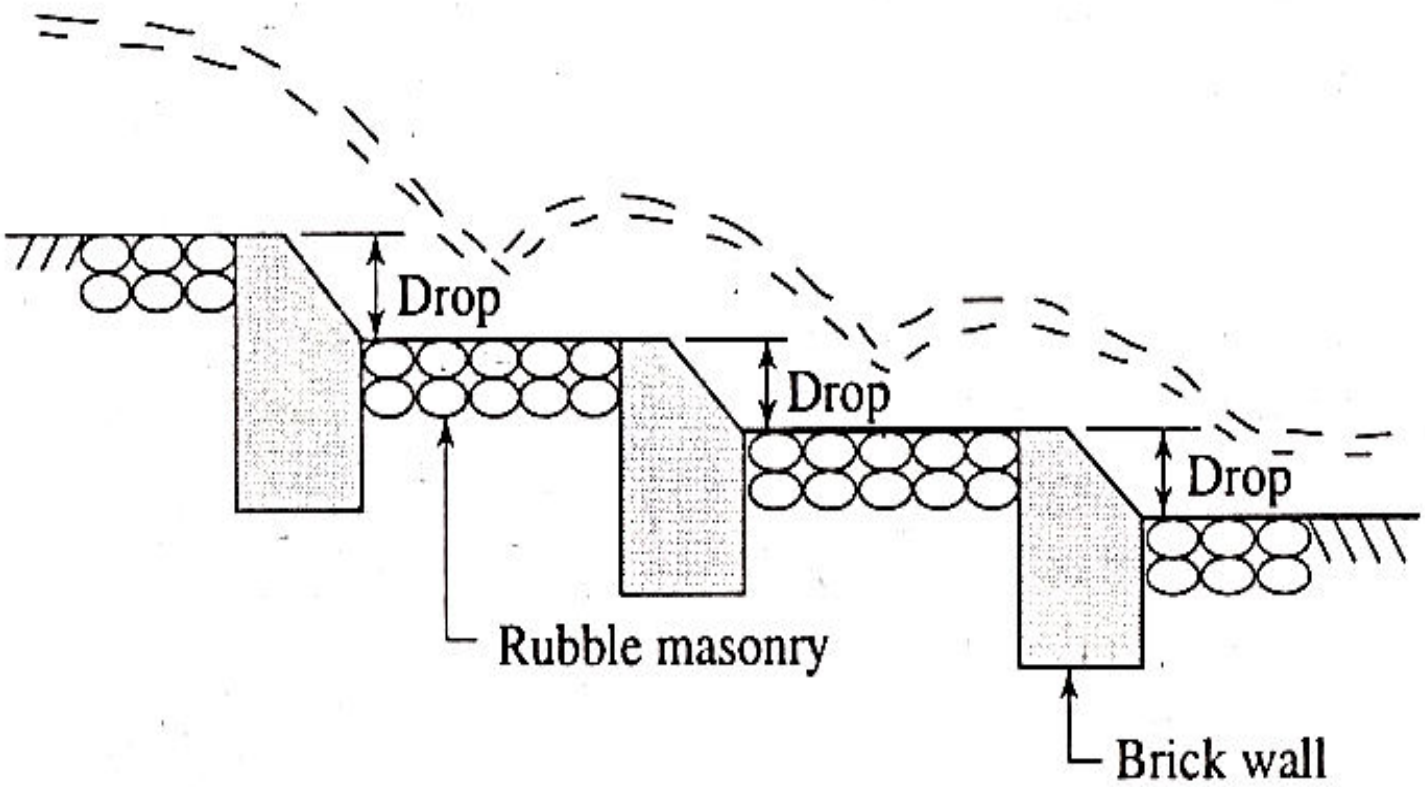


Fig: Stepped Fall

Types of Canal Fall

Vertical Fall (Sarda Fall)

- In the simple type, canal u/s bed is on the level of upstream curtain wall, canal u/s bed level is below the crest of curtain wall. In both the cases, a cistern is formed to act as water cushion. Floor is made of concrete u/s and d/s side stone pitching with cement grouting is provided. This type of fall is used in Sarda Canal UP and therefore, it is also called Sarda Fall.

Vertical Fall

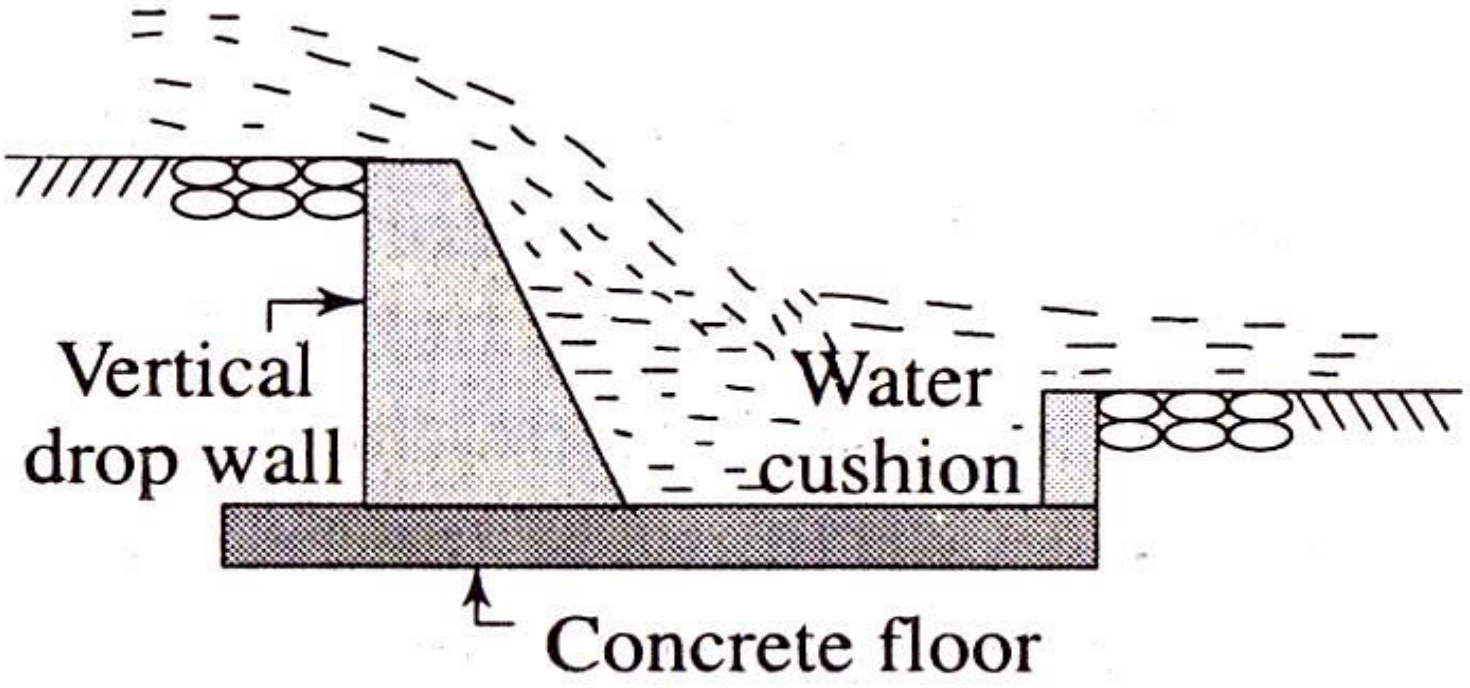


Fig: Vertical Drop Fall

Types of Canal Fall

Rapid Fall

- When the natural ground level is even and rapid, this rapid fall is suitable. It consists of long sloping glacis. Curtain walls are provided on both u/s and d/s sides. Rubble masonry with cement grouting is provided from u/s curtain wall to d/s curtain wall. Masonry surface is finished with a rich cement mortar.

Rapid Fall

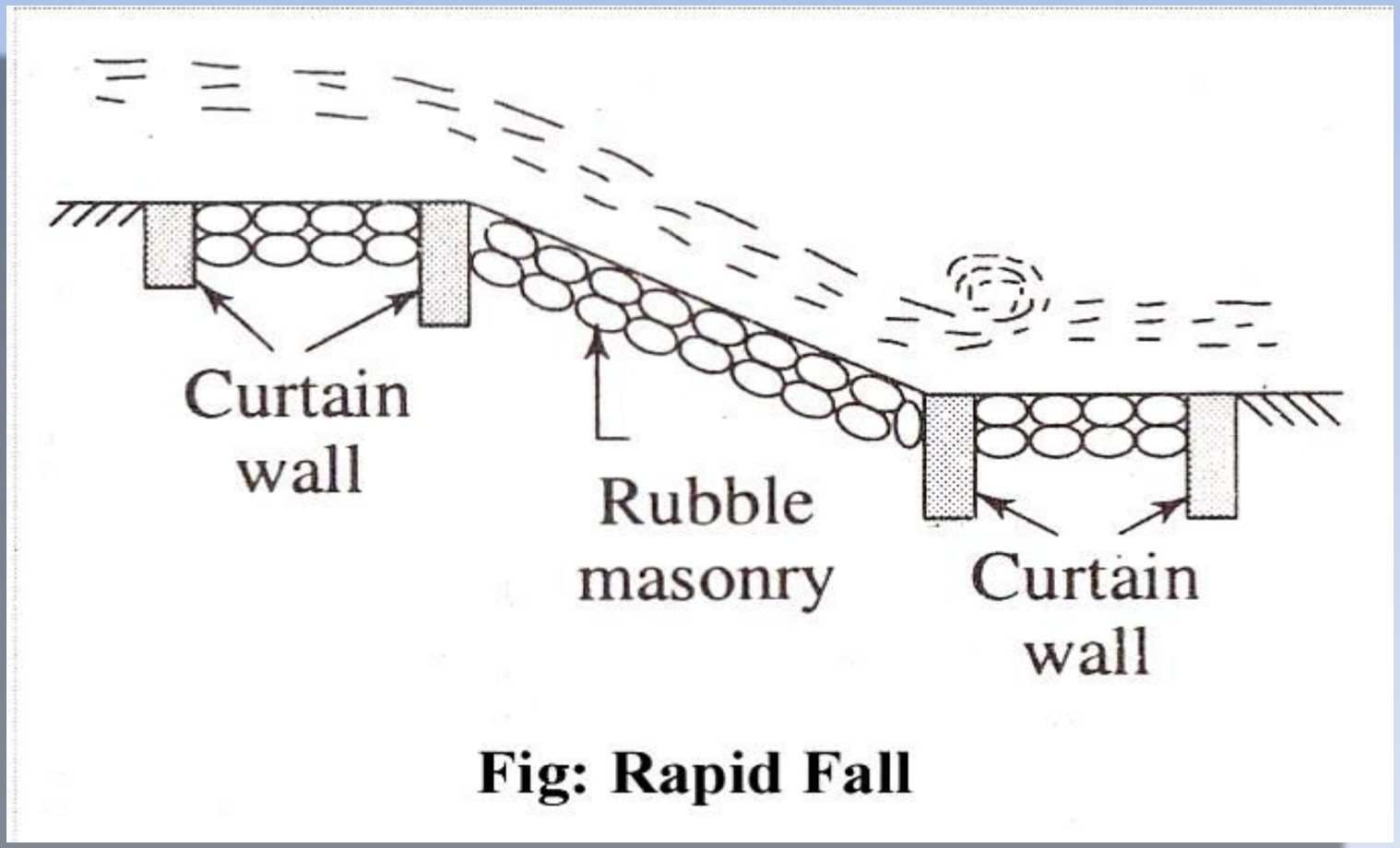


Fig: Rapid Fall

Types of Canal Fall

Straight Glacis Fall

- It consists of a straight glacis provided with a crest wall. For dissipation of energy of flowing water, a water cushion is provided. Curtain walls are provided at toe and heel. Stone pitching is required at upstream and downstream of the fall.

