

Inlet and outlet structures

Gulshan Kumar
School of Fisheries

Seepage and its control

- The ponds constructed on porous soils are required to be protected with impervious material to prevent loss of water owing to seepage from the pond. There are many types of pond lining but the type selected should be cheapest combine with its stability, use fullness and efficiency. Pond lining has some other advantages also. Lining prevents growth of weeds and vegetation on the pond surface. It prevents raise of water table and add safety to the pond structure. **Clay puddling, brick work with cement mortar, cement concrete and plastic membrane are few methods of pond lining.**

- ***Clay puddling***

Clay puddle lining is quite satisfactory under wet condition. A layer of good clay of at least **15 cm thick**, uniformly spread on the bed and the sides of the pond and compact it. The surface is then cover with 30 cm of silt.

- ***Brick lining***

It reduces the seepage at about 80% provided bricks are manufactured of best material and observed less water. Bricks may be laid flat or on edge and are embedded on 1.2 cm layer of 1:6 cement mortar on consolidated pond surface. The bricks should be plastered or pointed with cement mortar of 1:3 proportions.

- ***Plastic lining***

The plastic membrane or poly vinyl chloride (PVC) lining offers a compact water barrier. This system is considerable economy. This method of lining the pond is very simple. The pond surface should be cleared first of all roots, vegetation etc., and the surface is made smooth over which the PVC membrane is laid. Anchorages are made in the ground for holding the membrane in proper position. The membrane is then covered with 30 cm of thick earth layer and well compact it.

- If your pond bottom soil contains a high percentage of coarse-grained particles and not enough clay, adding **bentonite** to it is another method of reducing excessive seepage.
- Bentonite is a fine-textured colloidal clay with as much as **90 percent of montmorillonite**. When exposed to water, dried bentonite absorbs several times its own weight of water; at complete saturation, it swells as much as eight to twenty times its original dry volume.

- it is relatively easy to apply;
- it can offer a long-lasting solution to excessive seepage;
- cost may be excessive if the transport distance is too long;
- burrowing animals such as crayfish or crabs and strong bottom-feeders such as common carp can penetrate through the bentonite-treated layer;

- According to the bentonite and soil laboratory analyses, **uniformly spread from 5 to 15 kg of bentonite per m²** : the better the quality of bentonite and the more clay or silt your soil contains, the less bentonite you will require.
- Thoroughly **mix the bentonite with the bottom soil** to a depth of about 15 cm.

Inlet and outlet structures

- **Inlet structure and outlet structures**
- **Pipes**
- For small ponds the best inlet structure is P.V.C pipes of about 10-15 cm diameter with a control top and a screen basket.

- The outlet may be open channels, conduits or pipes.
- The pipes or conduit outlets are suitable for all types of ponds. Asbestos pipes, cement concrete, galvanized iron pipe, PVC pipes, cast iron pipe are some of different types of pipes used for pond drainage system.
- The size of the drainage pipe depends on the area of the pond and volume of water in the pond to be drained out. For a pond of 0.1 to 0.2 ha area, an outlet pipe of about 15 cm diameters will be ideal.
- The pipes of less than 10 cm diameter may lead to clogging. The outlets or drainage pipes installed at the lowest elevation of bottom of the pond.

- For larger fish ponds the construction of concrete outlet are highly useful.
- The outlet pipes should be properly covered with screens to prevent the escape of fish form ponds. For larger ponds pipes are bigger diameter as 20-25 cm are preferable.
- Drainage pipe should be laid at a slope of 1 in 400.
- The pipe should be rest on layer of sand hard bed to prevent the pipe against unequal settlement at the base. The percolation of water along sides of drainage pipe can be checked by providing a few concrete collars with pipe which will acts as impervious barriers against the path of flow of seeping water.

Calculation of time required for emptying the pond

$$\text{Time required for emptying of pond } t = \frac{V}{Q}$$

V = Volume of water in the pond (m³)

Q = Discharge of water (m³/sec.)

$$V = A \times H$$

$$Q = C_d \ a \ v$$

v = Velocity of water m/sec

a = Area of the pipe (m²)

C_d = Co-efficient of discharge

A = Area of the pond (m²)

H = Depth of water (m)

$$v = \sqrt{2 \times g \times h}$$

Please ignore

g is acceleration due to gravity is 9.8 m/sq sec

- **Water control structures or Gates**

Gates are part of water distribution system in an aquaculture farm and are installed to control the water flow. Following are the basic requirements of a gate.

- It should be of sufficient capacity to handle the required flow of water during pond draining and filling.
- It should be properly located and carefully constructed taking into the account the pond bottom level and channel bed level for an efficient flow of the water and complete drainage as and when required.

