Unit - IV

Design of Syphon Aquaduct

Introduction :-
The hydraulic structure in which irrigation canal is passing over the drainage but the drainage water can not pass clearly below the canal is known as Syphon Aqueduct.
It flows under siphoned action.
This structure is suitable when the bed level of the canal is below the highest flood level of the drainage.

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Design a Syphon Aqueduct for the following data –

Canal –

Discharge – 40 cumecs
Bed width – 30 m.
Full Supply depth – 1.6 m
Bed level – 206.4 m.
Side slopes of Canal – $1\frac{1}{2}$ H : 1 V

Drainage –

Flood discharge – 450 cumecs
High Flood level – 207.0 m.
Bed level – 204.5 m.
General Ground level – 206.5 m.

Step-I

Given values –

10 Piers.

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Step-II

Design of Drainage water way –

Lacey's Formula

$$P = 4.75\sqrt{Q}.$$

where

P = wetted Perimeter.

Q = High flood discharge of drainage.

$$P = 4.75\sqrt{450} = 100.8\ m$$

Provide 11 clear spans of 8m each and let the width of each pier ~~by~~ be 1.5m.

The length of clear water way =

$11 \times 8 = 88\ m.$

The length occupied by 10 Piers of 1.5 each =

$10 \times 1.5 = 15\ m.$

Total length of water way.

$= 88 + 15 = 103\ m$

$= 103\ m$

Let velocity of flow through syphon = 2 m/sec.

Height of barrels required =

$$\frac{\text{Discharge}}{\text{velocity} \times \text{clear width of water way}}$$

$$= \frac{450}{2 \times 88} = 2.56\text{ m.}$$

Provide height of barrel = 2.5 m.
Hence, provide 11 rectangular barrels, each of 8 m wide and 2.5 m high.

∴ Actual velocity through the barrels =

$$\frac{450}{11 \times 8 \times 2.5} = 2.05\text{ m/sec.}$$

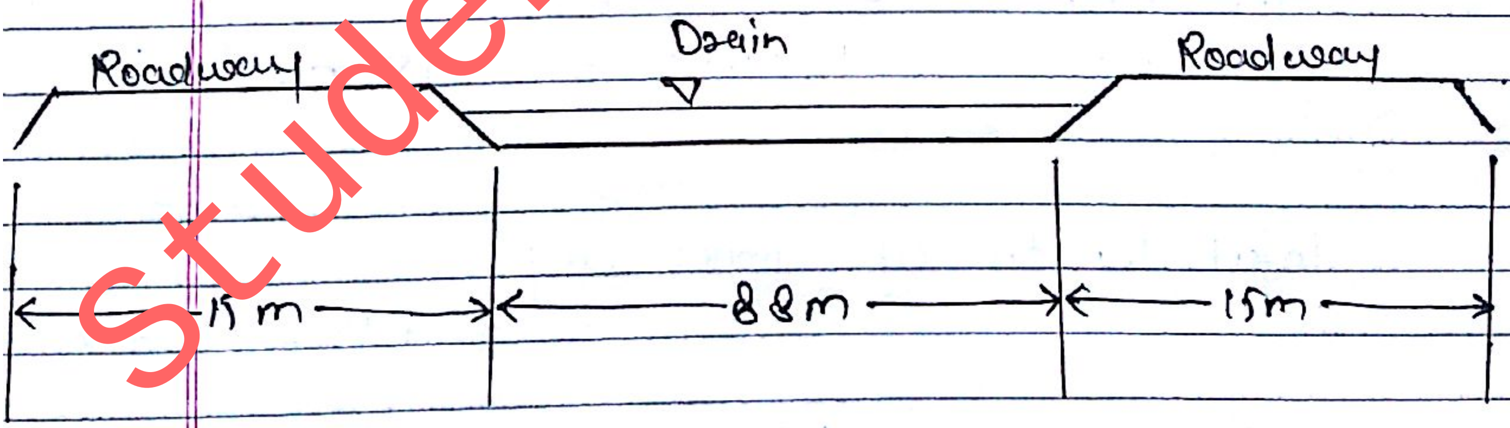

fig- Design of Drainage water way.