Straight Glacis Fall

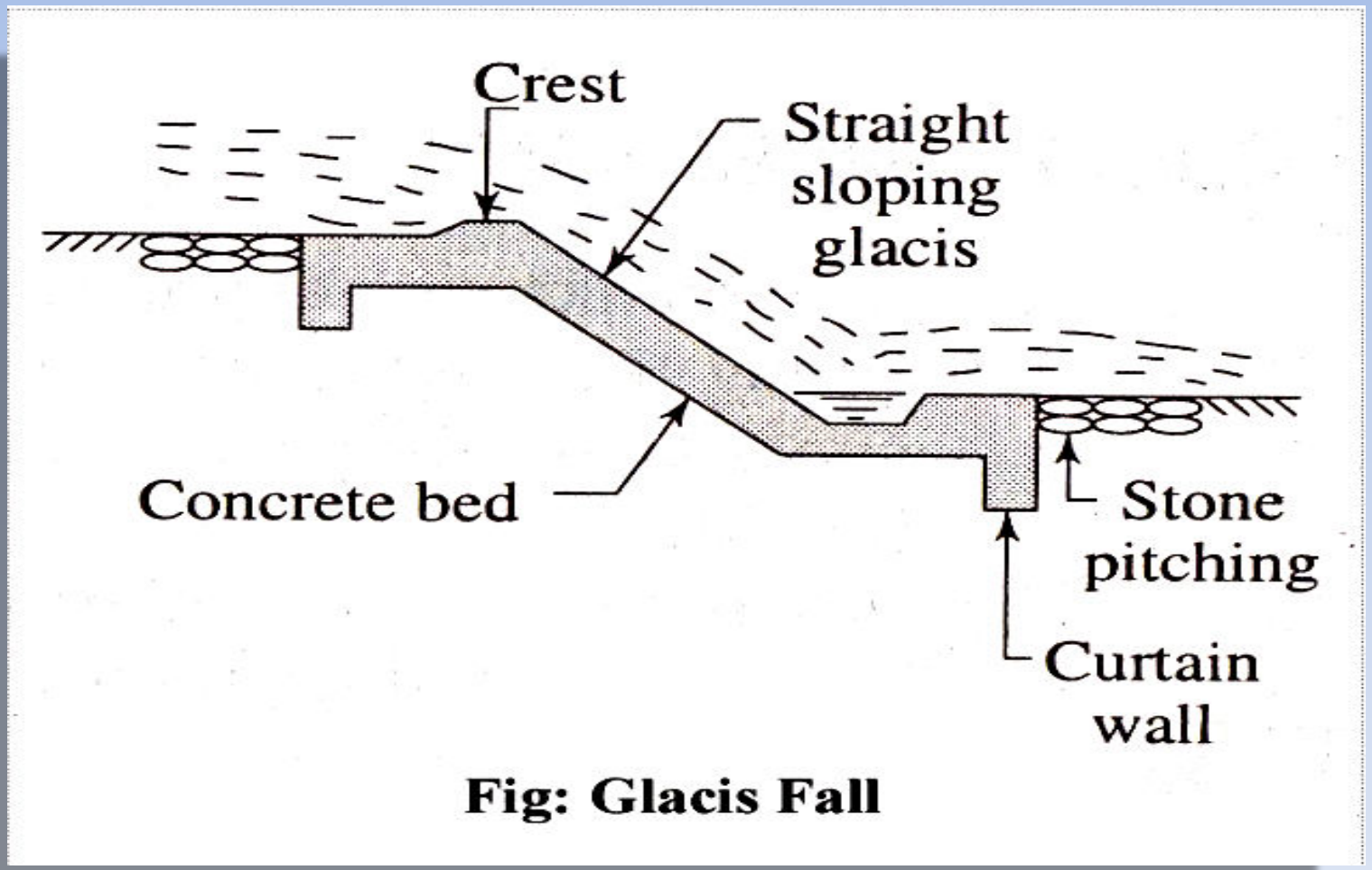


Fig: Glacis Fall

Types of Canal Fall

Trapezoidal Notch Fall

- It was designed by Reid in 1894. In this type a body or foundation wall across the channel consisting of several trapezoidal notches between side pier and intermediate pier is constructed. The sill of the notches are kept at upstream bed level of the canal. The body wall is made of concrete. An impervious floor is provided to resist the scouring effect of falling water. Upstream and downstream side of the fall is protected by stone pitching finished with cement grouting

Trapezoidal Notch Fall

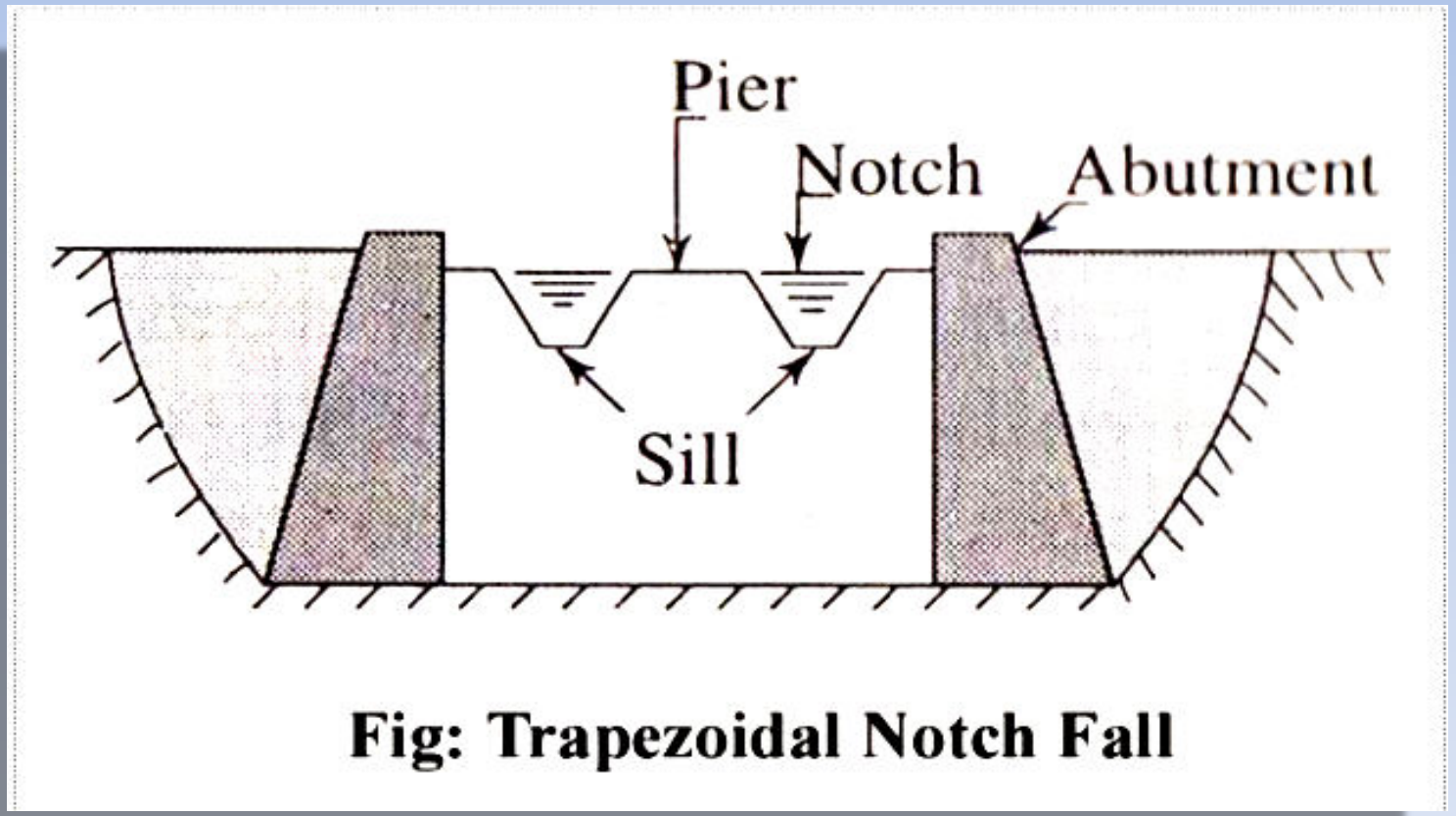


Fig: Trapezoidal Notch Fall

Types of Canal Fall

Well or Cylinder Notch Fall

- In this type, water of canal from higher level is thrown in a well or a cylinder from where it escapes from bottom. Energy is dissipated in the well in turbulence. They are suitable for low discharges and are economical also.