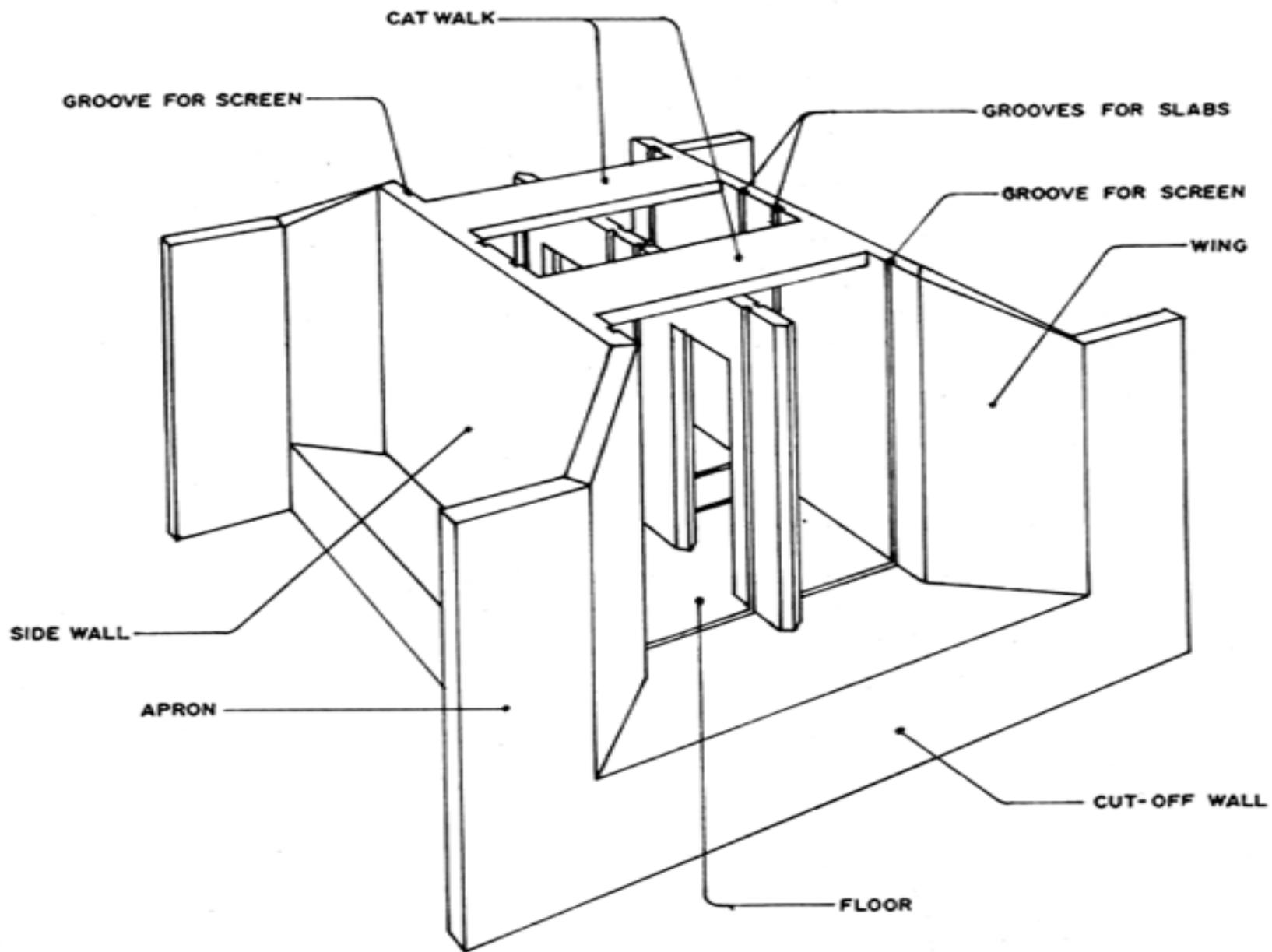
- It should be made of a material which can withstand the saline action and where fouling action is minimum.
- Self weight of the gate as far as possible should be lighter but not sacrificing the structural requirements. It should require minimum additional foundation depending upon the soil characteristics and should be economical and easy to construct.
- It should be firmly situated at the bottom of pond or channel and linked with the dikes to prevent seepage and possible collapse.
- It should be easy to operate and maintain, and should have proper provision for filtering predatory fishes, their eggs and other organism.

- **Main gate**

The main gate connects the main channel of the pond system to the source of water. In a tide fed farm, it regulates the exchange of water.

- It is the biggest gate in the pond system and is usually made of reinforced cement concrete (R.C.C.).
- Main gates may have one or more openings, size of each opening being usually 1 to 1.2 m in width for easy handling.

- The height of the main gate depends on the combine height of highest tide and the river flood. Generally the height of main gate is taken as that of the main or peripheral dike. It is located at a place where fresh sea water can be obtained most of the time.
- The various components of the main gate are floor, apron, cut off walls, side walls, wing walls, walking plat form, flash boards and screens.



- The gate rests on a **floor** which serves as its foundation. The elevation of the floor should be lower than the lowest pond bottom elevation inside the pond system of the farm.
- Preferably it should be lower than lowest tide to ensure complete drainage of the pond system.
- The extended and clear part of the floor upstream and downstream of the gate is known as **apron**. It provides protection against scouring action of flow.
- **Cut off walls** are necessary at both ends of the gate floor if it lies over alluvial soils, for its safety against seepage and consequent piping action.

