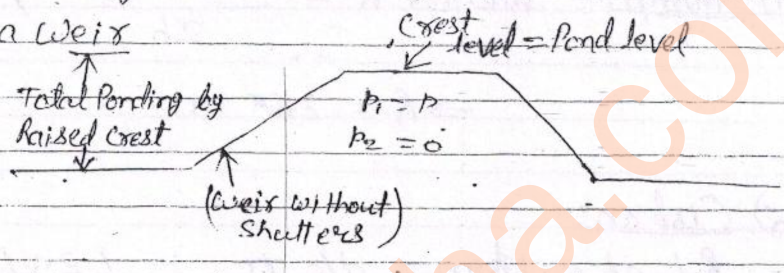
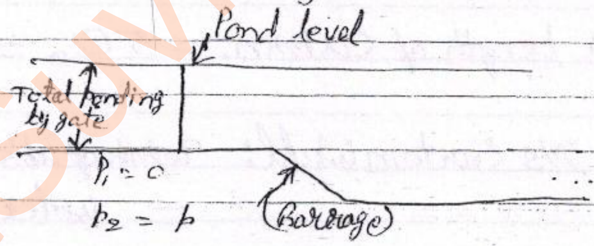
Unit-III

Weir & Barrage :→

- If the major part of the entire ponding of water is achieved by a raised crest and a smaller part or nil part of its is achieved by the shutters, then this barrier is known as a weir



- If the most of the ponding is done by gates and a smaller or nil part of it is done by the raised crest, then the barrier is known as Barrage or a River Regulator.

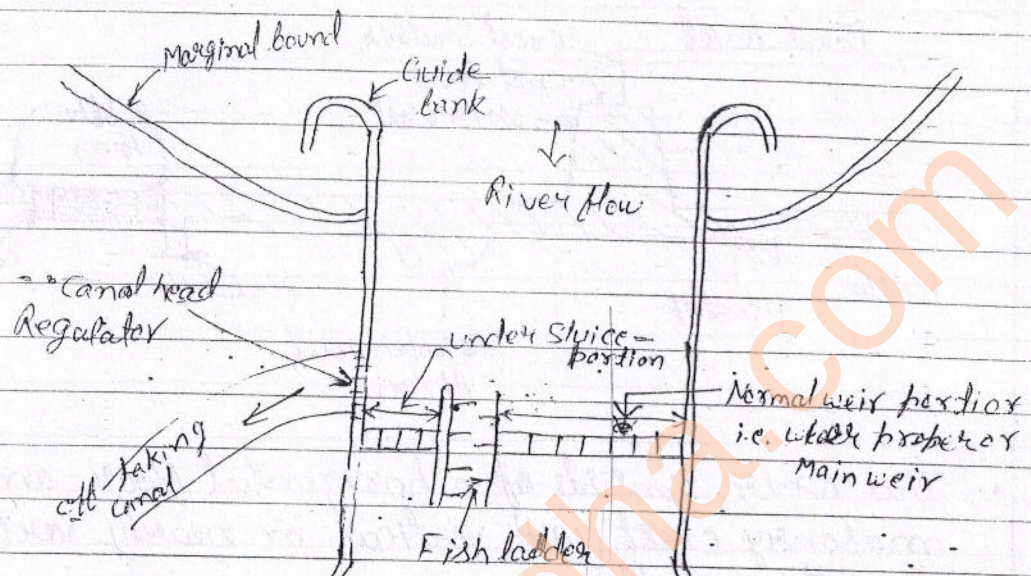


Layout of a Diversion Head Works and its Components :→

Head works consists of :-

(1) Weir Proper (2) Under-Sluices
(3) Divide Wall (4) River training works (Marginal bunds, Guide bank)
(5) Fish ladder (6) Canal Head Regulator
(7) Weir's ancillary works such as shutter, gates etc.
(8) Silt Regulation Works.

① • Divide wall, dividing the river width into two portions; one is called the weir portion, and the other portion from which the canal takes off, is having opening is called the, under-sluice pocket or Under sluices or weir scouring sluices.