Types of Canal Fall

Montague Type Fall

- In the straight glacis type profile, energy dissipation is not complete. Therefore, montague developed this type of profile where energy dissipation takes place. His profile is parabolic and is given by the following equation,

Montague Type Fall

$$X = \upsilon \sqrt{\frac{4y}{g}}$$

Where, x = distance of point P from OX axis,

Y = distance of point P from OY axis,

υ = velocity of water at the crest,

g = acceleration due to gravity

Montague Type Fall

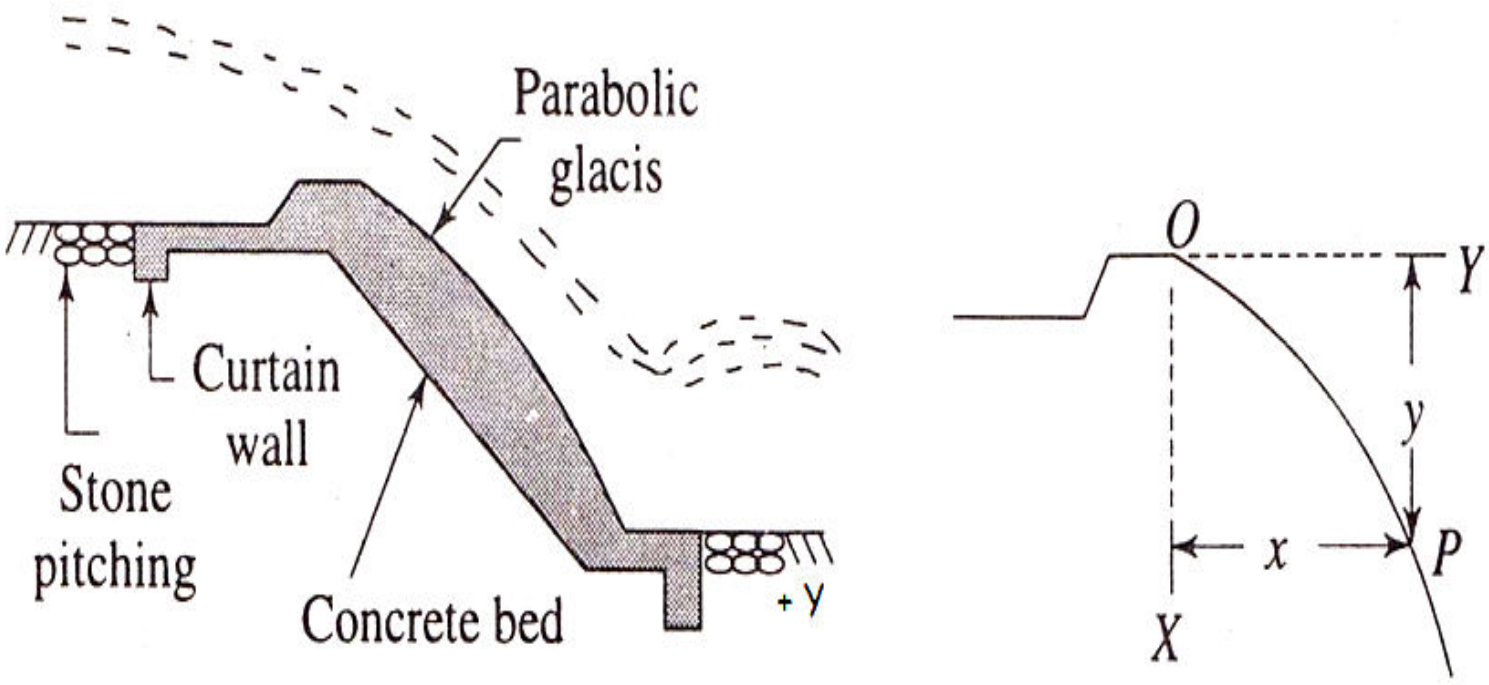


Fig: Montague Type Fall

Types of Canal Fall

Inglis or Baffle Fall

- Here glacis is straight and sloping, but baffle wall provided on the downstream floor dissipate the energy. Main body of glacis is made of concrete. Curtain walls both at toe and heel are provided. Stone pitching are essential both at u/s and d/s ends

Inglis or Baffle Fall

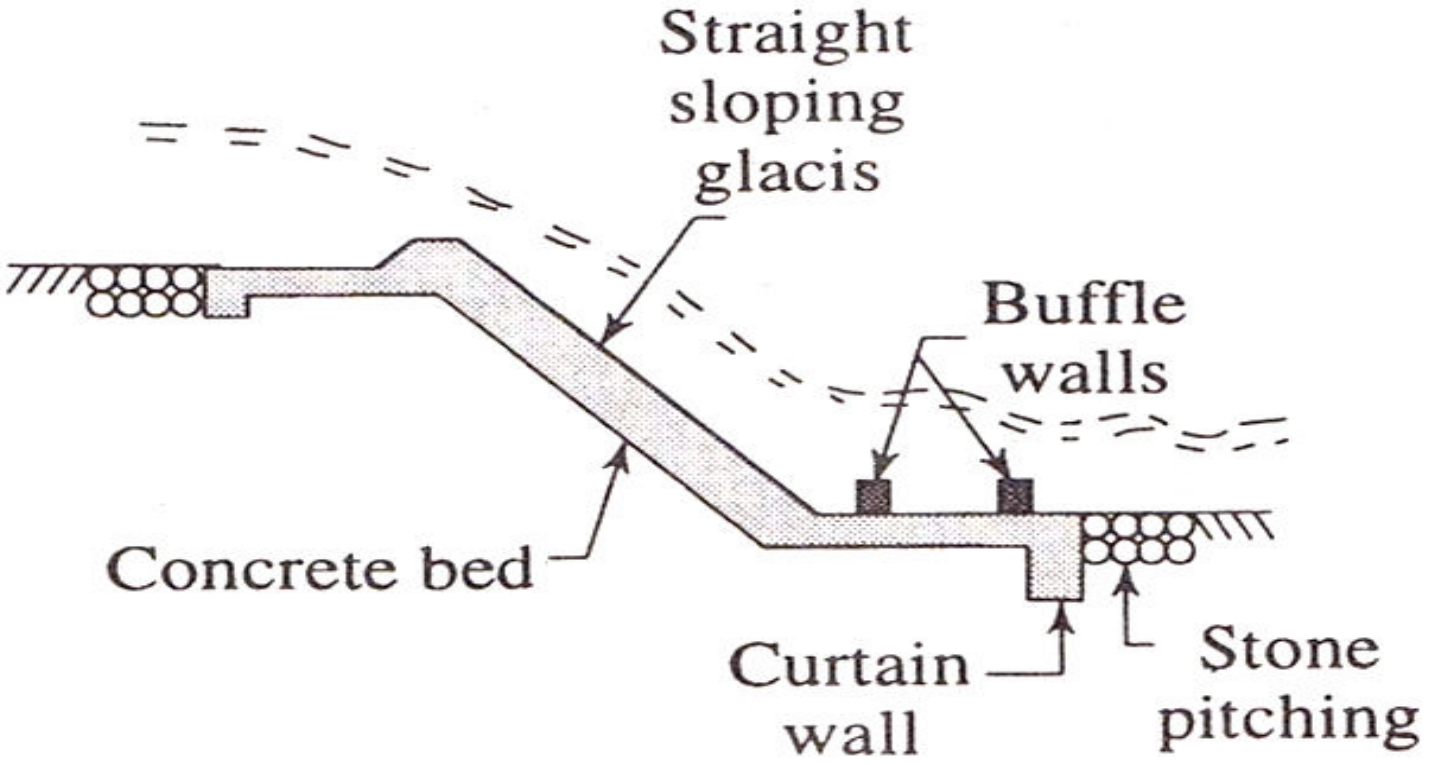


Fig: Inglis Type Fall

Canal Escape

- It is a side channel constructed to remove surplus water from an irrigation channel (main canal, branch canal, or distributary etc.) into a natural drain.
- The water in the irrigation channel may become surplus due to –
- Mistake
- Difficulty in regulation at the head
- Excessive rainfall in the upper reaches
- Outlets being closed by cultivators as they find the demand of water is over

Canal Escape

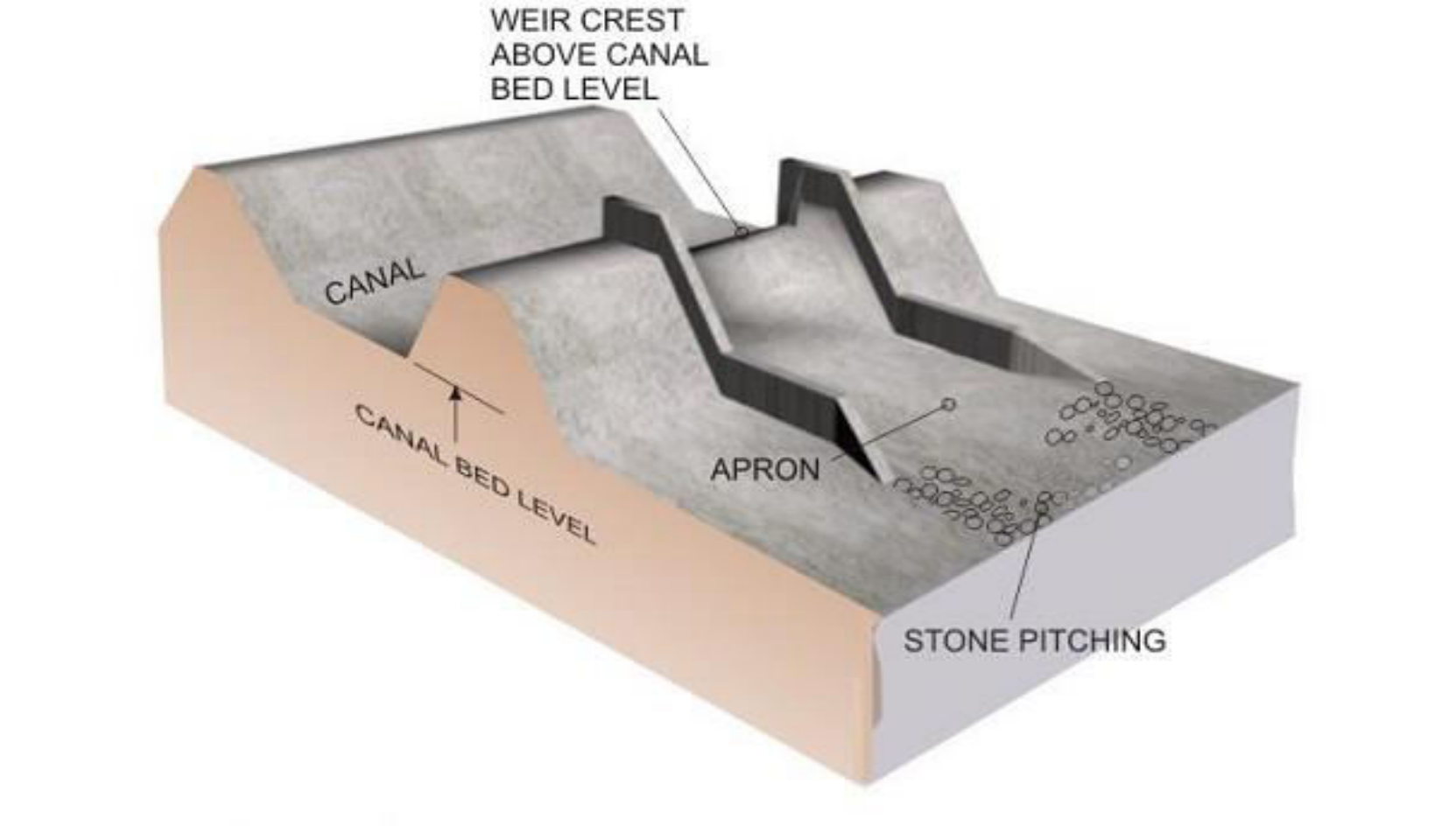
- It is the structure required to dispose of surplus or excess water from canal from time to time. Thus, a canal escape serves as safety valve for canal system. It provides protection to the canal from possible damage due to excess supply which may be due to mistake in releasing water at head regulator or heavy rainfall that makes sudden regular demand of water. The excess supply makes the canal banks vulnerable to failure due to overtopping or dangerous leaks. Therefore, provision for disposing this surplus water in form of canal escapes at suitable intervals along the canal is essential. Moreover emptying canal for repair and maintenance and removal of sediment deposited in the canal can also be achieved with the help of canal escapes.

