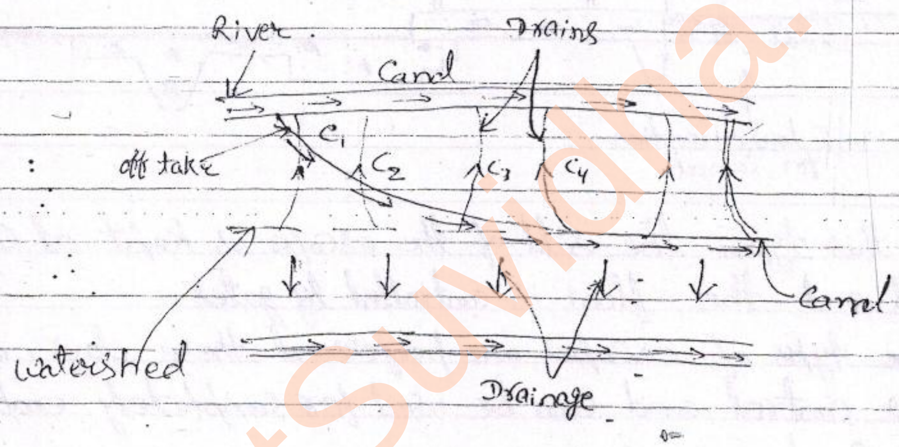
Section-B

Unit-II

⊠ Cross-Drainage Works:→

- It is a structure which is constructed at the crossings of a canal and a natural drain, so as dispose of drainage water without interrupting the continuous canal supplies.
- In order to reduce the cross drainage works, the artificial canals are generally aligned along the ridge line called watershed.



⊠ Classification or Types:→

The drainage water intercepting the canal can be diposed of in either of the following ways:

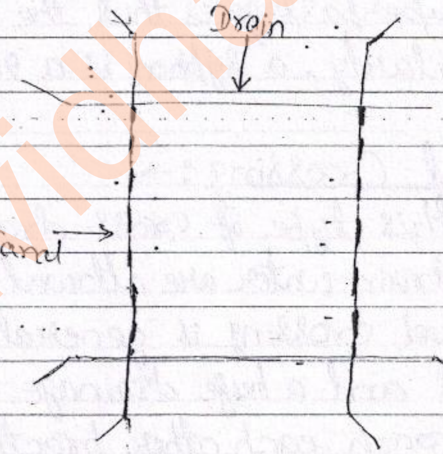
1) By passing the canal over the drainage. This may be accomplished either through (i) an aqueduct; or through a (ii) Syphon-aqueduct

2) By passing the canal below the drainage. This may be accomplished either through
(i) super-passage, (ii) Canal syphon, called a syphon

3) By passing the drain through the canal. This may be accomplished through
(i) a level crossing, (ii) inlet & outlets

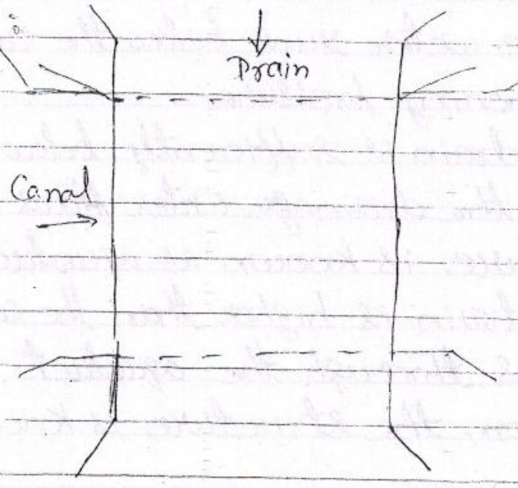
1) Aqueduct & Syphon Aqueduct :→

- In these works, the canal is taken over the natural drain, such that the drainage water runs below the canal either freely or under syphoning pressure.
- When the HFL of the drain is sufficiently below the bottom of the canal, so that the drainage water flows freely under gravity, the structure is known as aqueduct.
- If the HFL of the drain is higher than the canal bed and the water passes through the aqueduct barrels under syphonic action, the structure is known as Syphon Aqueduct.
- In this types of works, the canal water is taken across the drainage in a through supported on piers.
- In case of a syphone aqueduct, the drain bed is generally depressed and provided with pucca floor.



