Subject - DSS-II (BCE2A)
semester - VIII

Q.1 Explain the different types of imposed load considered in the design of gantry girder. Also explain the different parts of it with neat sketch.

Sol^n

The travelling over-head cranes commonly used in factories & workshops to lift & move heavy materials. and assembled parts from one point to other. The crane system consists of a bridge over which a trolley, hoist & cabin which houses the controls & operater move. The size of crab, wheel spacing etc. depend upon the capacity of the crane. The cranes may be operated manually or by electrically. The following imposed loads should be considered in the design.

1. Vertical loads from crane:- Vertical loads considered in design, are, self weight of gantry girder, self wt. of cross bridge, crab & the load lifted with hook (crane capacity).

2. Impact loads from crane:- Due to moving load i.e. cross bridge & hook load or lifted load, impact should be considered for adequate design.

electrically overhead crane

3. Longitudinal horizontal force along the crane rail.
→ 5% of static wheel loads.

4. Lateral thrust across the crane rail.
→ horizontal force transverse to the crane rail considered in following way.

(a). For electric operated cranes – 10% (wt. of trolley + wt lifted)

(b) For hand operated cranes – 5% of wt. of trolley & wt lifted.

Essential components of crane system are:

1. Crane bridge or cross-girder
2. Trolly or Crab, mounted on crane bridge
3. Gantry girder or crane girder
4. Crane runway (rail).

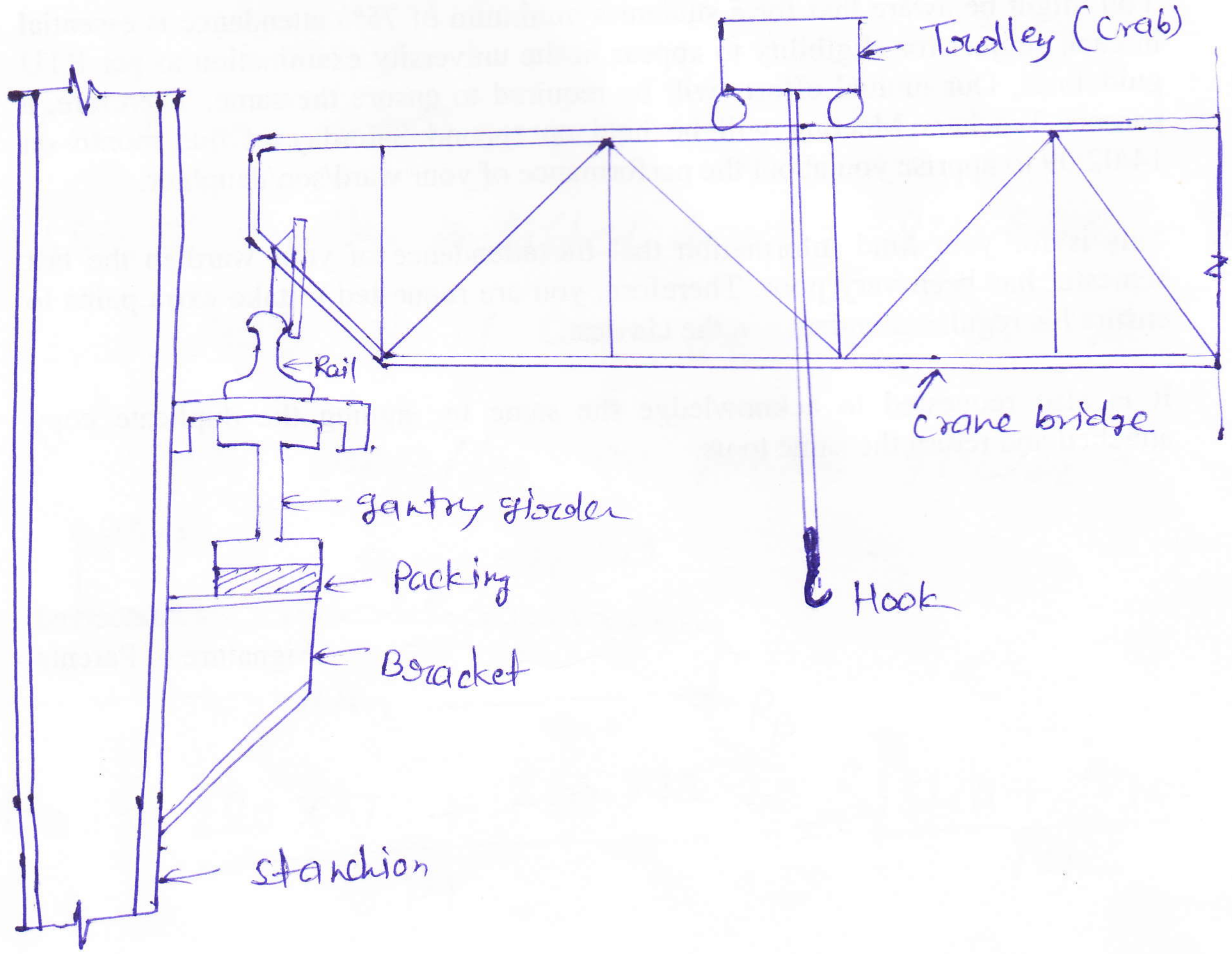


Fig. Components of Crane System

Calculate max^m B.M. due to vertical loads on S.S. gantry girder with an electric overhead travelling crane for following data:

Span of gantry girder - 5.5m

Span of crane girder - 14m

Crane capacity - 240kN

Self wt. of crane girder without trolley 220 kN

Self wt. of trolley - 45kN

min^m hook approach - 1.0m

Wheel base - 3.2m

Self wt. of rails 0.5 kN/m

Self wt. of gantry 1.5 kN/m

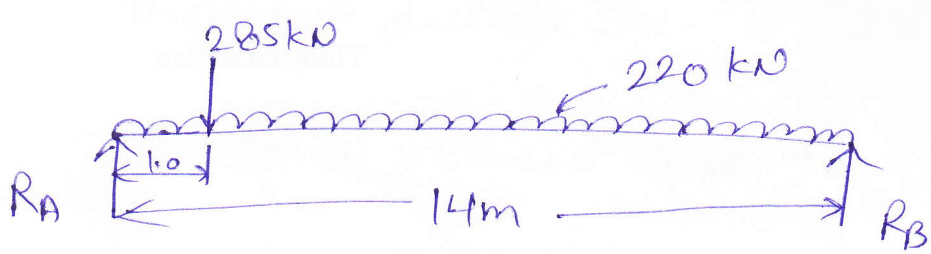
Sol^n

Load for max^m moment

wt. of trolley + lifted load = 240 + 45 = 285kN

Self wt. of crane girder = 220kN

For max^m reaction on gantry girder

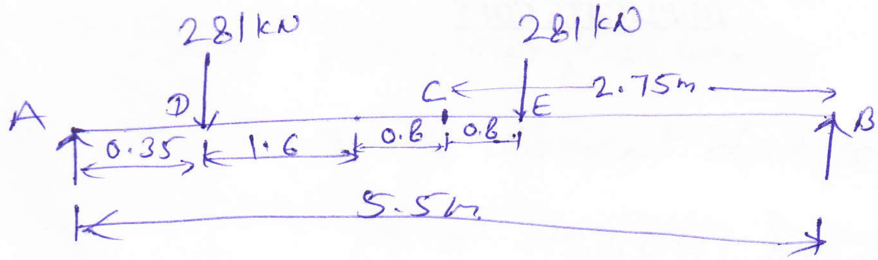


$$R_A = \frac{220 \times 7 + 285 \times 13}{14} = \frac{1540 + 3705}{14} = 374.64 \text{ kN}$$

This load is transferred to gantry girder through

Factored wheel load $= 1.5 \times 187.32 = 281$ kN

For max^m B.M. following load position



$$R_B = \frac{281 \times 0.35 + 281 \times 3.55}{5.5} = 199.256 \text{ kN} \simeq 199.26 \text{ kN}$$

Max^m B.M. $M_E = \cancel{2P}\ 199.26 \times 1.95$

$= \cancel{587.817}\ 388.557$ kN-m

moment due to impact $= 0.25 \times 587.817$

$= \cancel{146.954}\ 97.14$ kN-m

Dead wt. of gantry girder + rails $= 1.5 + 0.5 = 2$ kN/m

factored dead load $= 1.5 \times 2 = 3$ kN/m

moment due to D.L. $= 3 \times \frac{5.5^2}{8} = 11.344$ kN-m

Factored moment due to vertical loads

$= \cancel{587.817} + \cancel{146.954} + \cancel{11.344}$

$= 388.557 + 97.14 + 11.344$

$= 497.041$ kN-m.

3. Choose a section for gantry girder for problem 2 & locate its N.A. & calculate moment of inertia about it.

Sol^n

From previous problem

Design moment due to vertical load

$$M = 497.041 \text{ kN-m}$$

Using Fe 250 grade of steel

$$\frac{M}{f_y} = \frac{I}{y} = Z_e = \frac{497.041 \times 10^6}{250} = 1988164 \text{ mm}^3$$

increasing 20% section modulus

$$Z_e = 2385796.8 \text{ mm}^3$$

ISLB 600 section is chosen for trial

Area $A = 12669 \text{ mm}^2$

$h = 600\text{mm}$, $b_f = 210\text{mm}$, $t_f = 15.5\text{mm}$, $t_w = 10.5\text{mm}$

$I_{xx} = 72867.6 \times 10^4 \text{ mm}^4$, $I_{yy} = 1821.9 \times 10^4 \text{ mm}^2$

$Z_{xx} = 2428.9 \times 10^3 \text{ mm}^3$

minimum ~~width~~ of depth of channel section should be $b_f + 50\text{mm}$

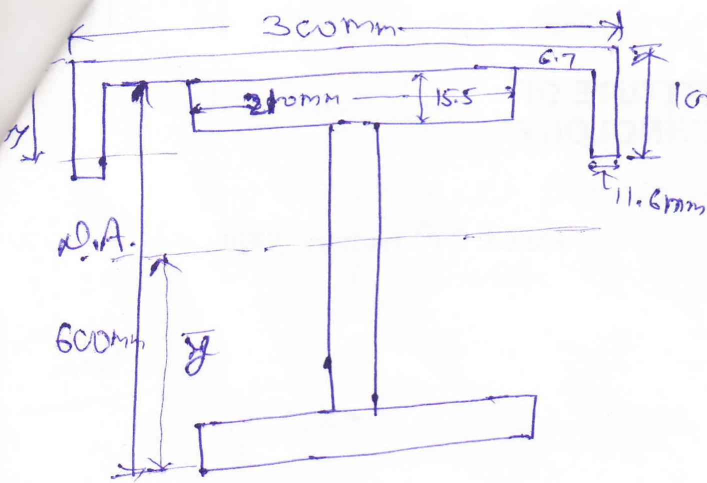
$= 210 + 50 = 260\text{mm}$

Let try ISLC 300

Area $= 4211 \text{ mm}^2$, $h = 300\text{mm}$, $b = 100\text{mm}$, $t_f = 11.6\text{mm}$

$t_w = 6.7\text{mm}$, $C_{yy} = 25.5\text{mm}$, $I_{xx} = 6047.9 \times 10^4 \text{ mm}^4$

$I_{yy} = 346 \times 10^4 \text{ mm}^4$



$$\bar{y} = \frac{12669 \times 300 + 4211\,(600 + 6.7 - 25.5)}{12669 + 4211} = 370.15\,mm$$

(from bottom fibre)

$$I_{zz} = 72867.6 \times 10^4 + 12669 \times (370.15 - 300)^2 + 346 \times 10^4$$
$$+ 4211 \times (600 + 6.7 - 370.15 - 25.5)^2$$
$$= 982.047 \times 10^6\ mm^4$$

1 A roof truss shed is to be built in mumbai for an industry. The size of shed is 24m X 40m. The height of building is 12m at the eves. Determine the basic wind pressure.