Escapes are usually of the following three types.

Surplus Escape

- It is also called regulator type. In this type sill of the escape is kept at canal bed level and the flow is controlled by a gate. This type of escapes are preferred now-a-days as they give better control and can be used for employing the canal for maintenance.

Surplus Escape



Surplus Escape

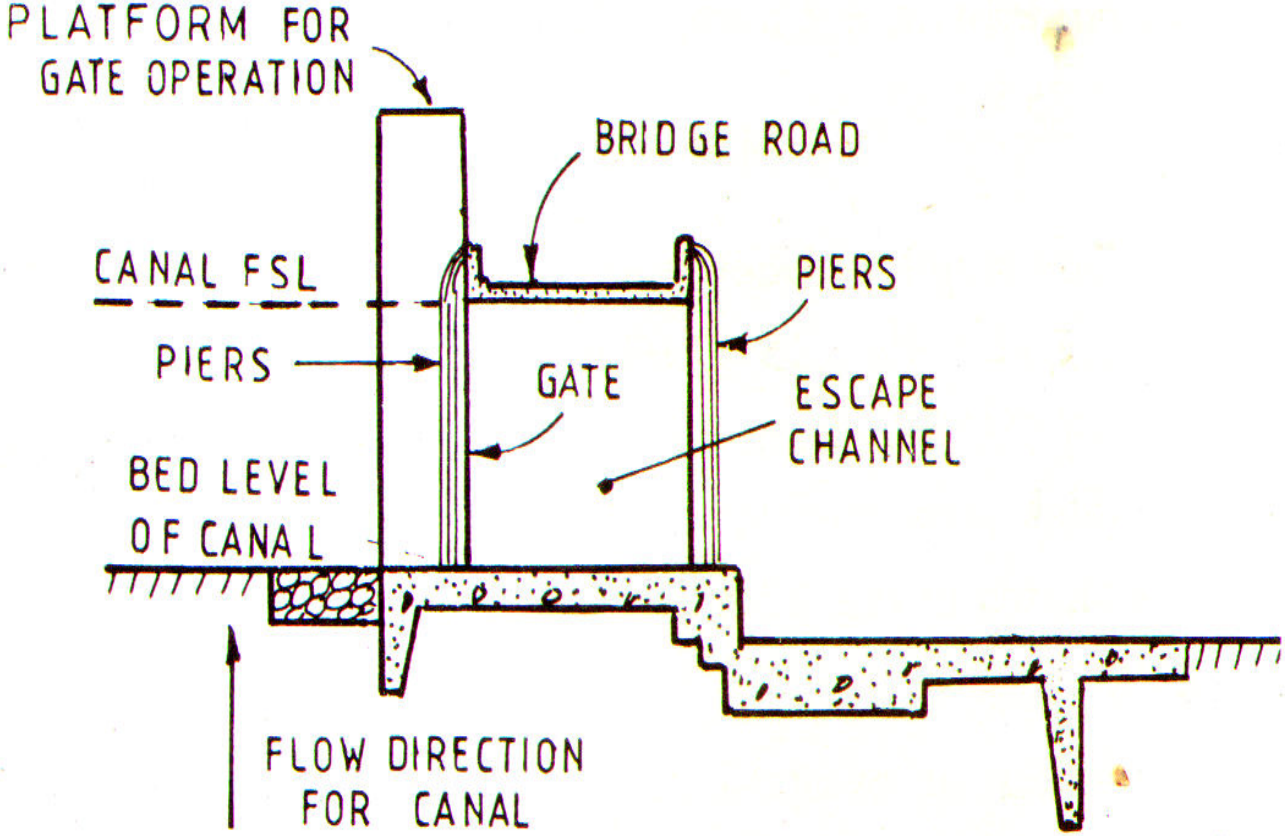


Fig. 13.10. Regulator type escape or 'Surplus water escape'.

Escapes are usually of the following three types.

Tail Escape

- A tail escape is provided at the tail end of the canal and is useful in maintaining the required FSL in the tail reaches of the canal and hence, they are called tail escape.

Tail Escape

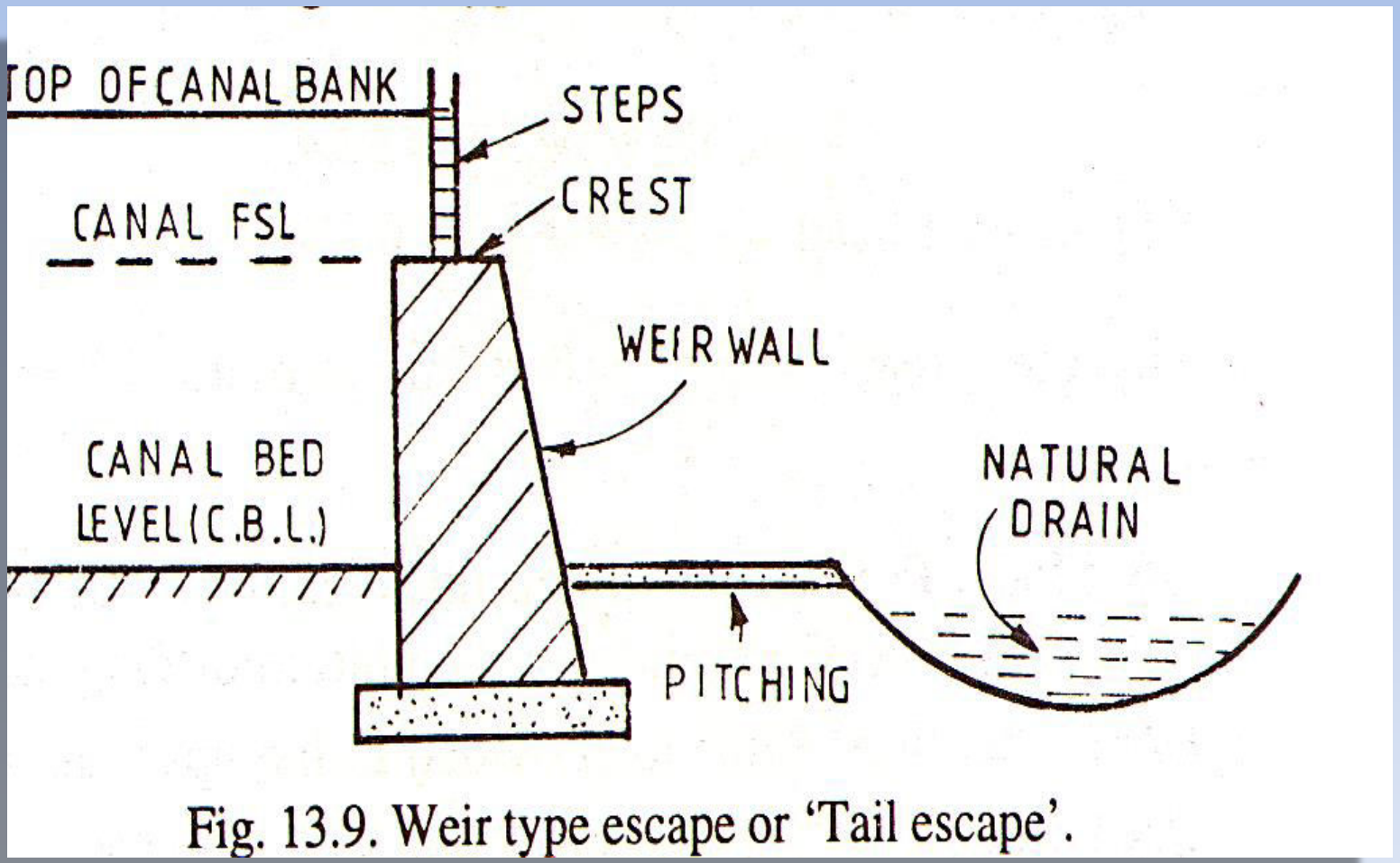


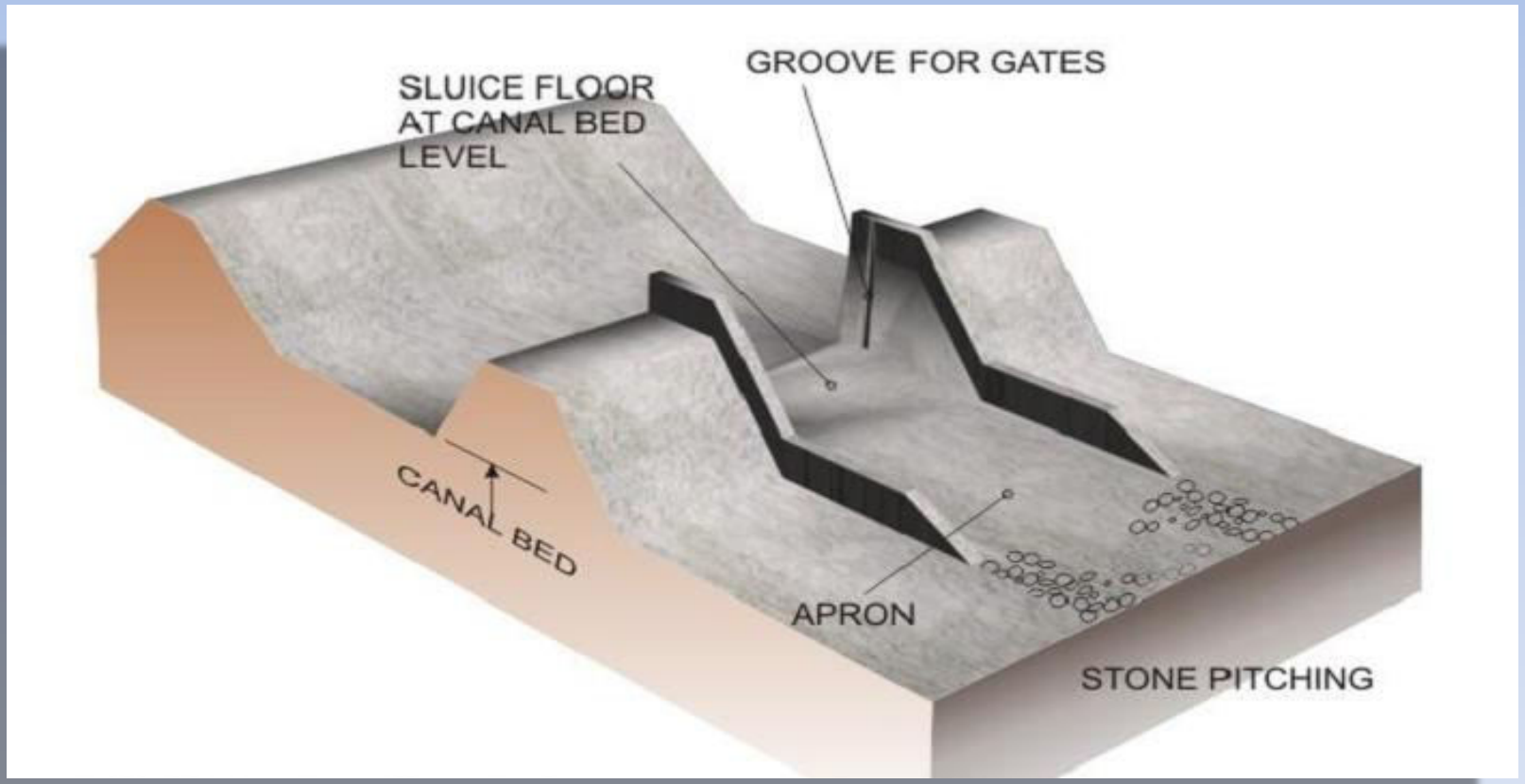
Fig. 13.9. Weir type escape or 'Tail escape'.