2) Super-Passage and Syphon :→

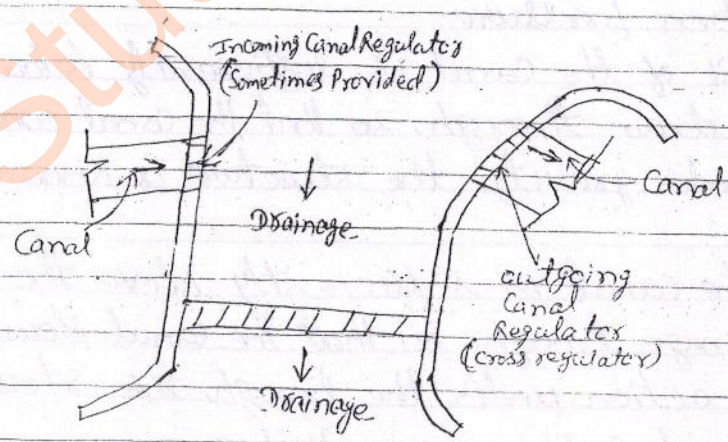
- In these works, the drain is taken over the canal such that the canal water runs below the drain, either freely or under syphon pressure.
- When the ~~GEL~~ FSL of the canal is sufficiently below the bottom of the drain through, so that the canal water flows freely under gravity, the structure is known as superpassage.
- If the FSL of the canal is sufficiently above the bed level of the drainage trough, so that the canal flows under syphonic action under the trough, the structure is known as canal syphon, or a syphon.



- A superpassage is thus the reverse of an aqueduct, and similarly, a syphon is a reverse of an aqueduct syphon.

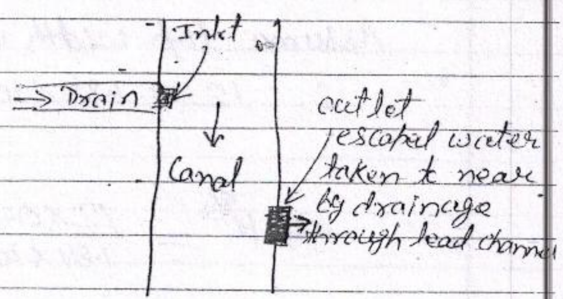
3) Level Crossing :→

- In this type of cross-drainage work, the canal water and drain water are allowed to intermingle with each other.
- A level crossing is generally provided when a large canal and a huge drainage (such as stream or a river) approach each other practically at the same level.
- A regulator is provided across the torrent (drainage) just on the d/s side of the crossing so as to control the discharge passing into the torrent.



4) Inlets and Outlets:→

- An inlet is a structure constructed in order to allow the drainage water to enter the canal and get mixed with the canal water and thus to help in augmenting canal supplies.
- Such a structure is generally adopted when the drainage discharge is small and the drain crosses the canal with its bed level equal to or slightly higher than the canal F.S.L.
- When the discharge is high or if the canal is small, so that the canal section cannot take the entire drainage water, an outlet may sometimes be constructed to escape out the additional discharge at a suitable site, a little d/s along the canal.
- It is not necessary that the escaped discharge should be equal to the admitted discharge.



Selection of a suitable type of Cross-Drainage Work:→

Depend upon following factors:

(i) Suitable canal alignment
(ii) Nature of available foundation
(iii) Position of watertable and availability of dewatering equipment
(iv) Suitability of soil for embankment
(v) Permissible head loss in canal
(vi) Availability of funds

8) Design a 1.5 m Sarda type fall for a canal having a discharge of 12 cumecs with the following data:

Bed level u/s = 103 m

Side slopes of channel = 1:1 m

Bed level d/s = 101.5 m

Fully supply level u/s = 104.5 m

Bed width u/s & d/s = 10 m

Soil = Good loam

Assume Bligh's Coefficient = 6

Ans:

1) Length of Crest: = d/s bed width = 10 m

2) Crest Level: Discharge < 14 m^3/s, so provide a rectangular crest

$$Q = 1.84\, L \cdot H^{3/2} \left[\frac{H}{B_T}\right]^{1/6}$$

Assume top width of the crest = 0.8

$$\therefore\; 12 = 1.84 \times 10 \times H^{3/2} \frac{H^{1/6}}{(0.8)^{1/6}}$$

or, $$H^{5/3} = \frac{12 \times 0.964}{1.84 \times 10} = 0.628$$

or, $$H = (0.628)^{3/5} = 0.755\ m = 0.76\ m$$

$$\text{Vel. of approach} = V_a = \frac{\text{Discharge}}{\text{Area}} = \frac{12}{(10+1.5)1.5}$$

$$= \frac{12}{11.5 \times 1.5} = 0.696\ m/s \quad [\because \text{Depth of water} = 1.5]$$

$$\text{Vel. head} = \frac{V_a^2}{2g} = 0.025\ m$$

U/s TEL = U/S FSL + Vel. head = 104.5 + 0.025

= 104.525 m

R.L of the crest = (U/S FL − H) = 104.53 − 0.76 = 103.77 m

[Ht. of crest above d/s floor = 103.77 − 103 = 0.77 m]