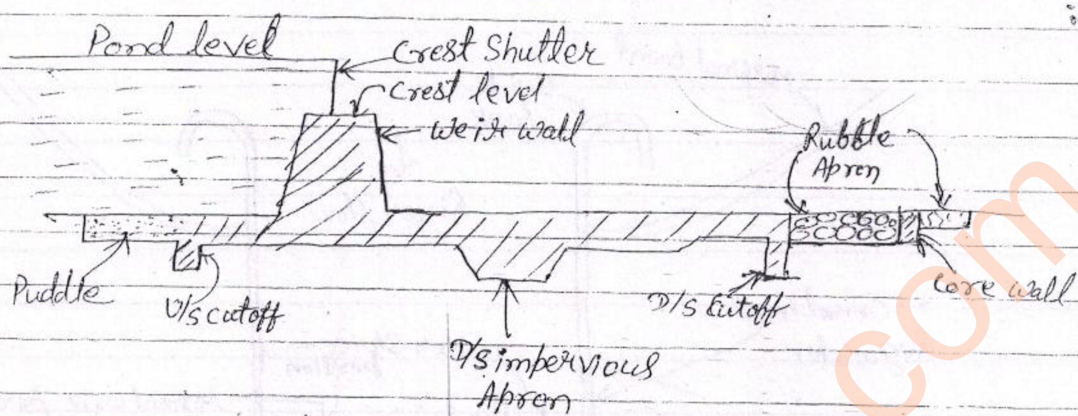
The diversion weir and its types:→

The entire length of the weir is divided into a number of bays by means of divide piers so as to avoid cross-flow in floods. As far as possible, the weirs should be aligned at right angle to the direction of the main river current. This right-angled alignment is better and therefore common, especially, when the river bed is silty or sandy. This ensures lesser length of the weir, better discharging capacity and lesser cost.

Types:→ Divided into three classes:-

(i) Masonary weirs with vertical drop
(ii) Rock-fill weirs with sloping aprons
(iii) Concrete weirs with sloping glacis

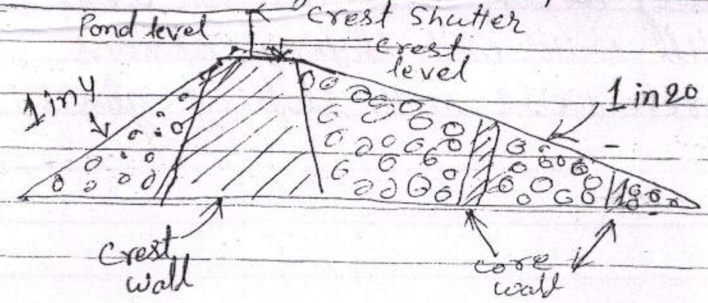
(i) Masonry weirs with vertical drop:→



- This weir consists of a horizontal floor and a masonry crest with vertical or nearly vertical downstream face.
- The raised masonry crest does the maximum ponding of water, but a part of it is usually done by shutters at the top of the crest.
- The shutters can be dropped down during floods, so as to reduce the afflux by increasing the waterway opening.
- This type of weir was used in the old-headworks, such as Bhimgoda etc and is particulary suitable for hard clay and consolidated gravel foundations.

(ii) Rock-fill Weirs with sloping aprons:→

- Such a weir is called 'Dry Stone Slope Weir'.