Soln

From wind zone map of country

$$V_b = 44 \text{ m/sec}$$

Risk coeff. $k_1 = 1.0$

Since the shed is in an industrial area, it may be considered belonging to category 3.

$k_2 = 0.88$ if $h = 10m$

$\quad = 0.94$ if $h = 15m$

$\therefore$ for $h = 12m$

$$k_2 = 0.88 + (0.94 - 0.88)\frac{2}{5} = 0.904$$

Topography factor k_3: In Mumbai, the ground near shed may be assumed plain.

$$k_3 = 1 + cs$$

where

$$c = \frac{z}{L} = 0$$

$$k_3 = 1.0$$

Design wind speed $V_z = k_1 k_2 k_3 V_b = 1 \times 0.904 \times 1.0 \times 44$

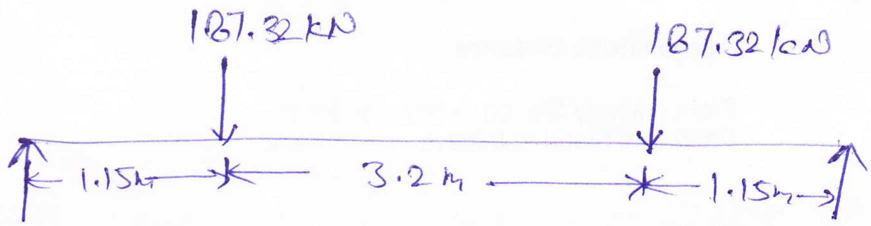
$$= 39.78 \text{ m/sec}$$

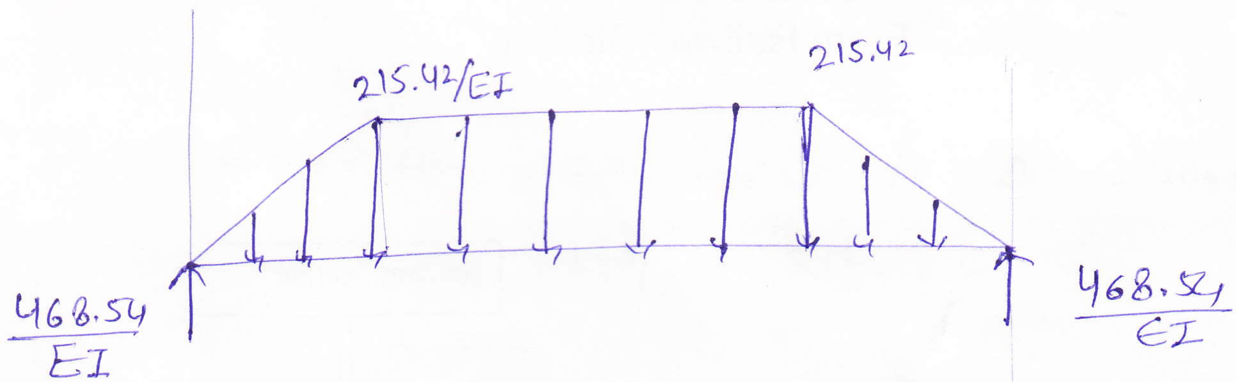
Hence basic

5 Check problem 2 for deflection.

Sol^n Serviceability checks are applied under working loads. At working load, deflection is to be limited to $\frac{L}{750}$

For max^m deflection wheel load is as shown in figure





Conjugate beam with $\frac{M}{EI}$ dia.

Reaction in conjugate beam $R_A' = R_B' = \frac{1}{2} \times 1.15 \times \frac{215.42}{EI} + \frac{215.42}{EI} \times 1.6$

$$= \frac{468.54}{EI}$$

Max^m deflection occurs at mid span = moment of $\frac{M}{EI}$ load in conjugate beam

$$EI\Delta = 468.54 \times \frac{5.5}{2} - \frac{1}{2} \times 215.42 \times 1.15 \times \left(\frac{1.15}{3} + 1.6\right) - 1.6 \times 215.42 \times \frac{1.6}{2}$$

$$= 767.078$$

$$\Delta = \frac{767.078}{EI}$$

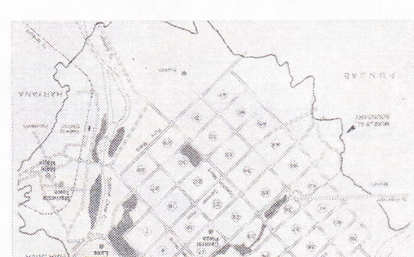
where $EI = \frac{2 \times 10^5 \times 10^6}{10^{8}} \frac{982047227.7}{(10^3)^4} = 196409.45$

$$\Delta = \frac{767.078}{196409.45} \times 10^3 = 3.906 \text{ mm}$$

Permissible deflection $\Delta = \frac{L}{750} = \frac{5500}{750} = 7.33 \text{ mm}$

Deflection requirement is $\Delta = 3.906 \text{ mm} < \frac{L}{750}$

Hence safe.