3) Shape of crest:

Width of the crest (B_t) = $0.55\sqrt{d}$

d = Ht. of crest above d/s bed = 103.77 − 101.5 = 2.27 m

$\Rightarrow B_t = 0.55\sqrt{2.27} = 0.825\,m = 0.85\,m$

Thickness at base = $\frac{h+d}{2} = \frac{(0.755 - 0.025) + 2.27}{2}$

$= \frac{0.73 + 2.27}{2} = 1.5\,m$

4) U/s Curtain Wall: Max. depth of U/S curtain wall

$= \frac{y_u}{3} = \frac{1.5}{3} = 0.5\,m$

5) Cistern: Depth of cistern = $X = \frac{1}{4}(H \cdot H_L)^{2/3}$

$= \frac{1}{4}(0.76 \times 1.5)^{2/3} = 0.273$

= 0.3 m deep

∴ R.L of Cistern = 101.5 − 0.3 = 101.2 m

Length of cistern = $5\sqrt{H H_L} = 5\sqrt{0.76 \times 1.5} = 5.34$

= 5.5 m

6) D/S Wings: Length of D/s wings = $5\sqrt{H H_L}$

= 5.5 m

7) D/s Pitching:

Length = $9 + 2H_L = 9 + 2 \times 1.5$

= 12 m

1.5 × 0.76

= 1.900

8) Design a straight flumed meter glacis fall with the following data:

Fully supply discharge of the canal = $12 m^3/s$

Bed level of the canal u/s = 107.5 m

" " " " " d/s = 106 m

Drop (H_L) = 1.5 m

FSL of the canal u/s = 109.7 m

" " " " d/s = 108.2 m

Bed width of the canal u/s & d/s = 60 m

Safe exit gradient for canal material = 1/5.5

Ans:→ I) Length of Crest: For $H_L = 1.5 m$, Fluming Ratio = 75%

∴ Length of the crest = 75% of bed width of canal
= 75% × 60 = 45 m

2) Crest level: Discharge $Q = 1.70 L H^{3/2}$

$\Rightarrow 120 = 1.70 \times 45 H^{3/2}$

or $H^{3/2} = \frac{120}{1.7 \times 45} = 1.57$

or, $H = 1.35 m$

Vel. of approach $= V_a = \frac{Q}{A} = \frac{120}{(60+2.2)2.2} = 0.876$

Vel. head $= \frac{(V_a)^2}{2g} = 0.039$ [∴ Taking water d/p = 2.2 m]

$= 0.04 m$

U/S TEL = U/S FSL + Vel. head

= 109.7 + 0.004 = 109.74 m

Crest level = U/S TEL − H

= 109.74 − 1.35 = 108.39 m

Ht. of the crest above u/s bed = 108.39 − 107.5 = 0.89 m
which is approx. equal = 4 × water depth = 4×2.2 = 0.88 m

3) Crest Width: For broad crest, crest width = 2.5 H
$= 2.5 \times 1.35 = 3.375\ m$

4) Hump: Radius, $R = \dfrac{(L_a^2 + h^2)}{2h}$, where $L_a = 2\ m$ (assum)
$h = 0.89$

$\Rightarrow R = 2.69\ m$

5) Cistern:
R.L of cistern = d/s TEL − 1.25 E_{f_2} [∵ $E_{f_2} = 1.85$]
~~= 108.39 − 1.25×~~
= (108.2 + 0.04) − 2.31 = 105.93 m

6) Length of Cistern: = 5 E_{f_2} = 9.25 m 6 × 6 × 1.85 = 11.10 m

7) D/s Curtain Wall: Depth of d/s curtain wall below bed
$= \dfrac{\text{water depth}}{2} = \dfrac{2.2}{2} = 1.1\ m$

8) U/s Curtain Wall: Min. depth $= \dfrac{y_u}{3} = \dfrac{2.2}{3} = 0.73\ m$