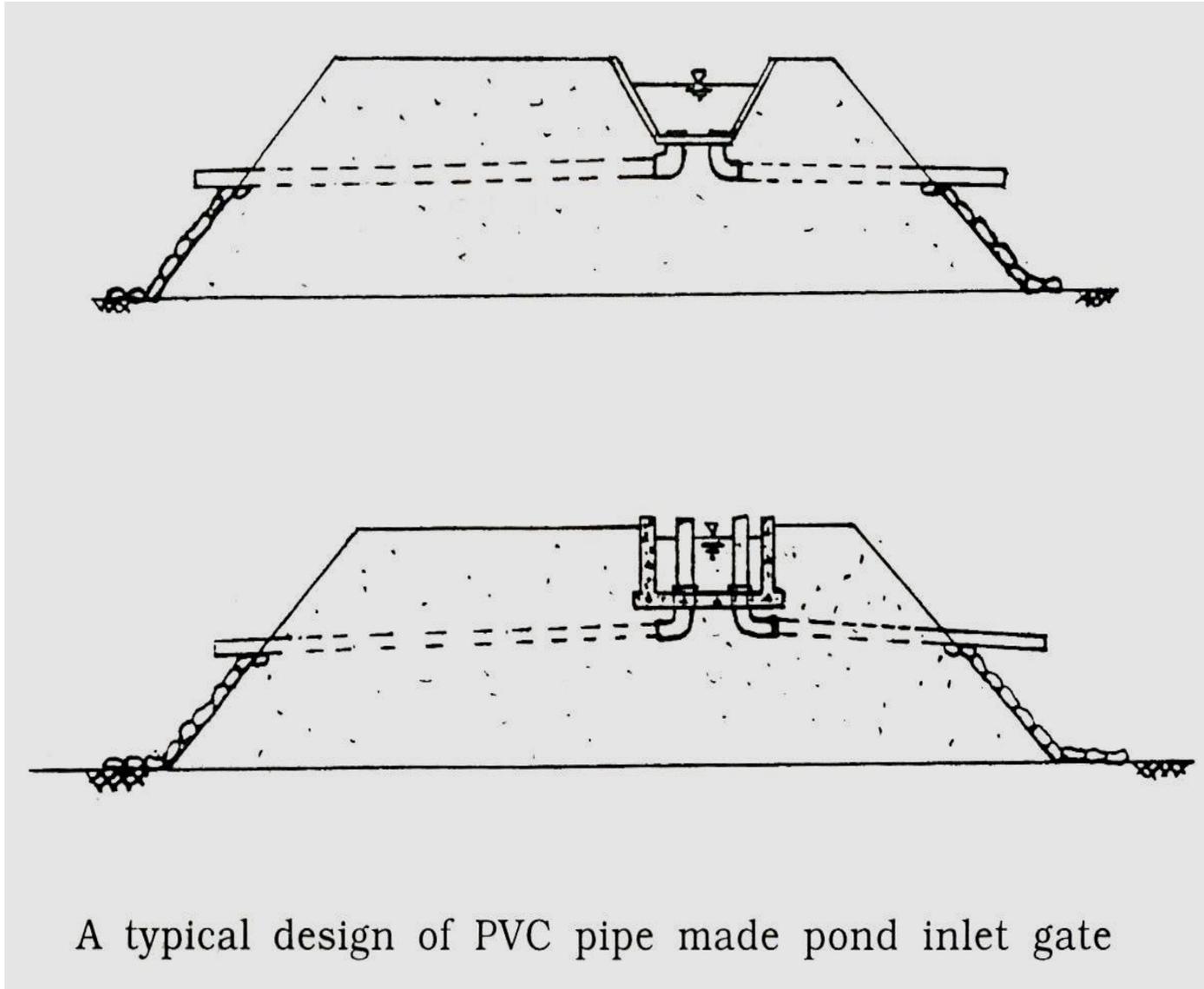
- In the side walls, grooves are made for fixing screens and flash boards. Most of the main supply gates are provided with 4 grooves two at each sides. Usually the top of the walls are made the same height as that of the dike.
- Wing walls in the main gate provides transition of the flow from water source such as tidal creek to the gate and then from gate to the channel.

- Cat walks or walking plat forms are provided between the two side walls.
- Amount of water flowing through the gate is controlled by the flash boards.
- They are generally made of wooden planks of size 5 cm thick and 30 cm wide inserted into the remaining two grooves of the main gate.
- A one meter wide opening of the main supply gate needs a channel bed of at least 3 m wide.

- Secondary gates regulate the flow of water from the main feeder channel to the secondary feeder channels.
- The secondary feeder channel bed should be wider than its supply gate by at least 0.5 m on both sides to minimize scouring.

- Pond inlet gates regulate the flow of water from feeder channel into the various ponds.
- The three commonly used pond gates are P.V.C. pipe made and open sluice and monc sluice.
- **Inlet made up of P.V.C pipes**

- It consists of P.V.C. elbow or bend and two pieces of P.V.C. pipes.
- One pipe is horizontal can take water from channel and discharge in the pond.
- The elbow or bend is fixed at the channel side. From this elbow one more pipe is fixed which remain in upright position. It is detachable and has to be removed while taking water.
- The length of this vertical stand pipe should be higher than the maximum in the feeder channel.



A typical design of PVC pipe made pond inlet gate

$$Q = C_d A \sqrt{2gH}$$

Where,

Q = Discharge capacity of the pond inlet gate at free fall condition m^3/sec

$$A = \text{Cross sectional area of the pipe} = \frac{\pi d^2}{4} \text{ m}^2$$

d = Internal diameter of the pipe (m)

g = Acceleration due to gravity $9.81 \text{ m}/\text{sec}^2$

H = The vertical height of the water at its free surface in the feeder canal above the central axis of the horizontal pipe (m)

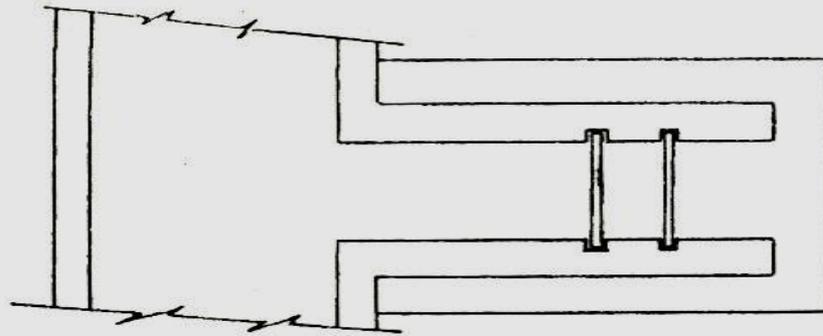
C_d = Co-efficient of discharge, value of which may be taken equal to 0.81 for length of pipe equal to 3 times the diameter i.e., for $L = 3 D$