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JAGANNATH GUPTA INSTITUTE OF ENGINEERING & TECHNOLOGY JAIPUR

I-Mid Term Examination Session 2018

B.Tech IV Year VIII Semester

Branch: Civil Engineering | **Subject: WRE-II**

Time: 10:00-11:30 AM | **Subject Code: 8CE1A**

Date: 14-02-2018 | **Max. Marks: 20**

Note: Attempt any four questions out of five. Each question carries equal marks.

1. Design a Sarda fall for the following data: Discharge in canal =12 cumecs ; Drop= 1.5m; U/S bed level=207.5m; D/S bed level = 206.0m;U/S F.S.L.=210m;D/S.F.S.L.=208.5m;U/S & D/S.bed width=11m.;Top width of crest=0.9m;Specific gravity of masonry=2.24. Assume any missing data suitably.
2. Name the different types of falls generally provided in canals . What are the various design parameters to be considered for designing any type of fall?
3. Name the various types of cross drainage works . In what condition is each type most suitable?
4. Differentiate between:
   c. Aqueduct and Siphon Aqueduct
   d. Super-passage and Siphon Super-passage
5. Explain Bligh's creep theory . How is the safety against piping and uplift pressure considered by this theory?

JNIT JAIPUR

I Mid-Term Exam '2018

B-Tech, IV Yr, VIII Sem

Branch: Civil Eng. Sub: WRE-II (8CE1A).

Faculty: Swetha Singh

① Design a Sarda fall for the following data:

Discharge in Canal = 12 cumecs

Drop = 1.5 m

U/s Bed level = 207.5 m

D/s Bed level = 206.0 m

U/s FSL = 210 m

D/s FSL = 208.5 m

U/s Ramp ; D/s Bed width = 11 m.

Top width of crest = 0.9 m

Specific Gravity of masonry = 2.24

Assume any missing data suitably.

A: (1) Cistern wall:

Calculation of H and d:

Since the discharge is less than 14 cumecs, rectangular crest will be adopted.

$$Q = 1.835 L H^{3/2} \left(\frac{H}{B_t}\right)^{1/6}$$

L = width of canal = 11 m = bed width

Q = 12 cumecs.

Assume B_t = 0.8 m = Top width of crest.

$$\Rightarrow \quad 12 = 1.835 \times 11 \times H^{3/2} \left[\frac{H}{0.8}\right]^{1/6}$$

$$12 = 1.835 \times 11 \times H^{3/2 + 1/6} \times \left(\frac{1}{0.8}\right)^{1/6}$$

$$\therefore H^{5/3} = \frac{12 \times (0.8)^{1/6}}{1.835 \times 11}$$

$$\therefore H = (0.5727)^{3/5} = 0.716\ m \simeq 0.72\ m.$$

Assume Full supply depth $\frac{U/S}{D/S} = \frac{1.50\,m}{1.50\,m}$.

RL of crest = U/S FSL − H = 210 − 0.72
= 209.28 m

Height of crest above d/s bed,

d = Crest level − D/S bed level.
= 209.28 − 206.0
= 3.28 m.

Top width of crest wall,

$B = 0.55\sqrt{d}$
$= 0.55\sqrt{3.28} = 0.996\,m$
$\simeq 1.0\,m$ (say)

Now, $H + d = D_2 + H_L$
$= 1.5 + 1.5 = 3\,m$.

Bottom width, $B_1 = \frac{H+d}{G}$
$= \frac{3}{2.24}$ (G = 2.24, given)
= 1.34 m.

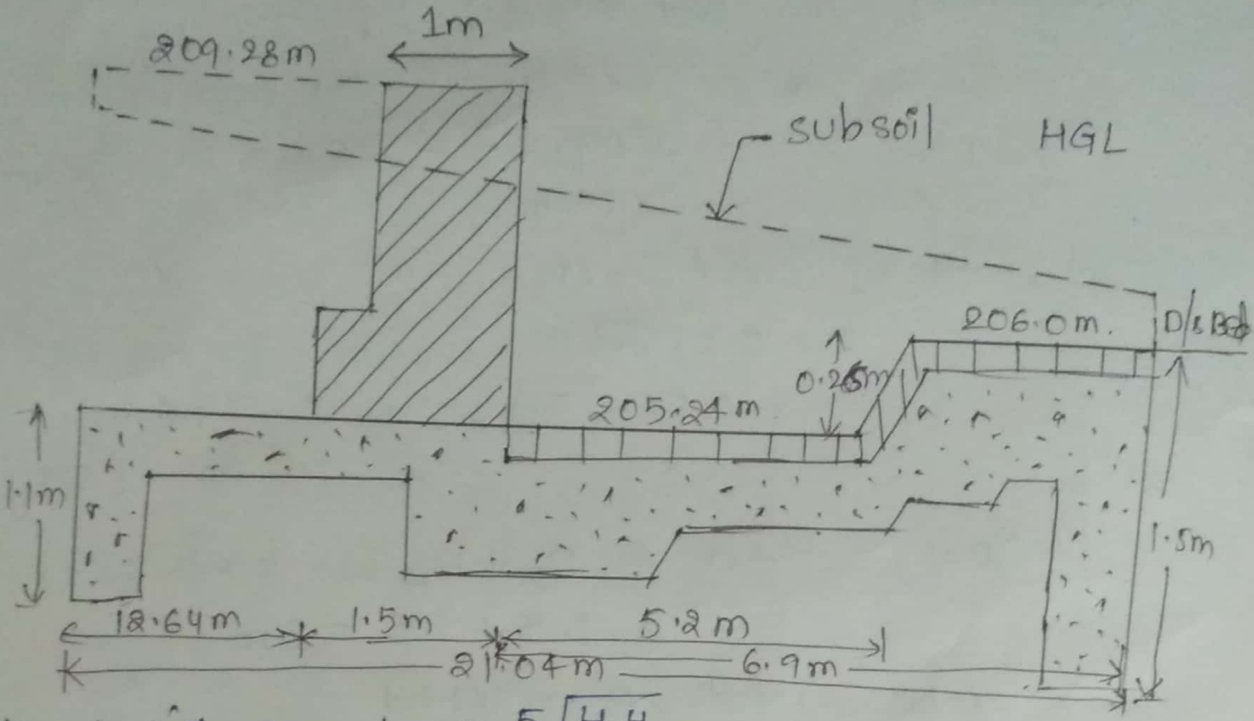
Provide u/s pitching for a length of 3m at a slope of 1 in 10 just u/s of the crest wall.