Escapes are usually of the following three types.

Scouring Escape

- This escape is constructed for the purpose of scouring of excess silt deposited in the head reaches from time to time. Hence, it is called scouring escape. Here the sill of the regulator is kept at about 0.3 m below the canal bed level at escape site. When deposited silt to be scoured, a higher discharge than the FSL is allowed to enter the canal from the head works. The gate of the escape is raised so as to produce scouring velocity which remove the deposited silt. This type of Escape has become obsolete as silt ejector provided in the canal can produce better efficiency.

Scouring Escape



Head Regulator

- Regulators Constructed at the off taking point are called head regulators. When it is constructed at the head of main canal it is known as canal head regulator. And when it is constructed at the head of distributary, it is called distributary head regulator.
- **Function:**
- To control the entry of water either from the reservoir or from the main canal.
- To control the entry of silt into off taking or main canal.
- To serve as a meter for measuring discharge of water.

Head Regulator

- **Construction:** The components of head regulator depends upon the size of canal and location of head regulator. It consists of one or more gated research openings with barrels running through the bank. For large canals head regulators are flumed to facilitate the measurement of discharge.

Head Regulator

Cross Regulator

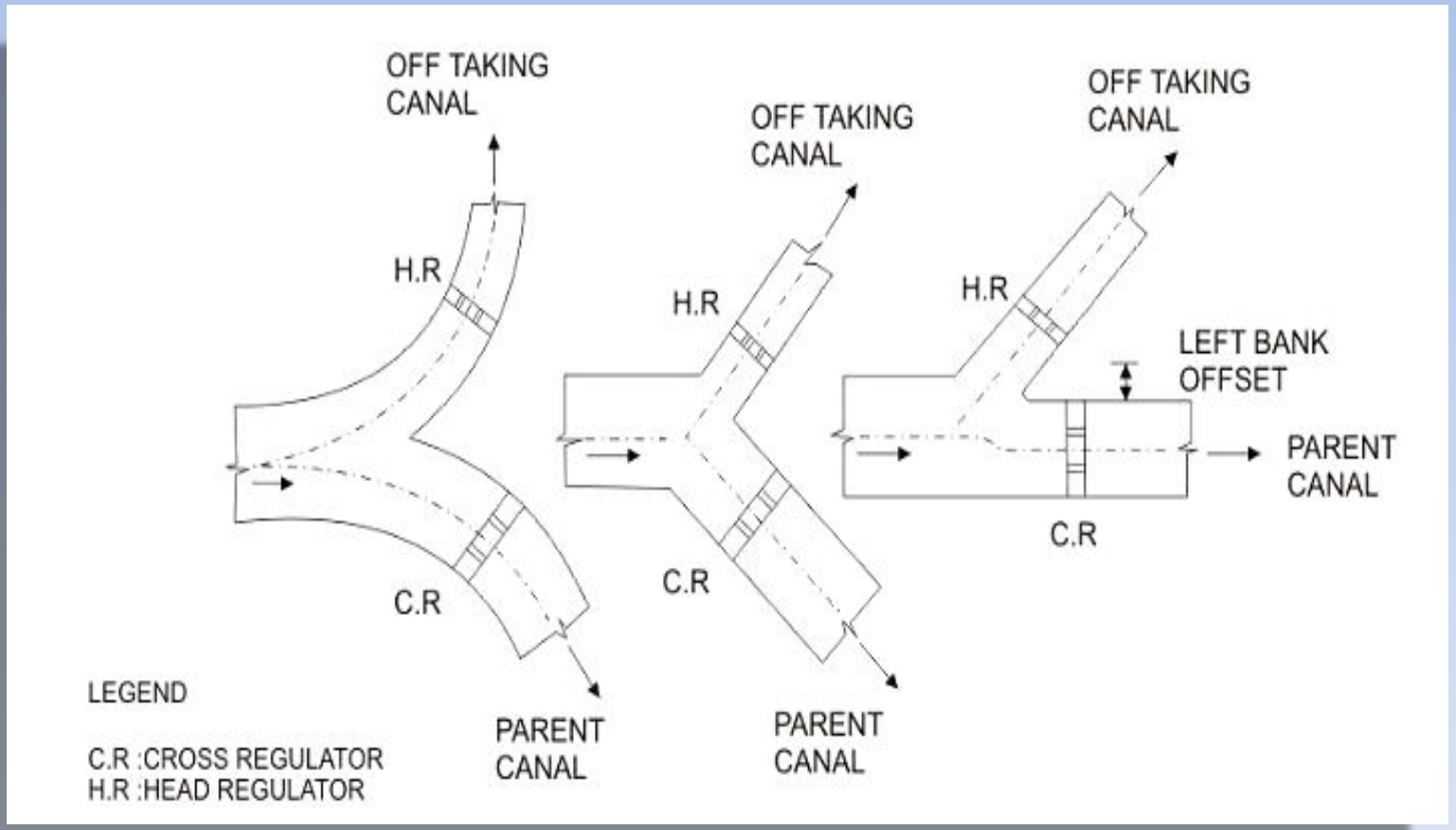
- **Cross Regulator**
- A Regulator Constructed in the main canal or parent canal downstream of an off take canal is called cross-regulator.
- It is generally constructed at a distance of 9 to 12 km along the main canal and 6 to 10 km along branch canal.
- **Functions:**
- (i) To Control the flow of water in canal system
- (ii) To feed the off taking Canals
- (iii) To enable closing of the canal breaches on the d/s
- (iv) To provide roadway for vehicular traffic

Cross Regulator

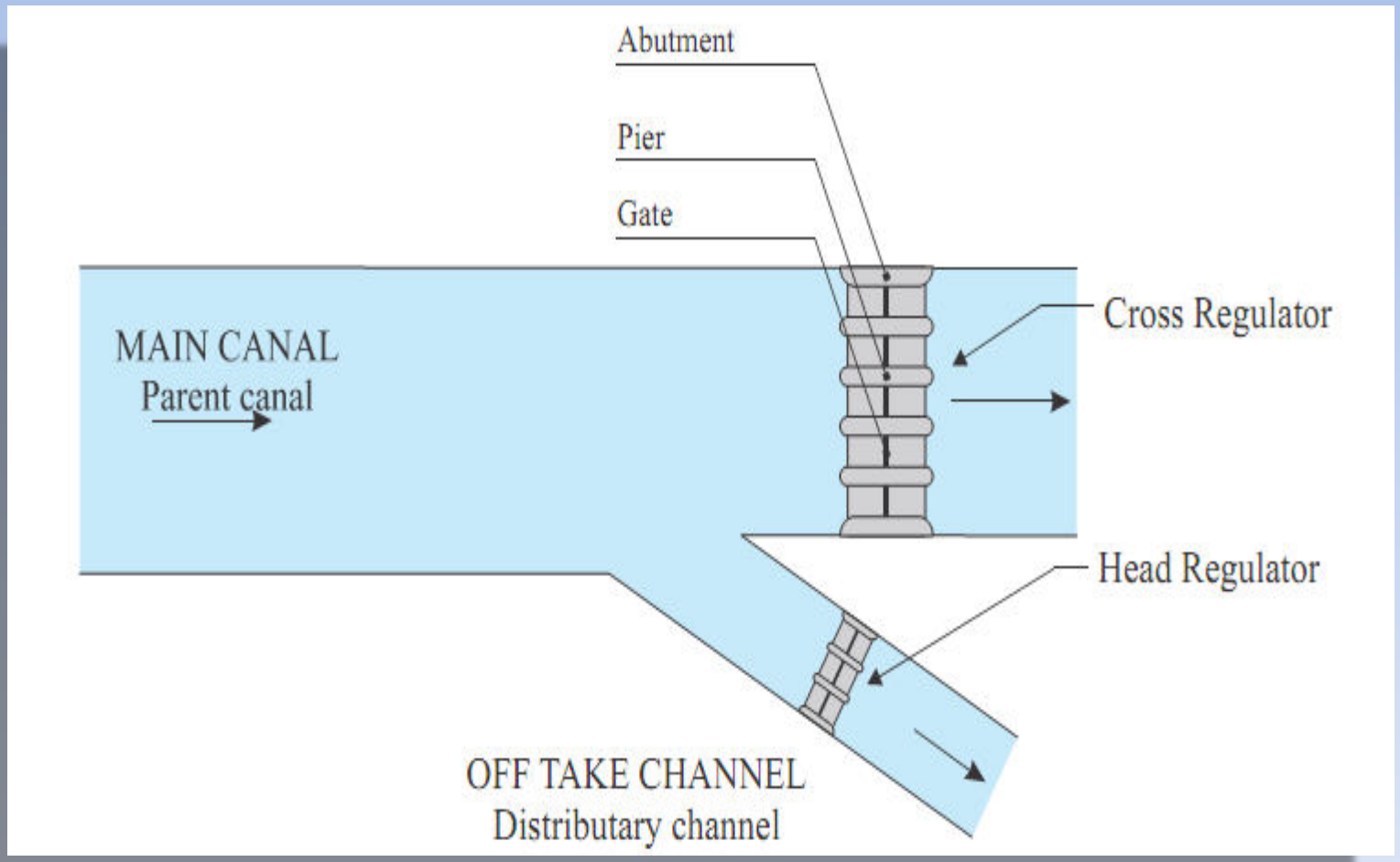
Cross Regulator

Construction: For Cross Regulators abutments with grooves and piers are constructed parallel to the parent canal. The sill of regulation is kept little higher than the u/s bed level of canal across which it is constructed. Vertical lift gates are fitted in the grooves. The gates can be operate from the road.