$C_d = 0.71$ for $L = 25 D$, $C_d = 0.64$ for $L = 50 D$

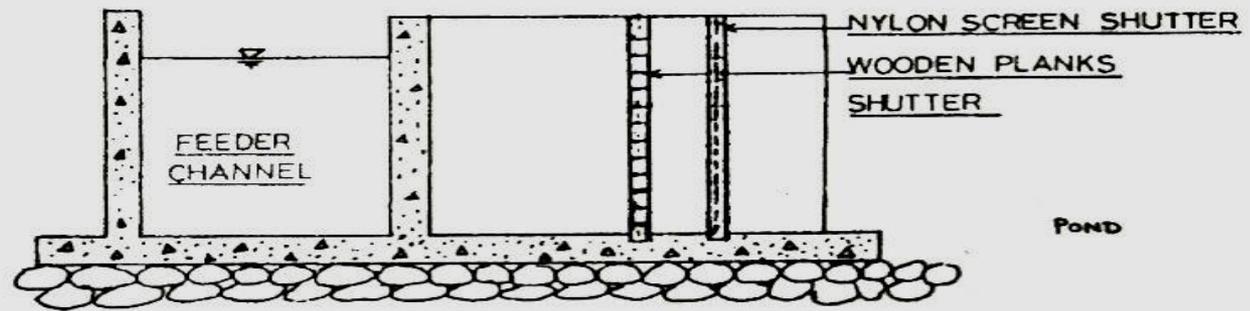
Sluice (open sluice)

- It is generally made of R.C.C. or wood.
- Usually two rows of grooves are made vertically in the side walls, one for mounting wooden planks or cast iron plate shutter and the other facing towards feeder canal for mounting screen shutter.
- Flow of water into the pond is regulated by sliding the wooden planks or cast iron plate shutter vertically up or down.
- It is best **to limit the inside width of the sluice gate to 0.80 m** at the most. More than that and it becomes difficult to handle the wooden boards, particularly when the pond is full. Generally 30 – 50 cm.

- **some advantages:**
- a sluice gate is easier to build;
- less water leaks within the dike;
- it frightens the fish less and makes their harvesting easier;
- its water discharge capacity for a given size is usually greater.
- However, its **major disadvantage** is that it is **more expensive to build:**
- it is built of bricks or cement blocks, concrete or reinforced concrete because, to last for a long time, it requires very good quality masonry;
- Because more material is needed, this difference in cost rapidly increases as the size of the dike increases, as shown in the illustration.
- Therefore, sluice gates are usually preferred to monks **for small- to medium-size ponds only**, when the dike to be crossed is relatively narrow.



PLAN



ELEVATION

A typical design of open type pond inlet structure

- **Computation of discharge through sluices**

While water flows through a sluice or gate following three conditions are possible

- Free flow condition
- Submerged flow condition
- Partially submerged flow condition

Free discharge through an open sluice

$$Q = \frac{2}{3} C_d b \sqrt{2g} (H_2^{3/2} - H_1^{3/2})$$

Where,

b = Bottom width of the sluice

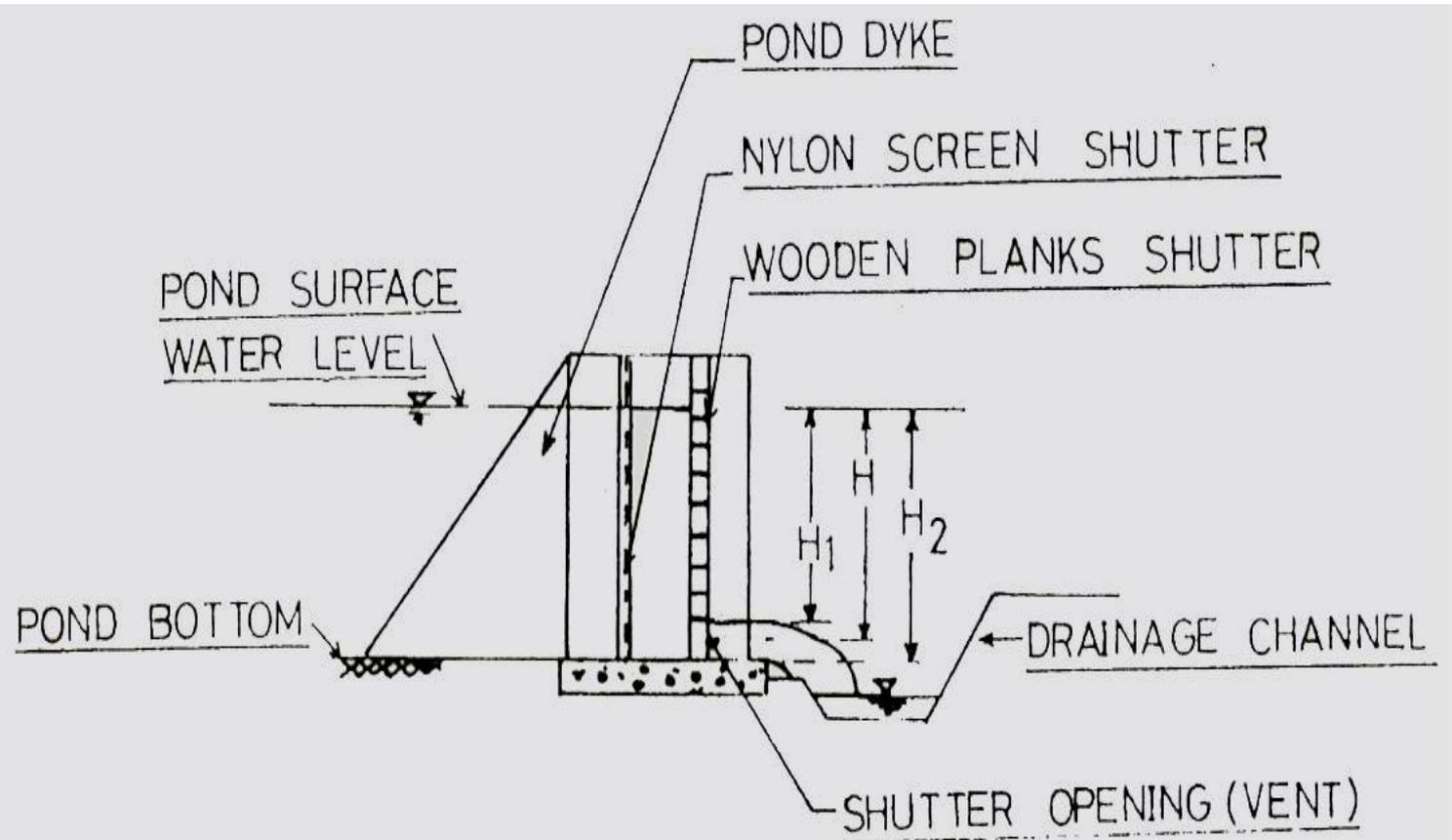
H_1 = Height of the water (on u/s side), above the top of the sluice opening or vent.