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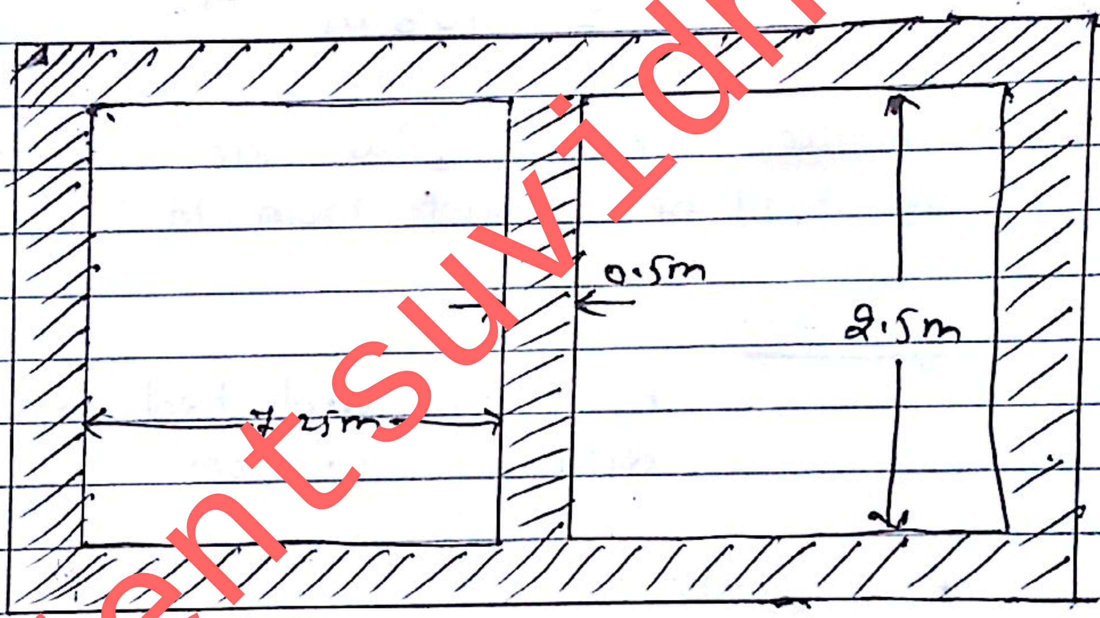
Step-III

Design of Canal water way -

Bed width of the canal = 30 m.
Let the width be reduced to 15 m.
Such that two barrels each ~~20~~ 7.25 m
with 0.5 m thick wall.
Let the height of the barrel = 2.5 m



Providing a splay of 2:1 in contraction
The length of the contraction transition =

$$= \frac{30-15}{2} \times 2 = 15 \text{ m.}$$

Providing a splay of 3:1 in expansion,
The length of the expansion transition

$$= \frac{30-15}{2} \times 3 = 22.5 \text{ m.}$$

Length of Flumed portion from abutment to abutment

$$= 103 \text{ m}$$

In the transition, the side slopes of the canal will be warped from $1\frac{1}{2}$ H : to 1 V.

Step - IV

Head loss and bed levels at different sections.

At Section 4.

Area of trapezoidal canal section =

$A = (B + 1.5 y) y$ B = Bed width = 30 m, y = depth = 1.6 m.

$$= [30 + 1.5 \times 1.6] \times 1.6$$

$$= 51.84 \text{ m}^2$$

velocity of flow $(V_4) = \frac{Q}{A} = \frac{40}{51.84}$

$$= 0.77 \text{ m/sec.}$$

velocity head $h_a = \frac{V_4^2}{2g} = \frac{(0.77)^2}{2 \times 9.81}$

$= 0.030$ m.

R.L. of Canal at Section 4 = 206.4 m (given)
water depth = 1.6 m (given)

R.L. of water Surface at Section 4 =
206.4 + 1.6 = 208.0 m

R.L. of T.E.L at Section =
208 + 0.030 = 208.03 m (

At Section 3

Assuming a constant depth of 1.6 m through out the channel, we have at section-3 a rectangular channel.

Bed width = 15 m
Depth = 1.6 m (assumed constant)
Area = 15 × 1.6 = 24 m^2
velocity (V_3) = $\frac{40}{24}$ = 1.67 m/sec.

velocity head $h_a = \frac{V_3^2}{2g} = \frac{(1.67)^2}{2 \times 9.81}$

$= 0.142$ m.

Loss of head in expansion from section 3 to section 4. =

$$= 0.3 \left[\frac{V_3^2 - V_4^2}{2g}\right]$$

$= 0.3 [0.142 - 0.030] = 0.3 \times 0.112$
$= 0.0336 m$ say $0.034 m$

R.L. of T.E.L. at section 3 = R.L of T.E.L at section 4 + loss in expansion.

$= 208.030 + 0.034 = 208.064 m.$

R.L. of water surface at section 3 =

$208.064 - 0.142 = 207.922 m$

R.L. of bed at section 3 =
$207.922 - 1.6 = 206.322 m.$

At Section 2.

From section 2 to section 3, the trough section is constant. Therefore, the area and velocity at section 2 are the same as at section 3.
There is friction loss b/w section 2 and 3 which may be computed by manning's formula given below

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$$H_L = \frac{n^2 V^2 L}{R^{4/3}}$$

$n = 0.016$
L (length of channel) = 100 m.

Area of trough section (A) = $15 \times 1.6 = 24\ m^2$
wetted perimeter (P) = $B + 2y = 15 + 2 \times 1.6 = 18.2\ m$

Hydraulic mean depth (R) = $\frac{A}{P} = \frac{24}{18.2} = 1.32\ m.$

velocity in trough (V) = $\frac{Q}{A} = \frac{40}{24} = 1.67\ m/sec.$

Head loss H_L =

$$\frac{n^2 V^2 L}{R^{4/3}} = \frac{(0.016)^2 \times 1.67 \times 103}{(1.32)^{4/3}}$$

$= 0.051\ m.$

R.L of T.E.L. at section 2 =
R.L. of T.E.L at section 3 + Head loss in trough
$= 208.064 + 0.051 = 208.115\ m$

R.L. of water surface at section 2 =
$208.115 - 0.142 = 207.973\ m$

R.L of bed at section 2.
$= 207.973 - 1.6 = 206.373\ m.$

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At section 1.