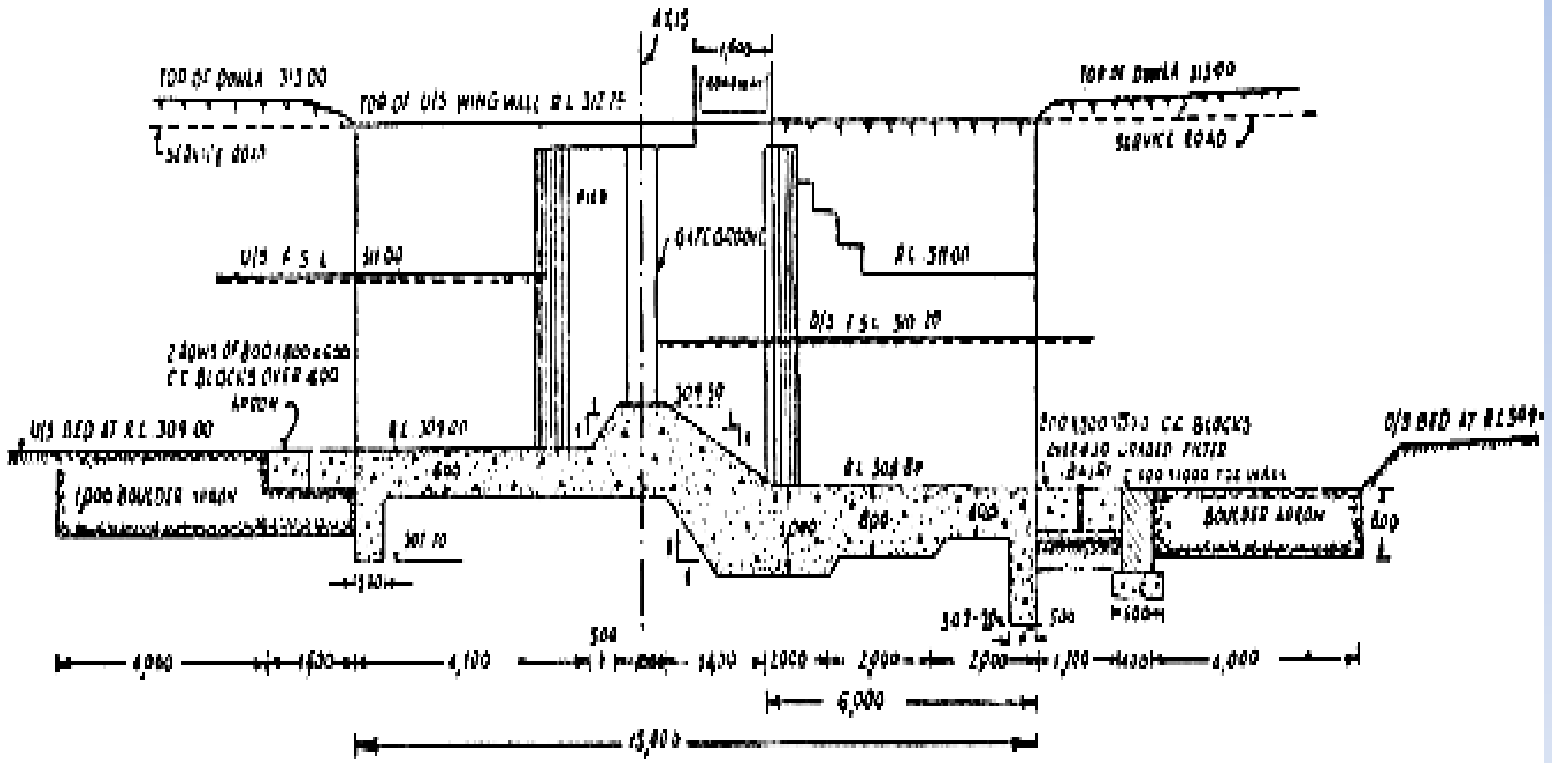
Canal regulators



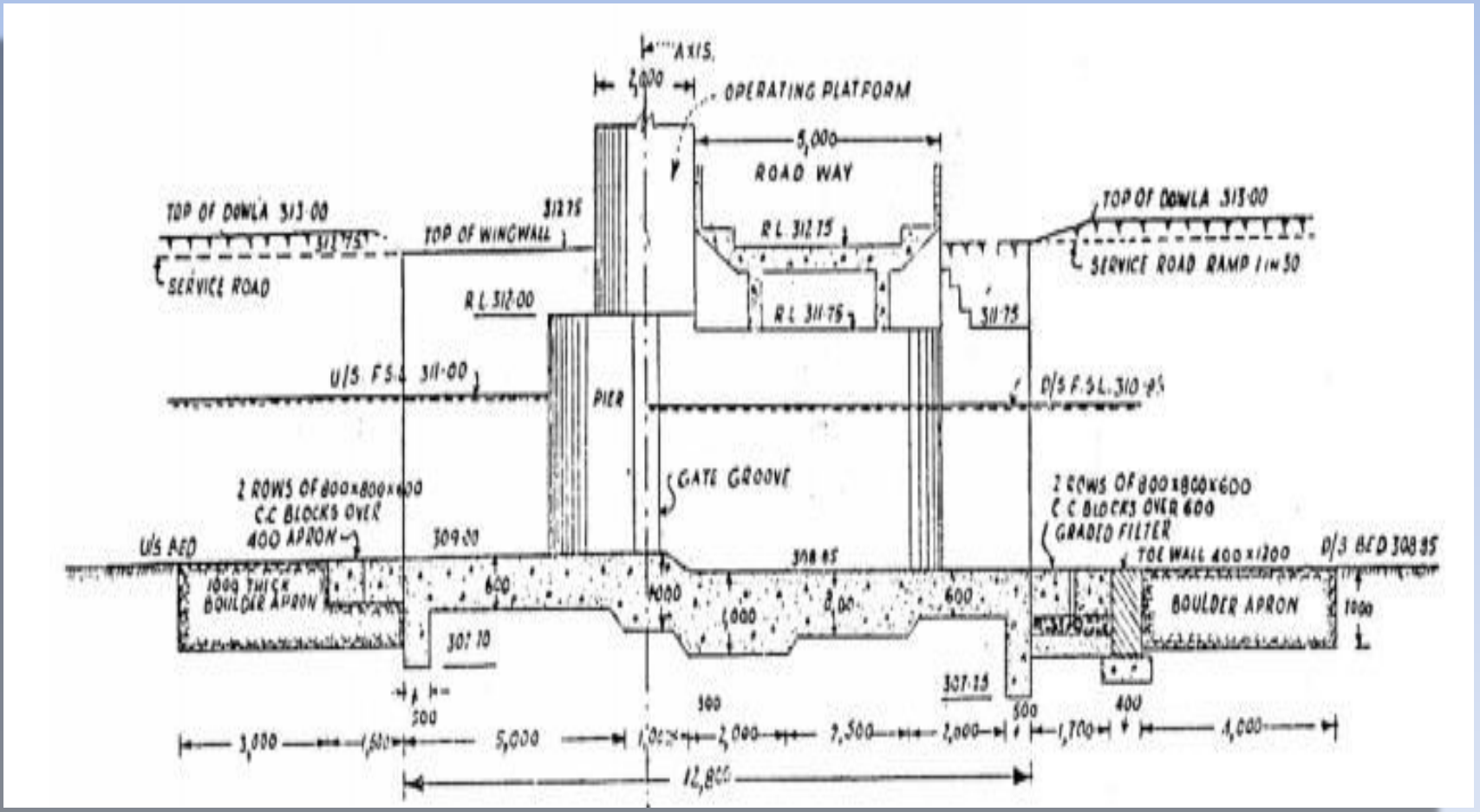
Canal regulators



Cross Regulator



Head Regulator



Silt Control Devices

- Scouring Sluices or Under sluices, silt pocket and silt excluders
- The above three components are employed for silt control at the head work. Divide wall creates a silt pocket. Silt excluder consists of a number under tunnels resting on the floor pocket. Top floor of the tunnel is at the level of sill of the head regulator.
- Various tunnels of different lengths are made. The tunnel near the head regulator is of same length of head regulator and successive tunnels towards the divide wall are short. Velocity near the silt laden water is disposed downstream through tunnels and under sluices.

Silt Control Devices

- **Silt Excluder:** The silt excluder is located on the u/s of diversion weir and in front of the head regulator. The object is to remove silt that has entered in the stilling basin through scouring sluices.
- **Silt Ejector:** Silt Ejector is located in the canal take off from the diversion weir at 6 to 10 km in the canal reach. It ejects the silt that has entered in the canal