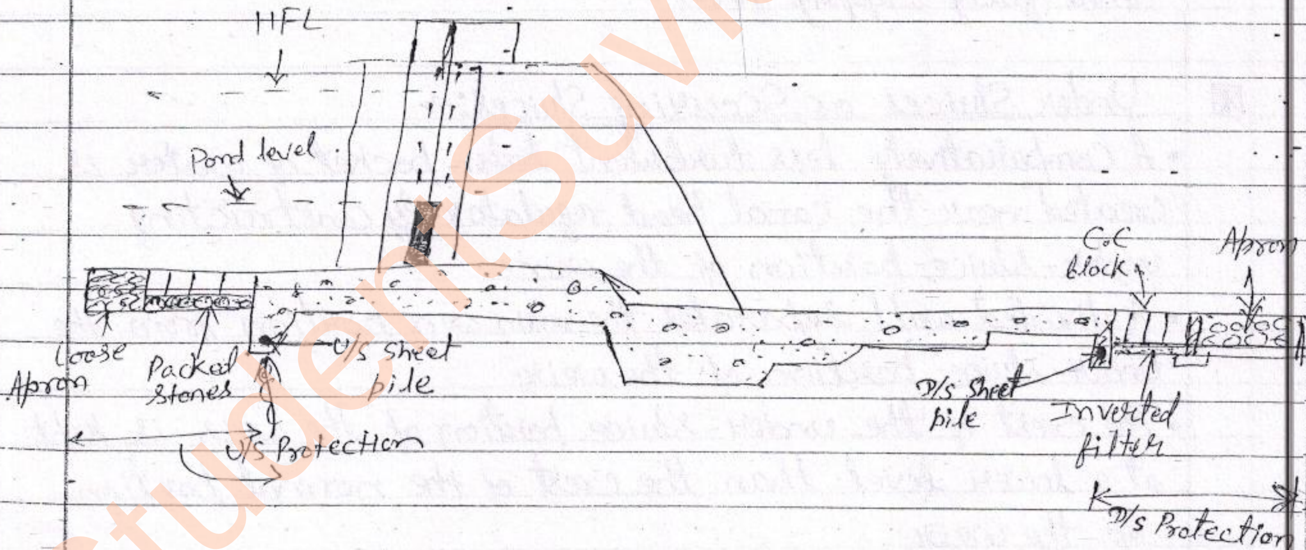


Date :
Page No. :

- It is the simplest type of construction, and is suitable for fine sandy foundations like those in alluvial areas in North India. Eg:- Old Okhla across Yamuna
- Such a weir requires huge quantities of stone and is economical only when stone is easily available.
- The stability of such a weir is not amenable to theoretical treatment.

(iii) Modern Concrete weirs with sloping downstream glacis:→

- These are of recent origin and their design is based on modern concepts of sub-surface flow (i.e. Khosla theory).



- Sheet piles of sufficient depths are driven at the ends of upstream & d/s floor. Sometimes, an intermediate pile line is also provided.
- The hydraulic jump is formed on the d/s sloping glacis, so as to dissipate the energy of the flowing water.
- Exclusively used, especially, on permeable foundations and are generally provided with a low crest with

| HFL – Max. flood level |

Counter-balanced gates, thus, making it a barrage.

⊠ Afflux:→

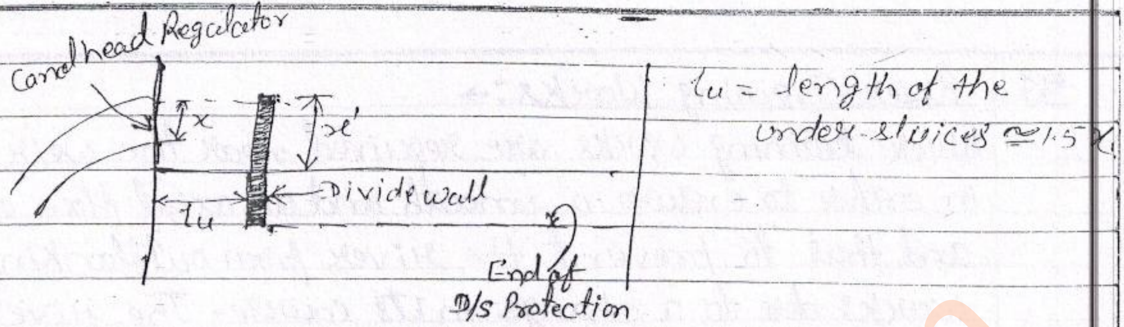
The rise in the maximum flood level (HFL) u/s of the weir caused due to the construction of the weir across the river, is called afflux.

⊠ Pond level:→

The water-level required in the under-sluice pocket u/s of the canal head regulator, so as to feed the canal with its full supply, is known as pond level.
The FSL of the canal at the head, depends upon the level is generally obtained by adding 1 to 1.2 m to Canal fully supply level.