Loss of head in contraction transition from section 1 to section 2 given as

$$0.2\left[\frac{V_2^2 - V_1^2}{2g}\right] = 0.2\left[\frac{(1.67)^2 - (0.72)^2}{2\times 9.81}\right]$$

$= 0.0224$ m say 0.022 m

R.L. of T.E.L. at section 1 =
R.L. of T.E.L. at section 2 + Loss in contraction
= 208.115 + 0.022 = 208.137 m

R.L. of water surface at section 1.
= 208.137 − 0.030 = 208.107 m

R.L. of bed at section 1 required to maintain constant depth
= 208.107 − 1.6 = 206.507 m

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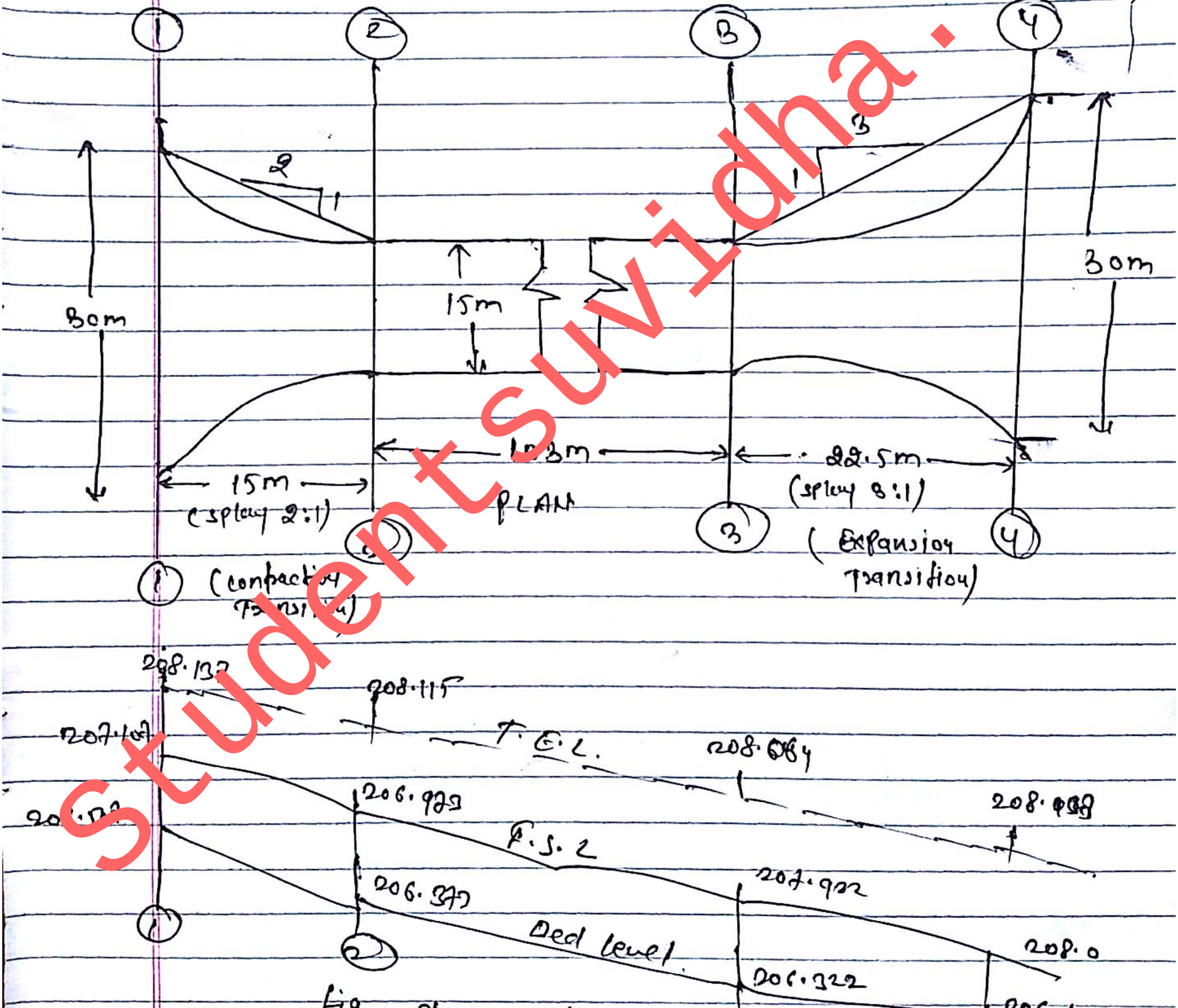

fig- plan and section of canal trough.