(ii) Cistern:

Depth of cistern,

$x = \frac{1}{4}(EH_L)^{2/3}$
$= \frac{1}{4}(H \cdot H_L)^{2/3}$ (Given, Drop, $H_L = 1.5m$)
$= \frac{1}{4}(0.72 \times 1.5)$
$= 0.26\,m$

RL of cistern = D/S bed level − x
= 206.0 − 0.26
= 205.74 m



Length of cistern, $L_C = 5\sqrt{H \cdot H_L}$

$= 5\sqrt{0.72 \times 1.5}$

$= 5.196 \simeq 5.2m.$

(iii) Impervious floor :

Maximum seepage head,

H_S = Crest level − D/s bed level

$= 209.28 - 206.0$

$= 3.28$ m.

Total creep length, $L = CH_S$ {Assume, C as 8}

$= 8 \times 3.28 = 26.24$ m

Depth of U/s cutoffs $= D_1/3 + 0.6 = \frac{1.5}{3} + 0.6 = 1.1m.$

Depth of D/s cutoffs $= D_2/2 + 0.6 = \frac{1.5}{2} + 0.6 = 1.35$ m.

$\simeq 1.5$m (say)

width of u/s & D/s cutoffs = 0.30m.

Vertical creep $= 2(1.1 + 1.5) = 5.2$ m.

Length of impervious floor (b) = Total creep length − vertical creep.

$= 26.24 - 5.2 = 21.04$m.

Min. length of d/s floor, $l_d = 2(D_2 + 1.2) + H_L$.

$\Rightarrow \quad l_d = 2(1.5+1.2) + 1.5$

$= 6.9\text{ m}$

Length of u/s floor $= 21.04 - 6.9 - 1.5 = 12.64\text{ m}$

(a) Thickness of impervious floor (a),
Residual head at the d/s toe of the crest wall,

$$h_r = 0.25 + \left[\frac{209.28 - 206.0}{26.24}\right] \times (6.9 + 3.0)$$

$$= 1.487 \simeq \underline{1.49\text{ m}} \text{ (say)}$$

Thickness of floor $= \dfrac{1.49}{2.24-1} = 1.199\text{m} \simeq 1.2\text{ m. (say)}$

Provide 0.2 m brick on edge over 1.20m thick concrete. and are the bricks on edge are in cement mortar and therefore impervious.

[while calculating the thickness of floor by Bligh's theory, the factor 4/3 has not be used because 0.2 m thick brick on edge provides additional safety].

(b) Residual head at 2 m from the toe of the crest wall.

$$h_r = 0.25 + \left[\frac{209.28 - 206.0}{26.24}\right] \times (4.9 + 3.0)$$

$$= \underline{1.2\text{ m}}$$

Thickness of floor $= \left(\dfrac{1.20}{2.24 - 1.0}\right) = 0.97\text{ m}$, say $\underline{1.0\text{ m}}$

Provide 0.2 m thick brick on edge over 1.00 m thick concrete.

(c) Residual head at 4.75 m from the toe of the crest wall.

$$h_r = 0.25 + \left(\frac{209.28 - 206.0}{26.24}\right) \times (2.15 + 3.00)$$

$$= 0.89\text{ m} \simeq 0.9\text{ m (say)}$$

Thickness of floor $= \dfrac{0.9}{2.24 - 1} = 0.72\text{ m}$.

Provide 0.2 m thick brick on edge over 0.70 m thick concrete.

(d) Residual head at end of d/s floor.

$$h_r = \left[\frac{209.28 - 206.0}{26.24}\right] \times 3.0 = 0.375 \text{ m}$$

$$\text{Thickness of floor} = \frac{0.375}{2.24-1} = 0.3 \text{ m}.$$

Provide 0.2 m thick brick on edge over 0.4 m thick concrete.

U/s floor: The uplift pressure on the U/s floor will be counter-balanced by the weight of water and soil. Provide a nominal thickness of 0.40 m.

(IV) U/s wing walls:

Provide U/s wing walls splayed at 45° (i.e. slope 1:1), starting from the U/s edge of the crest wall. Continue these walls into banks of the canals till they are embedded a minimum distance of 1m from the FSL.

Top level of U/s wing walls = 210 + 0.50 = 210.5 m

(V) D/s wing walls:

Length of d/s wing walls with a vertical face, measured from the crest wall

$$= 6\sqrt{E \times H_L}$$
$$= 6\sqrt{H \times H_L} = 6 \times \sqrt{0.72 \times 1.5} = 6.24 \text{ m}.$$

Keep it 6.60 m, i.e., upto the end of impervious floor. The d/s wing walls are then warped from the vertical face to 1:1 slope on a splay of 3:1.