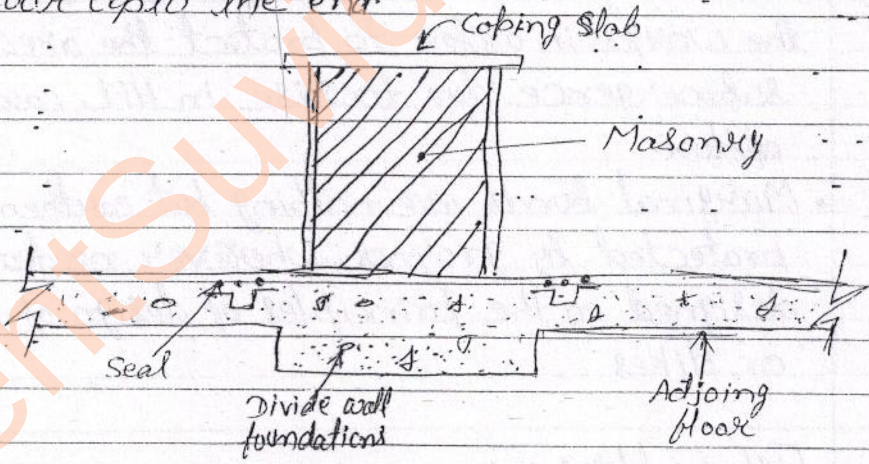
⊠ Under Sluices or Scouring Sluices:→

- A comparatively less turbulent ~~bulen~~ pocket of water is created near the canal head regulator by constructing under-sluice portion of the weir.
- A divided wall separates the main weir portion from the under-sluice portion of the weir.
- The crest of the under-sluice portion of the weir is kept at a lower level than the crest of the normal portion of the weir.
- Normally, the crest level of the under-sluices is kept equal to the deepest bed level of the river during non-monsoon season, whereas, the crest level of the 'weir' is kept higher by about 1 to 1.5 m.
- The under-sluices help in removing the silt from near the head regulator, they are also called scouring sluices.



Divide Wall:→

- The divide wall is a masonry or a concrete wall constructed at right angle to the axis of the weir, and separates the 'weir proper' from the 'under-sluices'.
- The top width of divide wall is about 1.5 to 2.5 m.
- These walls are founded on wells closely spaced beyond the pucca floor upto the end.



Main Functions:→

(a) It separates the under-sluices from the weir proper.

(b) It helps in providing a comparatively less turbulent pocket near the canal head regulator, resulting in deposition of silt in this pocket, and thus helps in the entry of silt-free water into the canal.

(c) It may keep the cross-~~section~~ currents, if at all they are formed, away from the weir.

River-Training Works:→

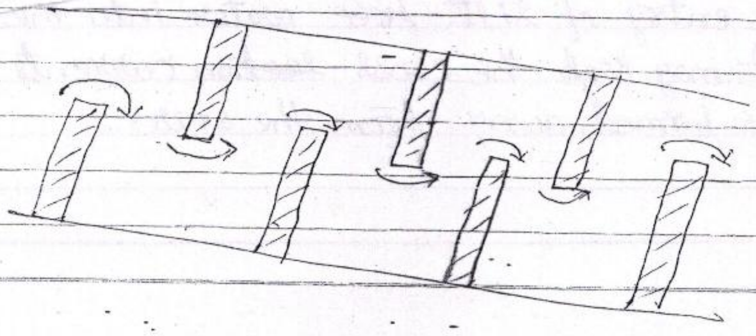
River training works are required near the weir site in order to ensure a smooth and an axial flow of water and thus, to prevent the river from outflanking the works due to a change in its course. The river training works required on a canal headworks are:

(i) Guide banks (ii) Marginal bunds
(iii) Spurs or groynes

- The guide banks force the river into a restricted channel, and thus, ensuring a smooth and an almost axial flow near the weir site.
- The marginal bunds are provided on the u/s side of the works in order to protect the area from submergence due to rise in HFL, caused by the afflux.
- Marginal bunds are nothing but earthen embankments, protected by groynes, wherever needed. They are designed on the principles of design of earthen dams or dikes.

Fish Ladder:→

Large rivers are generally inhabited by several types of fish, many of which are migratory. Such migratory type of fish, called anadromous fish and in India call known as Hilsa.



- A structure which enables the fish to pass u/s is called fish ladder
- Pool type and steep channel type are commonly used types of fish ladders in the weirs and barrages.
- Found economical on dams higher than 100m or so.

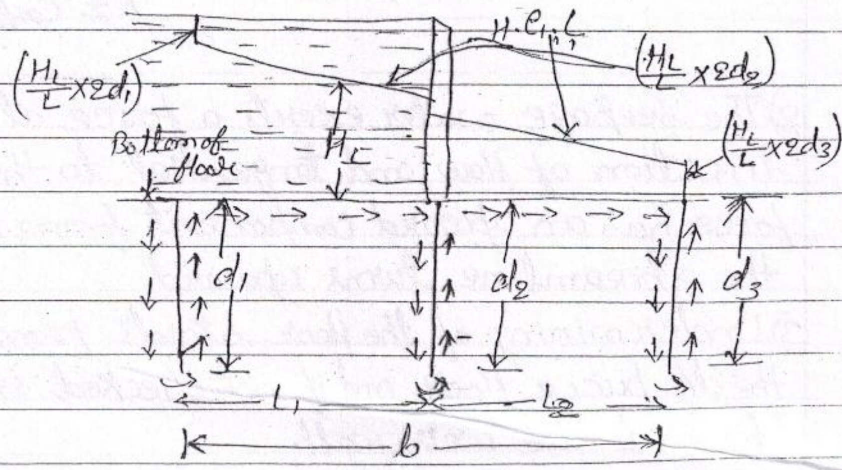
[*] Bligh's Creep Theory for Seepage flow :->

According to this theory, the percolating water follows the outline of the base of the foundation of the hydraulic structure.