H_2 = Height of water (on the u/s side) above the bottom of the sluice.

Description of the sluice

Value of Cd

- | | |
|--|------|
| 1) Sluices without side walls or ordinary lock sluice | 0.62 |
| 2) Sluice opening whose bottom is on a level with that of the pond and for sluices with walls in a line with its opening | 0.86 |
| 3) Short pipe (external cylindrical) or opening (vent) in a thick wall with square edge entry when the length of the pipe or the thickness of the wall is 2.5 to 3 times the diameter of the opening | 0.82 |
| 4) Ditto, when the thickness of the wall or the length of the pipe is short | 0.61 |
| 5) Opening with well rounded entry i.e., (bell mouthed) | 0.97 |



An open sluice under free flow condition

Discharge under submerged condition taking place through an open sluice can be computed by using the equation.

$$Q = C_d b (H_2 - H_1) \sqrt{2gH}$$

Description of the sluice

Value of C_d

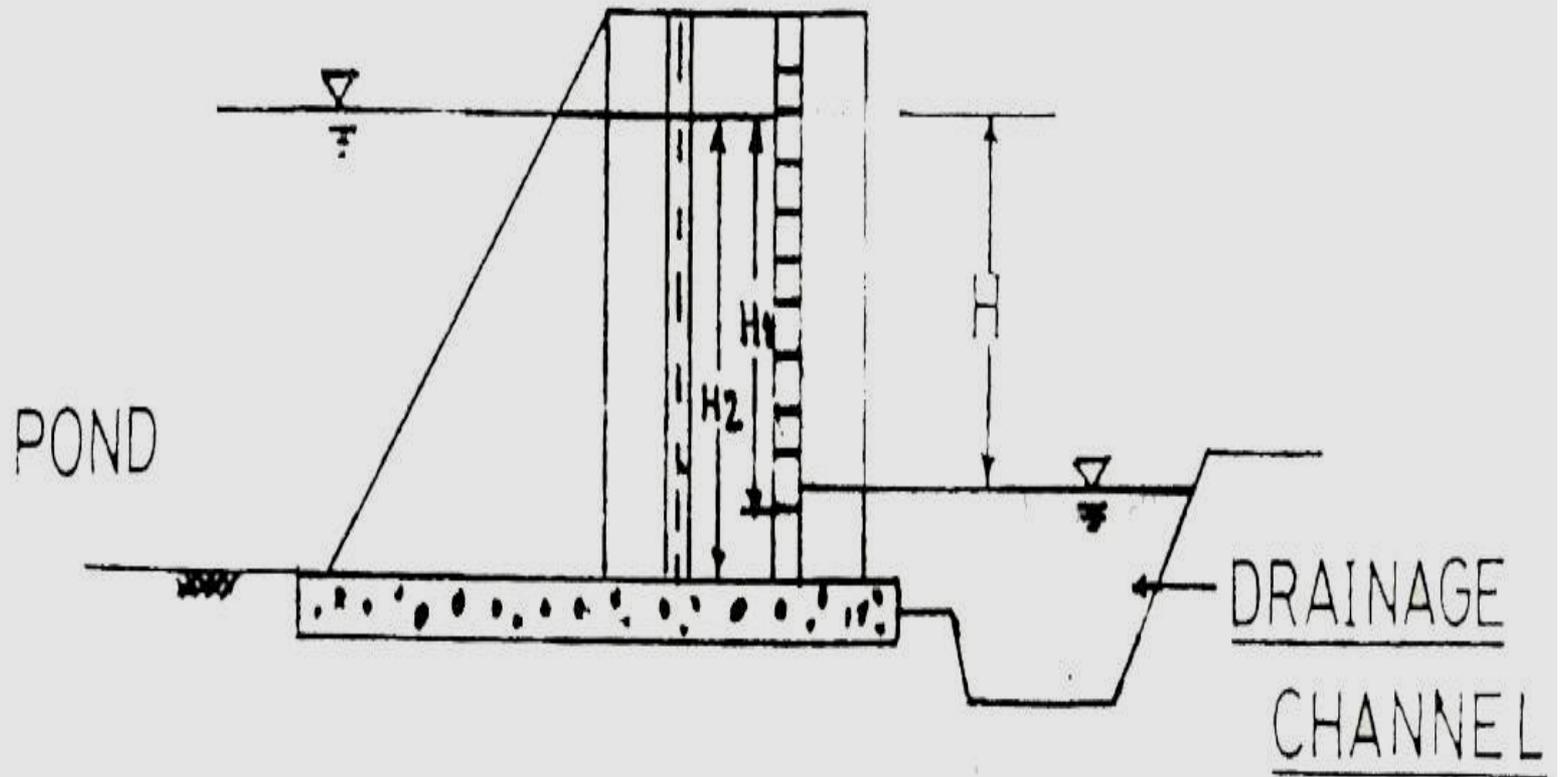
Sluices without side walls

0.66

Very large well-built sluices with side wall

0.94

Some times for a sluice, whose bottom is on a level with the pond and the water flows into water, the co-efficient is taken equal to 0.86.