Length of warped wall = 3(1.5 + 0.5) = 6.00 m

Total length of d/s wing wall = 6.9 + 6.00 = 12.9 m.

Top level of D/s wing walls = 208.5 + 0.5 = 209 m

(VI) D/s bed pitching:

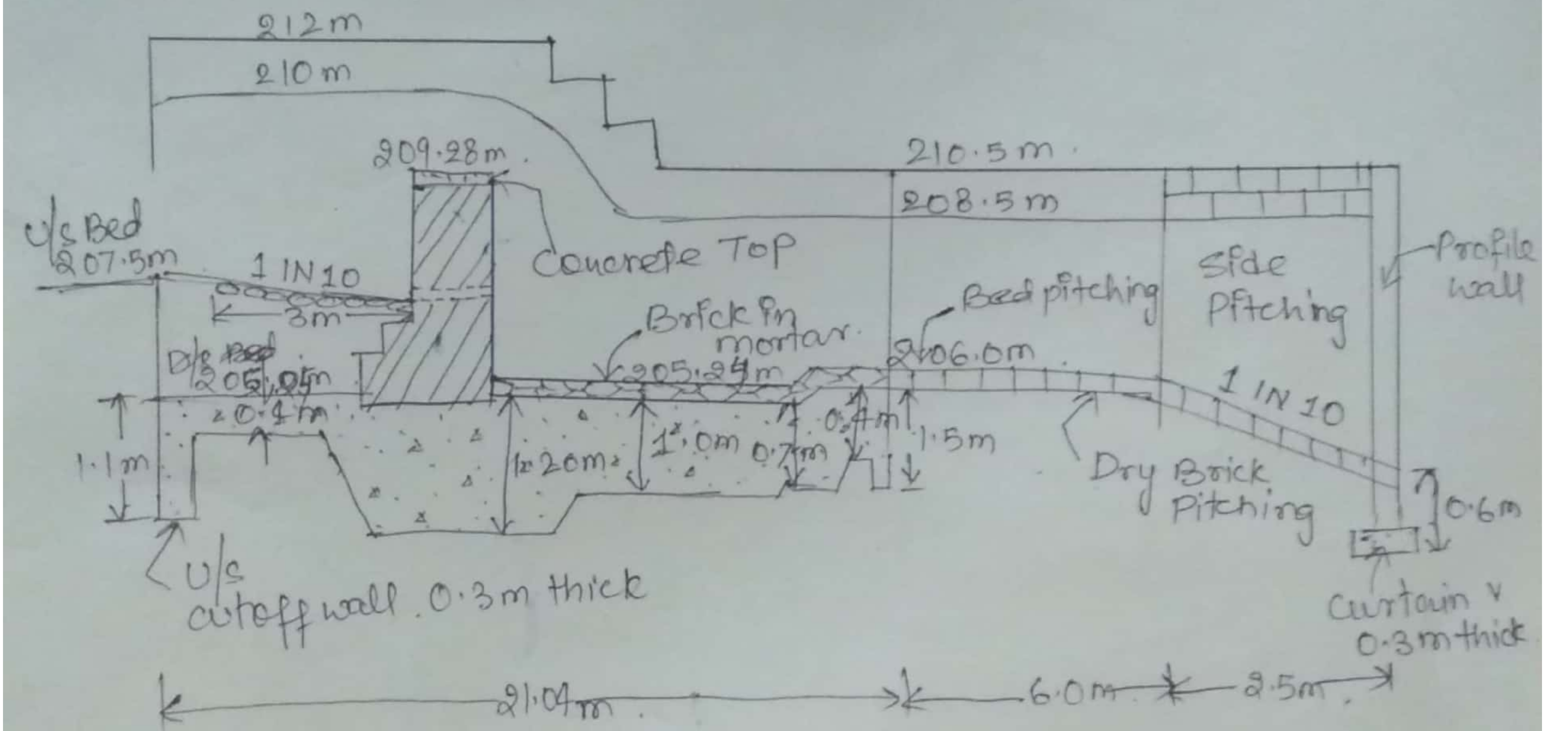
Length of pitching $= 6 + 2H_L$ (as H = 0.72 m)
$= 6 + 2 \times 1.5$
$= 9$ m

The bed pitching is provided horizontal upto the end of d/s wing for 6.0 m & the remaining 2.50 m sloping at 1 in 10. One curtain wall 0.3 m thick & 0.6 m deep is provided at the end of bed pitching.