In other works, water creeps along the bottom contour of the structures. The length of the path thus transversed by water is called the length of the creep. Further, it is assumed in this theory, that the loss of head is proportional to the length of the creep.

If the H_L is the total head loss between the u/s and d/s and L is the length of creep, then the loss of head per unit of creep length (i.e. H_L/L) is called the hydraulic gradient.

Further, Bligh's makes no distinction between horizontal and vertical creep.



$$L = d_1 + d_1 + L_1 + d_2 + d_2 + L_2 + d_3 + d_3$$

$$= (L_1 + L_2) + 2(d_1 + d_2 + d_3) = b + 2(d_1 + d_2 + d_3)$$

Head loss per unit length, or hydraulic gradient

$$= \left[\frac{H_L}{b + 2(d_1 + d_2 + d_3)}\right] = \left(\frac{H_L}{L}\right)$$

Head losses equal to $\left(\frac{H_L}{L} \times 2d_1\right), \left(\frac{H_L}{L} \times 2d_2\right), \left(\frac{H_L}{L} \times 2d_3\right)$

Khosla's Theory and Concept of Flow Nets

The main principles of this theory are :-

1) The seeping water does not creep along the bottom contour of pucca floor, but on the other hand, this water moves along a set of streamlines.
This steady seepage in a vertical plane for a homogeneous soil can be expressed by Laplace equation

$$\frac{d^2\phi}{dx^2} + \frac{d^2\phi}{dz^2} = 0 , \quad \phi = \text{Flow potential} = Kh$$

h = Residual head

K = Coefficient of permeability

2) The seepage water exerts a force at each point in the direction of flow and tangential to the streamlines. This force has an upward component from the point where the streamline turns upward.

3) Undermining of the floor starts from the d/s end of the d/s pucca floor and if not checked, it travels u/s towards the weir wall.

Khosla's Method of Independent Variables :–

In this method, a complex ~~ver~~ profile like that of a weir is broken into a number of simpler profiles.

The simple profiles which are most useful are :–

(i) A straight horizontal floor of negligible thickness with a sheet pile line on the u/s end or at the d/s end.

(ii) A straight horizontal floor depressed below the bed but without any vertical cut-offs.

(iii) A straight horizontal floor of negligible thickness with a sheet pile line at some ~~horizontal~~ intermediate point.

Various Corrections :–

(a) Correction for the natural interference of piles

(b) Correction for thickness of floor

(c) Correction for the slope of the floor.

(a) Correction for the natural interference of piles :–

The correction C to be applied as percentage of head due to ~~its~~ this effect, is given by

$$C = 19\sqrt{\frac{D}{b'}}\left[\frac{d+D}{b}\right]$$

where, b' = Distance between two pile lines

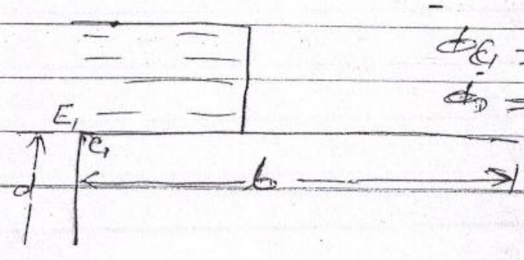
D = Depth of the pile line

d = depth of pile on which the effect is considered

b = Total floor length

$\phi_{E_1} = 100 - \phi_E$

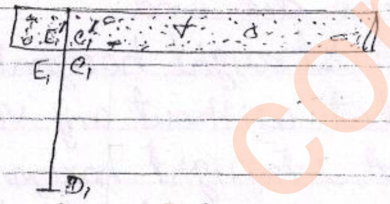
$\phi_{D_1} = 100 - \phi_D$



This correction is positive for the points in the rear or back water, and substractive for the points forward in the direction of flow

(b) Correction for the thickness of floor:-

The actual junction points E and C are at the bottom of the floor. Hence the pressure at the actual points are calculated by assuming a straight line pressure variation.



Since, the corrected pressure at E_1 should be less than the calculated pressure at E_1', the correction to be applied for the point E_1 shall be -ve.

Similarly, the pressure calculated C_1' is less than the corrected pressure at C_1, and hence, the correction to be applied at point C_1 is +ve.

(c) Correction for the slope of the floor:-

A correction is applied for a sloping floor, and is taken as +ve for the down, and -ve for the up slopes following the direction of flow.

This correction is applicable only to the key points of the pile line fixed at the start or the end of the slope.