Silt Control Devices

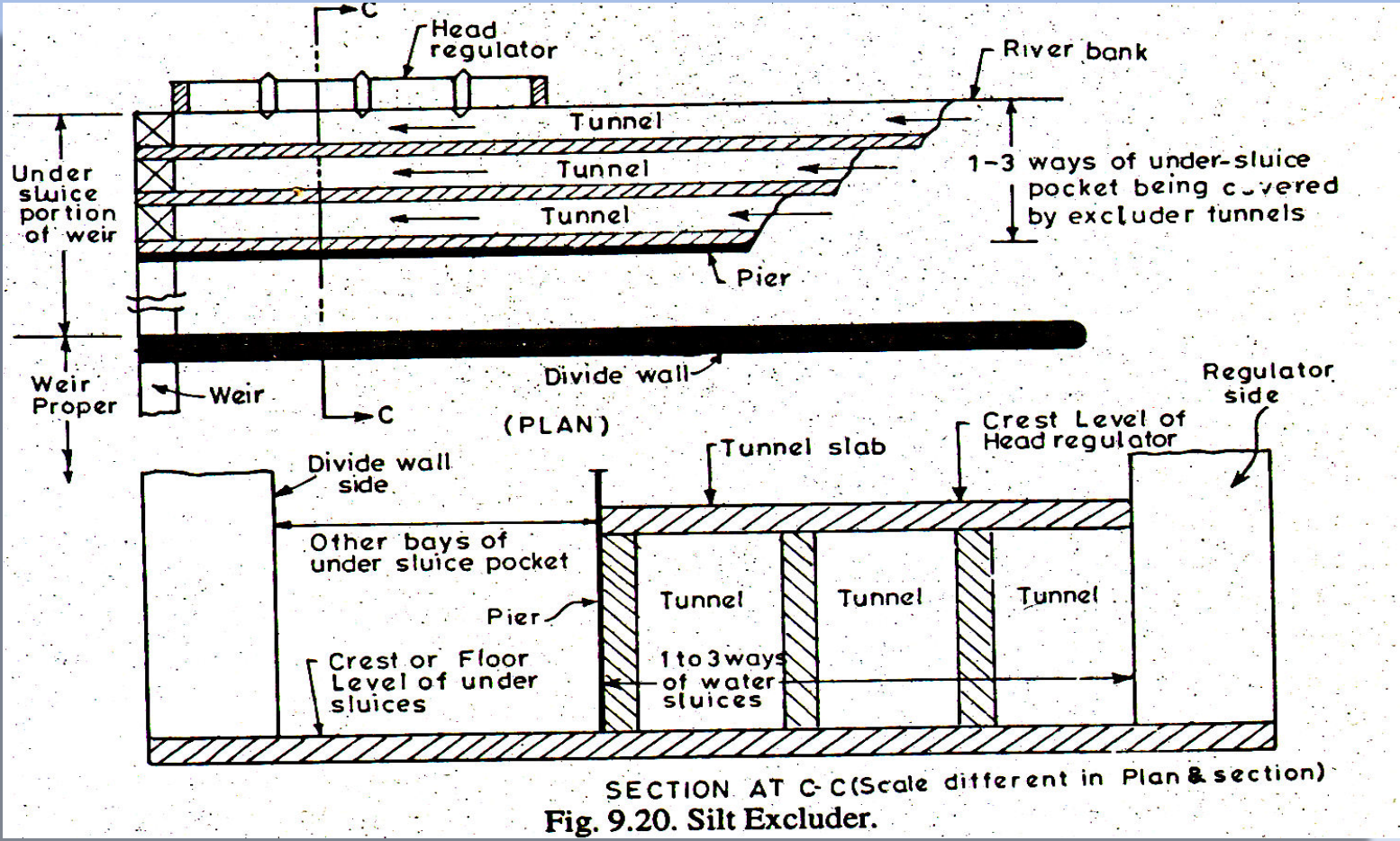


Fig. 9.20. Silt Excluder.

Silt Excluder

Silt Control Devices

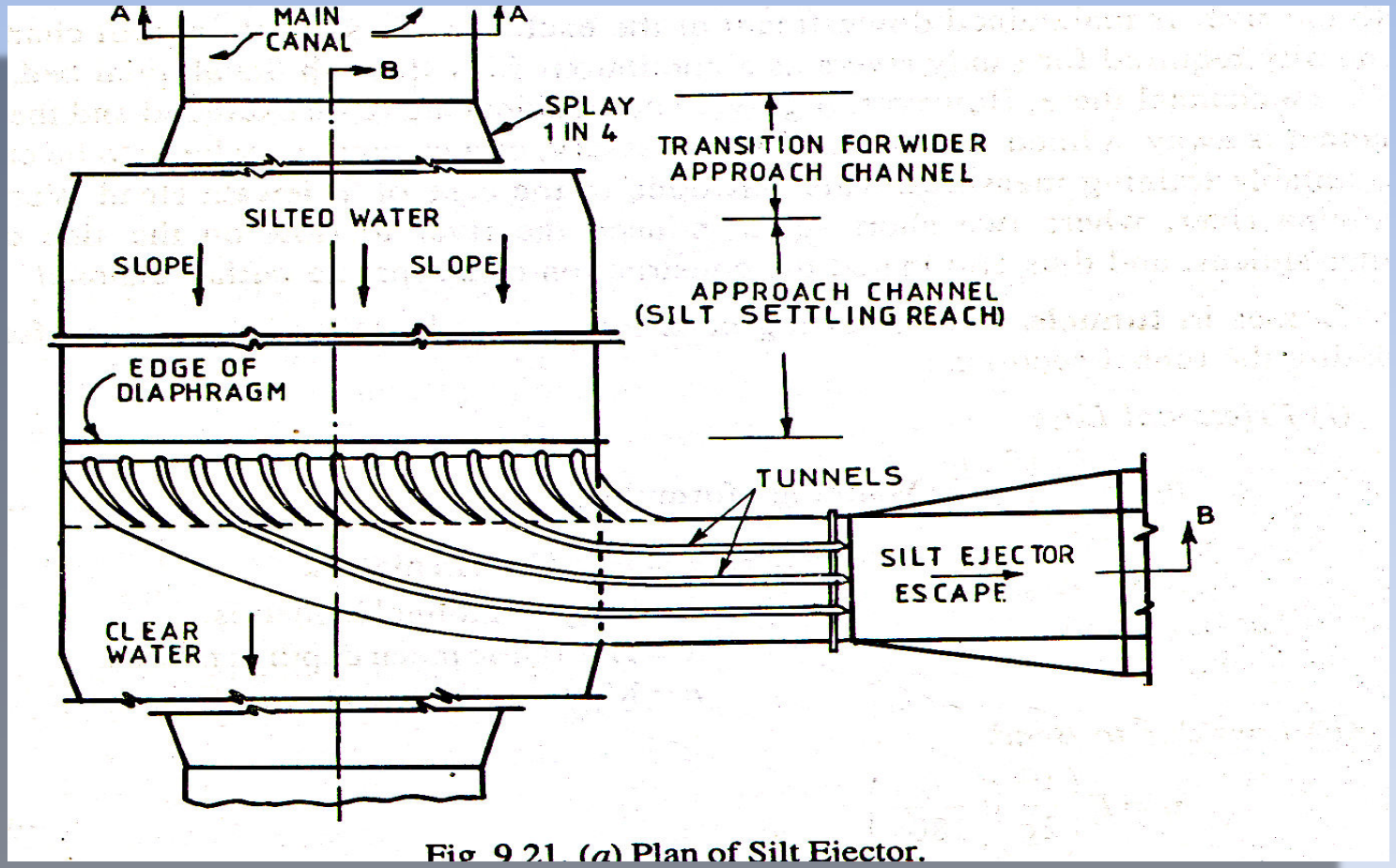
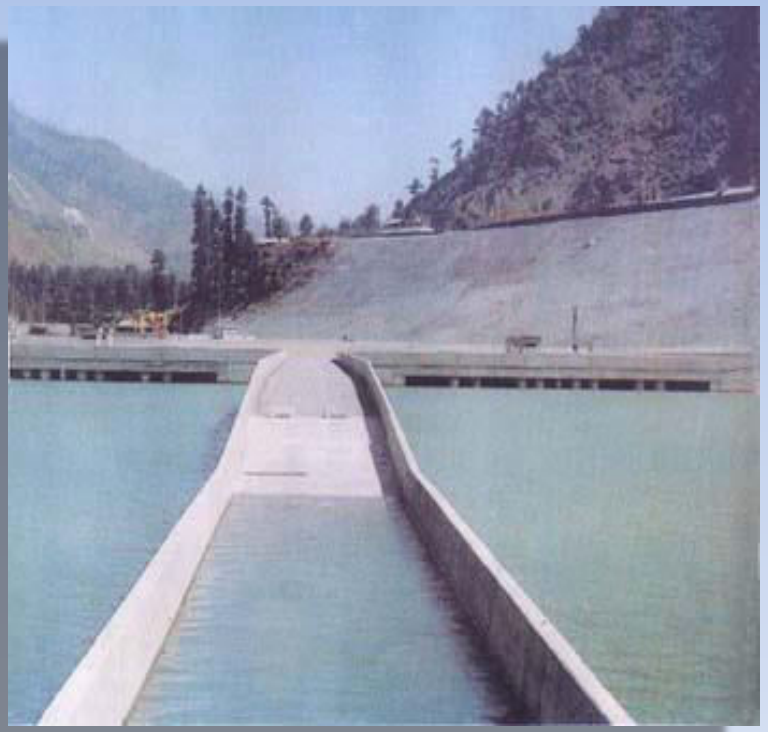


Fig. 9.21. (a) Plan of Silt Ejector.

Silt Ejector

Silt Control Devices



Canal Outlet/modules

- A canal outlet or a module is a small structure built at the head of the water course so as to connect it with a minor or a distributary channel.
- It acts as a connecting link between the system manager and the farmers.

Canal Outlet/modules

Non-Modular Modules

- Non-modular modules are those through which the discharge depends upon the head difference between the distributary and the water course.

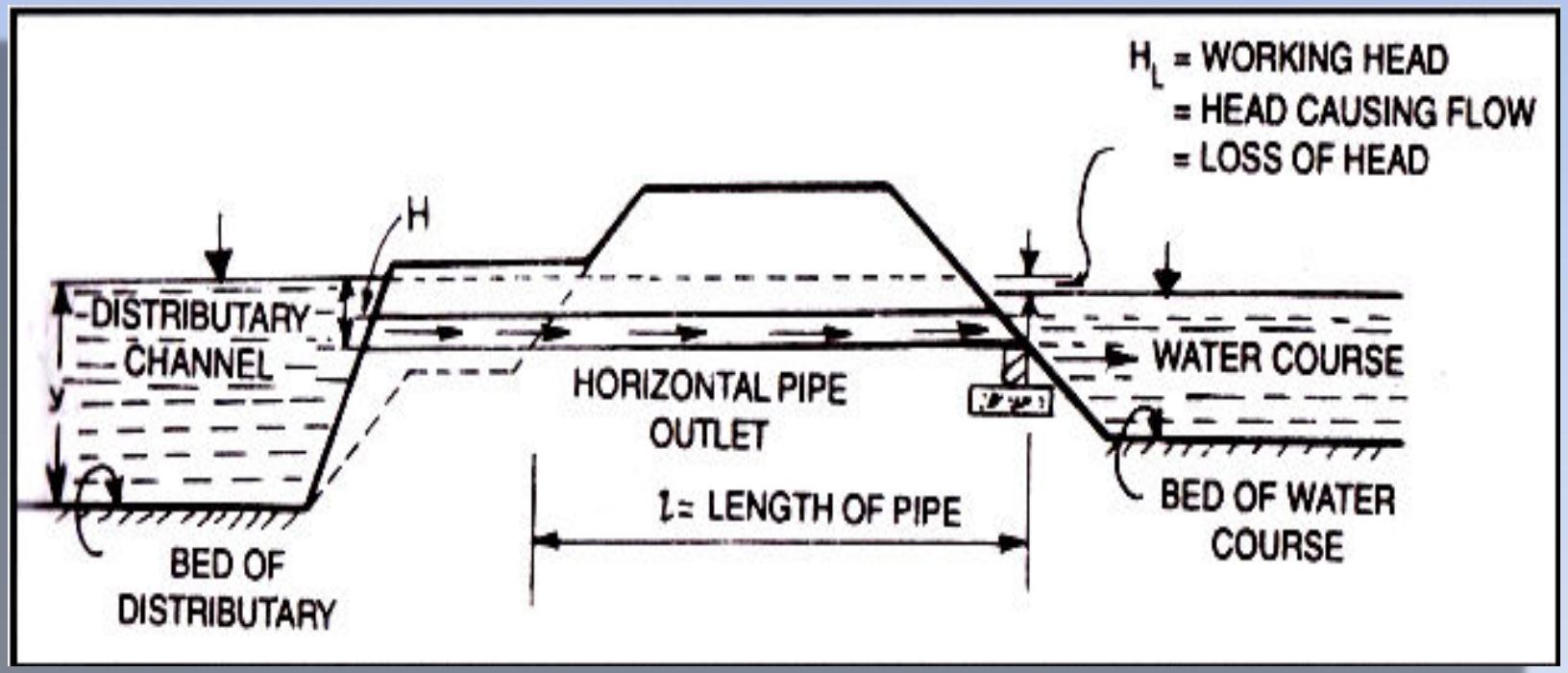
Common examples are:

(i) Open sluice

(ii) Drowned pipe outlet

Types of Outlet/modules

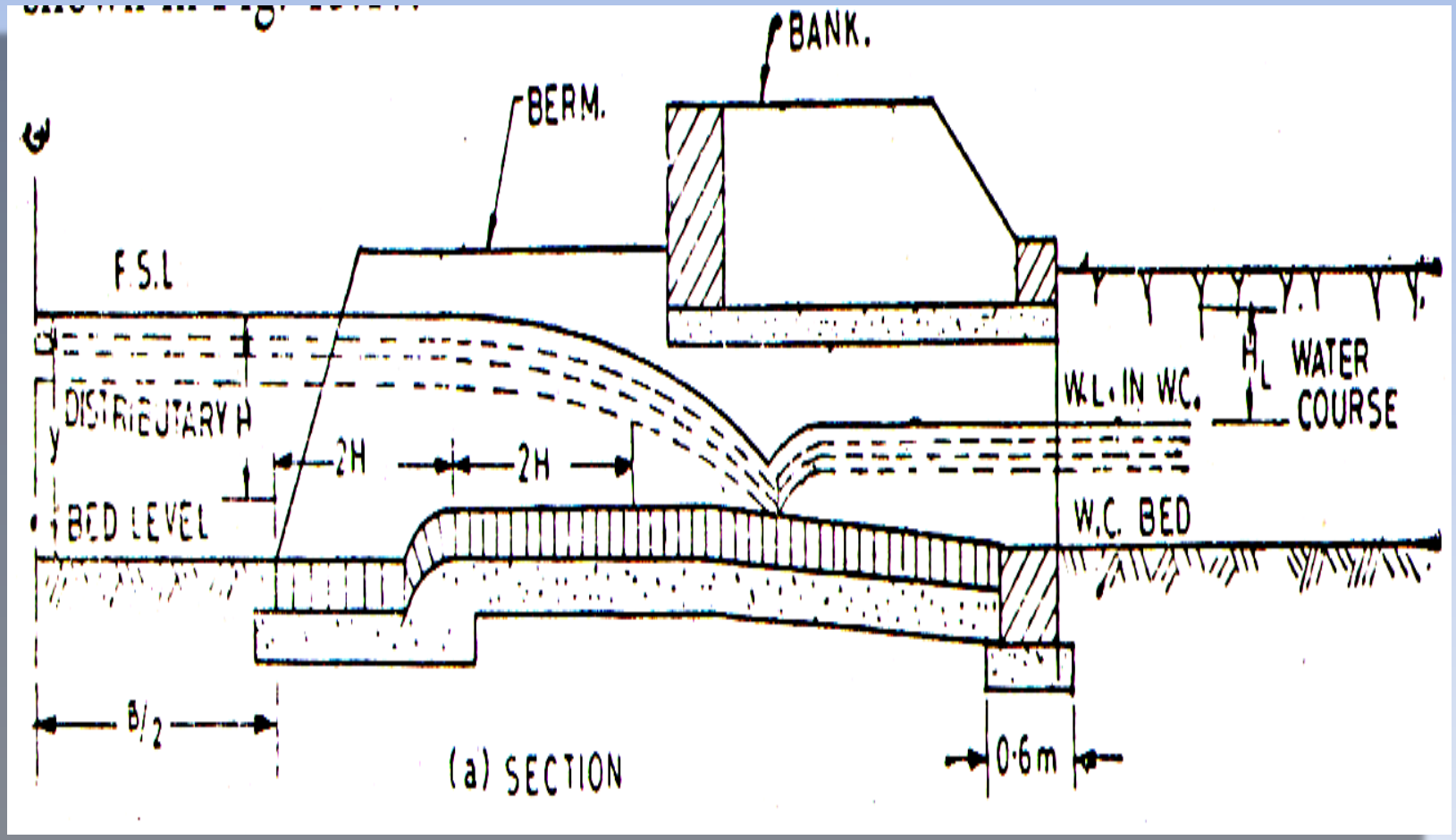
- Non-modular modules



Semi-Modules or Flexible modules

- Due to construction, a super-critical velocity is ensured in the throat and thereby allowing the formation of a jump in the expanding flume.
- The formation of hydraulic jump makes the outlet discharge independent of the water level in water course, thus making it a semi module. Semi-modules or flexible modules are those through which the discharge is independent of the water level of the water course but depends only upon the water level of the distributary so long as a minimum working head is available.
- Examples are pipe outlet, open flume type etc.

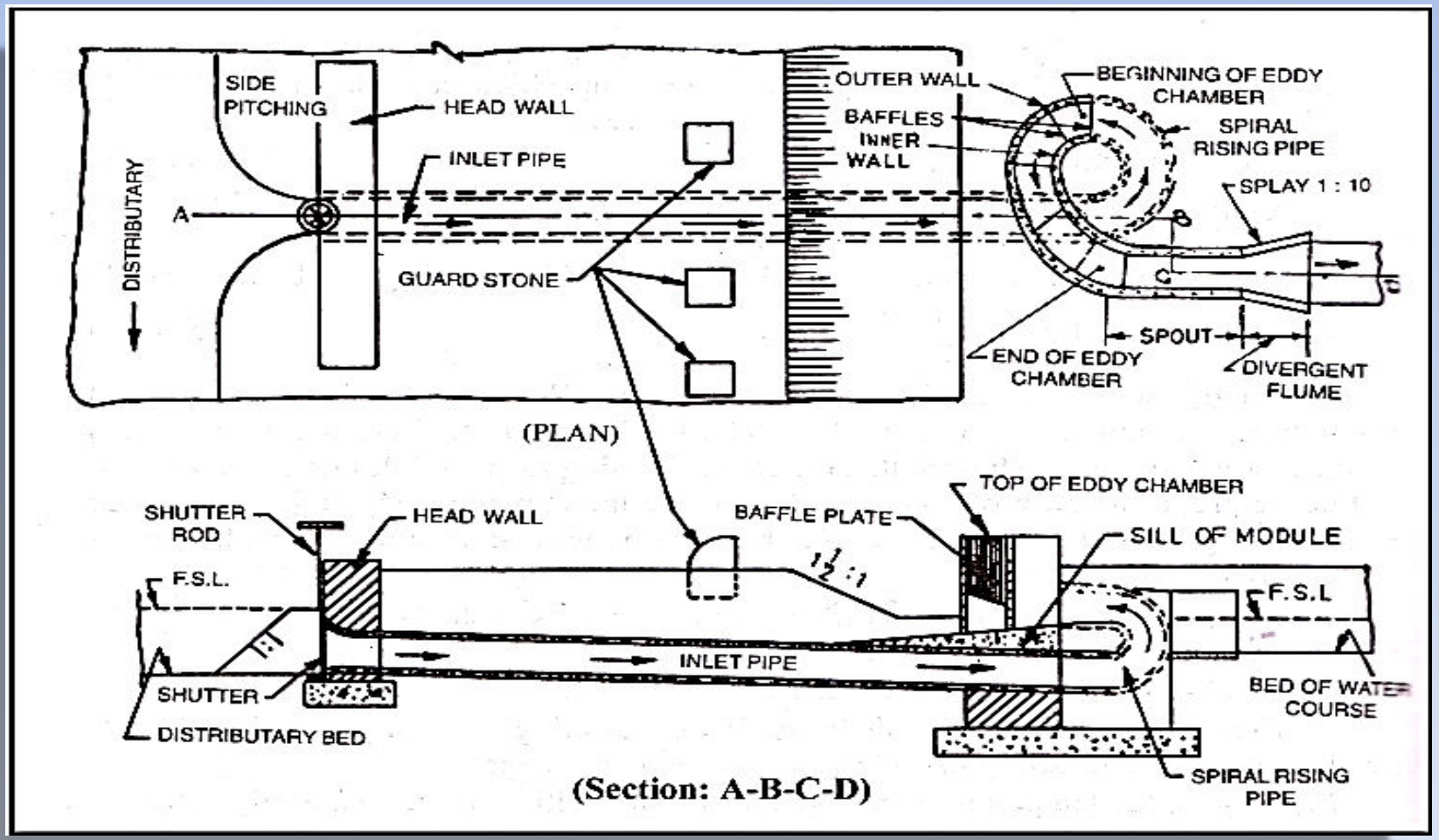
Semi-Modules or Flexible modules



Rigid Modules or Modular Outlets

- Rigid modules or modular outlets are those through which discharge is constant and fixed within limits, irrespective of the fluctuations of the water levels of either the distributary or of the water course or both.
- An example is Gibb's module:

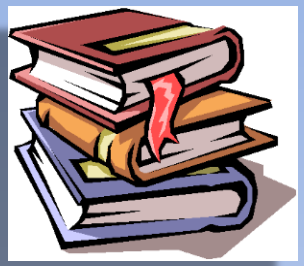
Gibb's Module



Exam Questions

Dec 2011, June 2012

- What do you understand by a fall in canal? Why it is necessary?
- What are the functions of a canal head regulator?
- Explain functions of cross regulator and distributory head regulator.
- Write a S.N. on Types of Canal Falls



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- **http://www.uap-bd.edu/**
- **Lecture Notes By: Dr. M. R. Kabir**
- Professor and Head, Department of Civil Engineering Department
- University of Asia Pacific (UAP), Dhaka