An open sluice under submerged flow condition

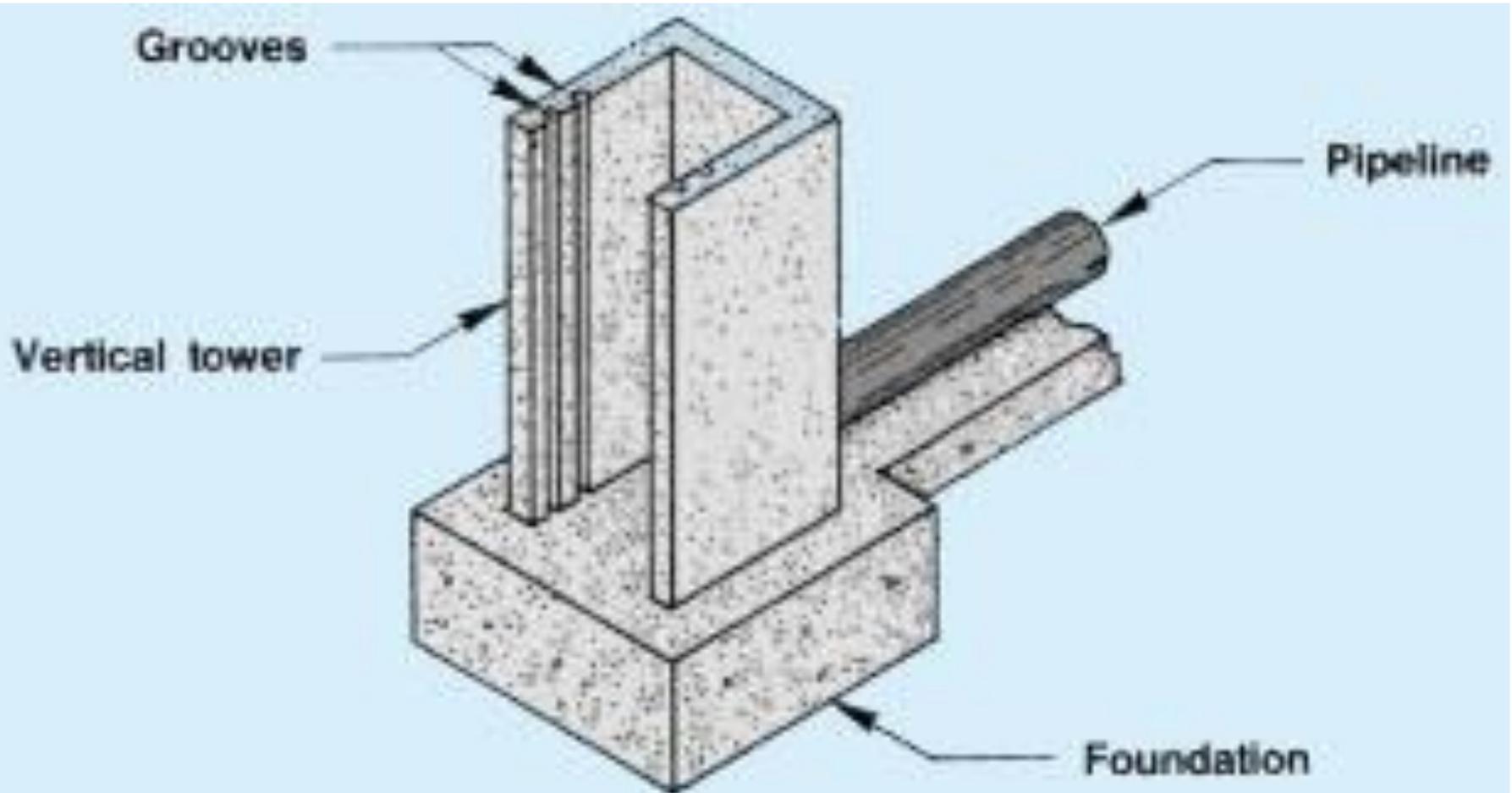
Monk

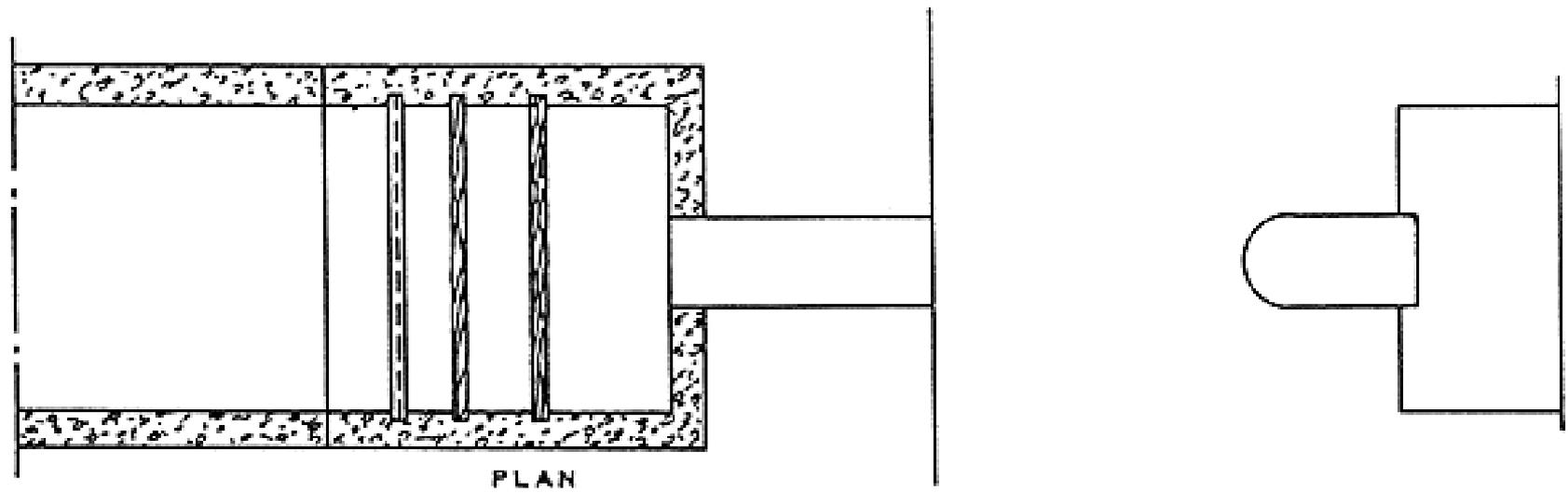
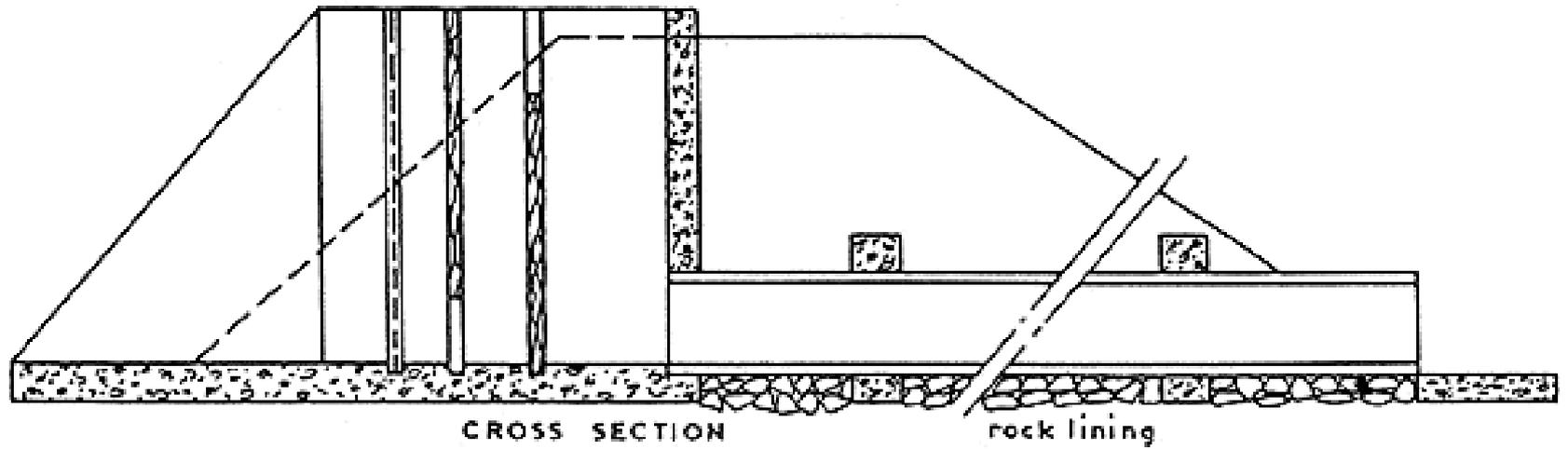
- The monk is one of the oldest and most common pond draining structures.
- It consists of a **vertical tower** closed with wooden boards to regulate the water level.
- The water is discharged through a pipeline buried under the dike.
- **A screen** keeps the farmed fish from leaving the pond.

- A monk has **advantages** similar to those of the sluice gate.
- The pond water level is easily controlled and adjusted.
- It can function as an overflow.
- It simplifies the fish harvest.
- In addition, a monk is more easily protected than a sluice gate,
- and it is more economical to build if the pond dike is large.
- However, it has **the disadvantage of not being very simple to construct**, particularly if it is built with bricks or concrete.

- **The complete monk outlet** consists of:
 - **a vertical three-sided tower** (called the monk), usually as high as the outlet dike, **a pipeline** running through the dike, which is sealed to the back of the tower at its base;
 - **a foundation** for the tower and the pipeline;
- and
- **grooves** to fix the wooden boards and screens which form the fourth side of the monk.
 - Earth will be filled between the boards.

- Internal width 30 – 50 cm
- Internal length 40 – 65 cm
- Diameter of pipe 10 – 30 cm





- Free discharge taking place through a monk sluice as shown in fig. can be computed by using the equation.