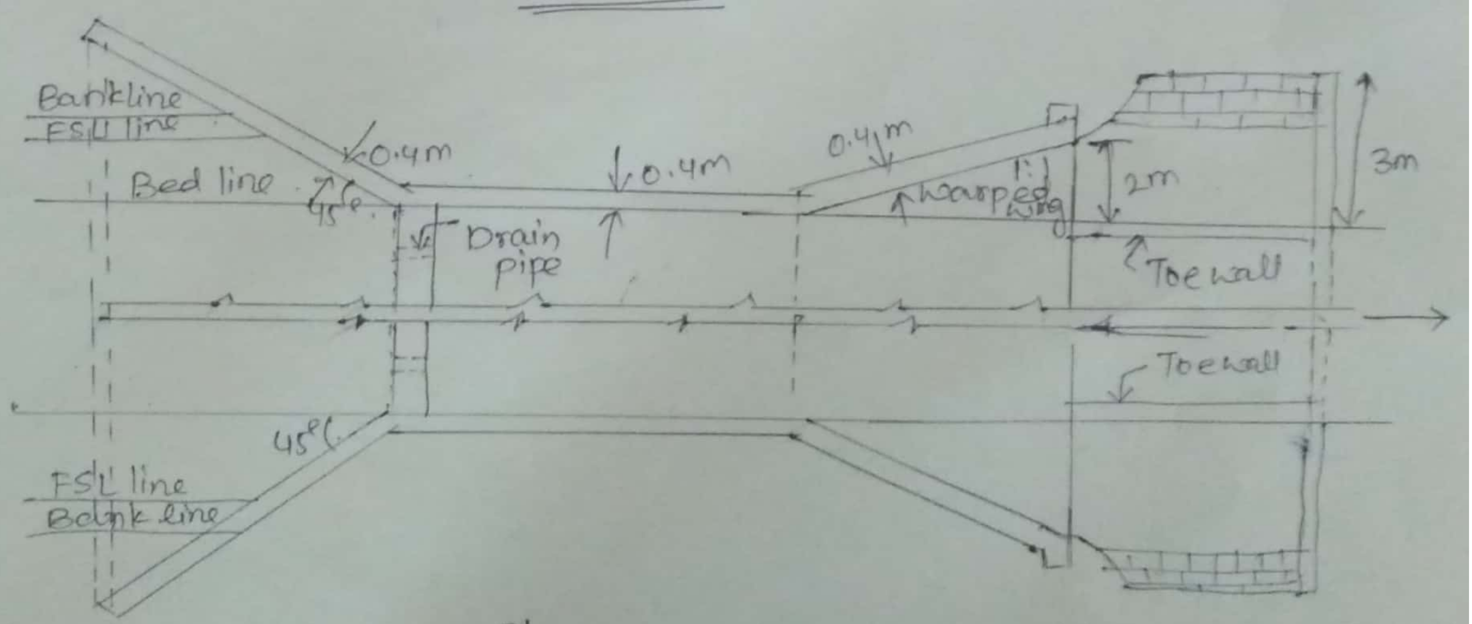
(VII) D/S side pitching:

Provide 20 cm thick side pitching, consisting of one brick on edge over one flat brick. The side pitching is warped from a slope of 1:1 to 1.5:1. It is supported on a toe wall, 0.4 m thick.

Depth of toe wall = $1.5/2 = 0.7$ m, say 0.8 m



L-section



Plan

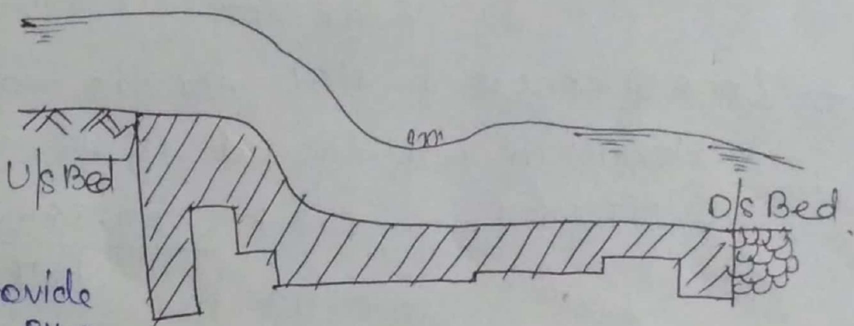
(2) Name the different types of falls generally provided in canals. What are the various design parameters to be considered for designing any type of fall?

A: Types of falls:

1. Ogee fall
2. Rapid fall
3. Stepped fall
4. Notch fall.
5. Vertical drop fall
6. Glacis type fall.
7. Meter & non-meter falls
8. Contracted & full width falls.

- Ogee fall:

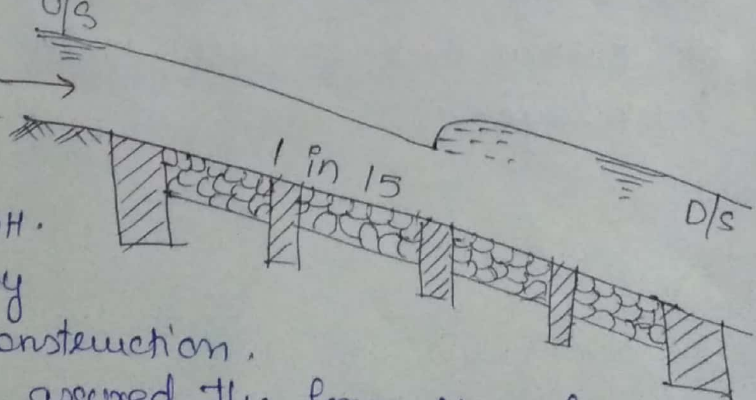
It has gradual convex & concave curves, with an aim to provide a smooth transition & to reduce disturbance & impact.



Ogee fall

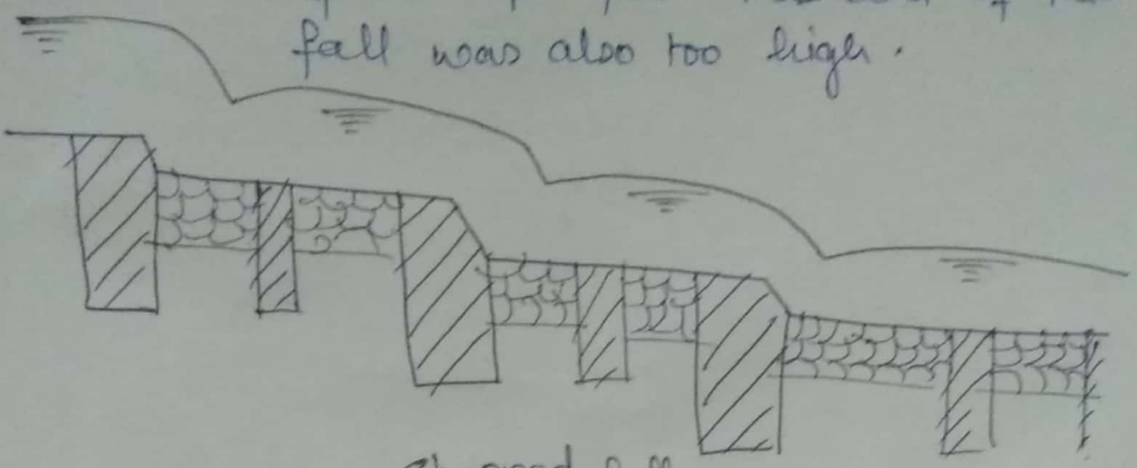
- Rapid fall:

Such a fall consists of a glacis sloping at 1 V to 10 to 20 H.
There was very high cost of construction.
The long glacis assured the formation of hydraulic jump.