$$Q = C_d A \sqrt{2gH}$$

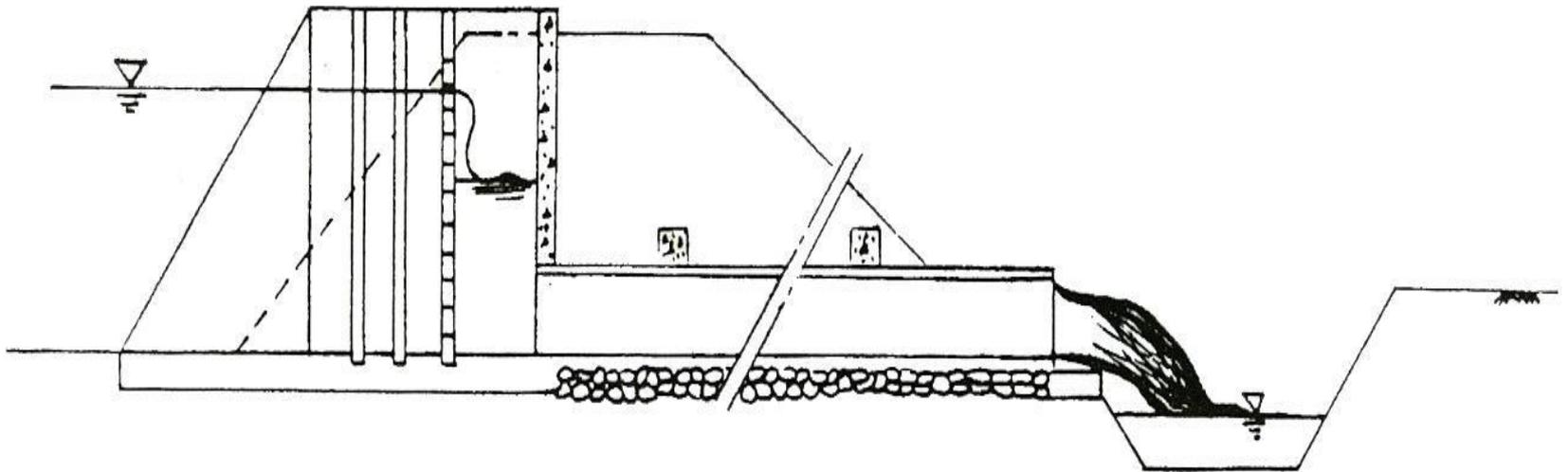
Where,

$Q =$ discharge m^3/sec

$A =$ Cross-sectional area of the pipe

$$A = \frac{\pi d^2}{4} \quad \text{m}^2$$

- g = Acceleration due to gravity 9.81m/sec^2
 H = Height of water (on u/s) above the central axis of the pipe (m)
 D = Internal diameter of the pipe (m)
 C_d = Co-efficient of discharge.



A monk sluice under free flow condition

Length of pipe

Value of Cd

3D

0.813

5D

0.79

10 D

0.77

25 D

0.71

50 D

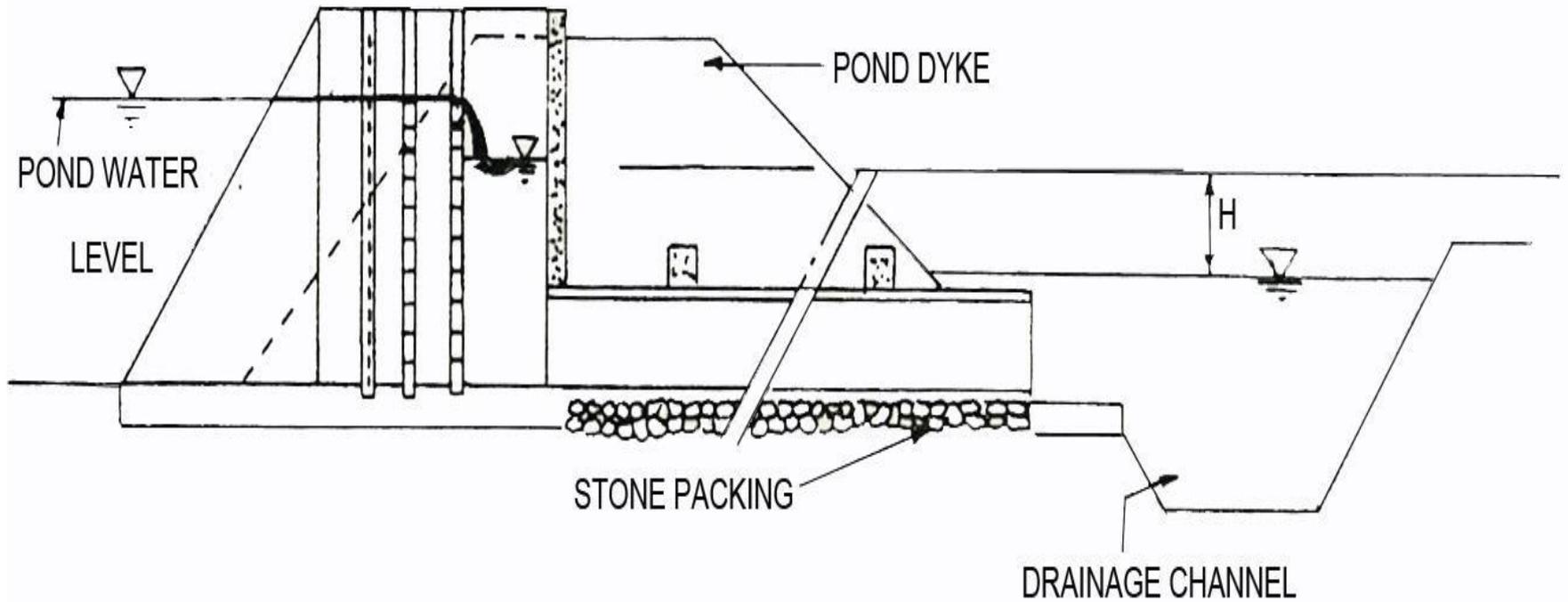
0.64

- Discharge through a monk sluice whose outlet pipe is under water can be computed by using the equation.

$$Q = C_d A \sqrt{2gH}$$

Where,

H = Difference between the two water levels, on either side of the pipe (m)



A monk sluice under submerged flow condition

Spillway

- To regularly carry away a **large flow of excess water**, we should build an open structure, called a **mechanical spillway**, and its draining channel, **the spillway channel**.
- A mechanical spillway consists of:
 - a horizontal part called **the crest**, across which the water flows;
 - two vertical **side walls**, each with a single groove;
 - a vertical board and/or coarse **screen** fitting into the grooves.
- **The level of the crest** controls the level at which the excess water in the pond will start to be carried away.

- **The grooves** can be fitted with a **board** to roughly control crest height. The **coarse screen** helps to avoid fish losses.