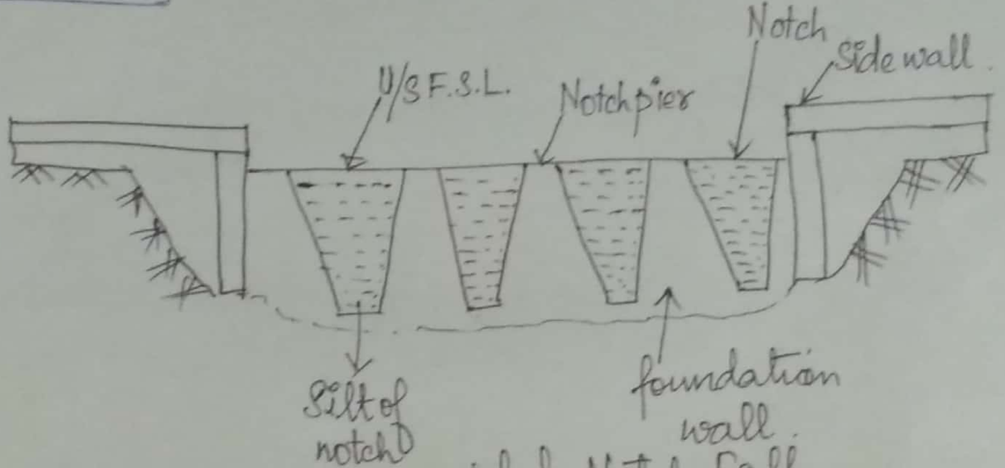
Rapid fall.

- Stepped fall : Stepped fall was a next development of the rapid fal. The cost of this fall was also too high.



Stepped fall.

- Notch fall :



Trapezoidal Notch Fall.

The trapezoidal notch fall was first designed by Ried in 1864. The efficiency of vertical impact on the floor for energy dissipation came to be recognished. The vertical fall came in the feild along with the cistern.

Vertical drop fall :

In the vertical drop fall, the nappe impinges clear into the water cushion. The grid consisted of baulks of timber horizontal or inclined and spaced some centimeters appart.

– **Glacis type fall:**

The glacis type of fall utilised the standing wave phenomenon for dissipation of energy.

The glacis fall may be

(i) straight glacis type
(ii) parabolic glacis type

– **Meter and non-meter fall:**

Meter fall are those which also measure the discharge of canal. The non-meter fall donot measure the discharge.

– **Contracted and full width fall:**

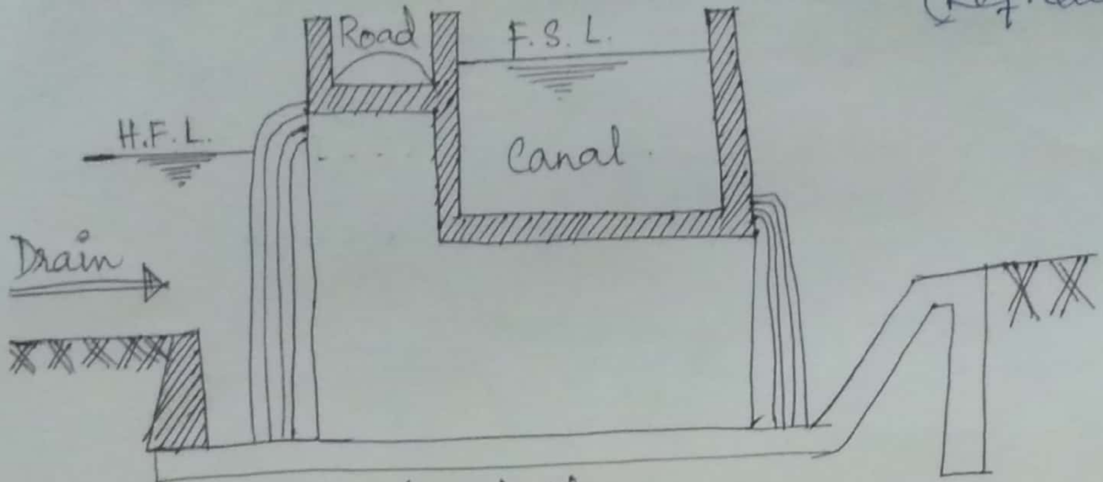
A fall may either be constructed of the full channel width or it may be contracted. The contracted falls, the later type, are also known as the flumed falls.

③ Name the various types of cross drainage works. In what condition is each type most suitable?

A: Depending upon the relative levels and discharges, cross-drainage works may be of the following types:-

(I) C.D works carrying canal over the drainage.

The canal is carried out over the natural drain. The canal is running perennially is above the ground and is open to inspection. and the damage done be the floods is rare.
The structures that falls in this type are:
(i) Aqueduct and (ii) Syphon Aqueduct
[Ref. Que. 4(a)]



Aqueduct

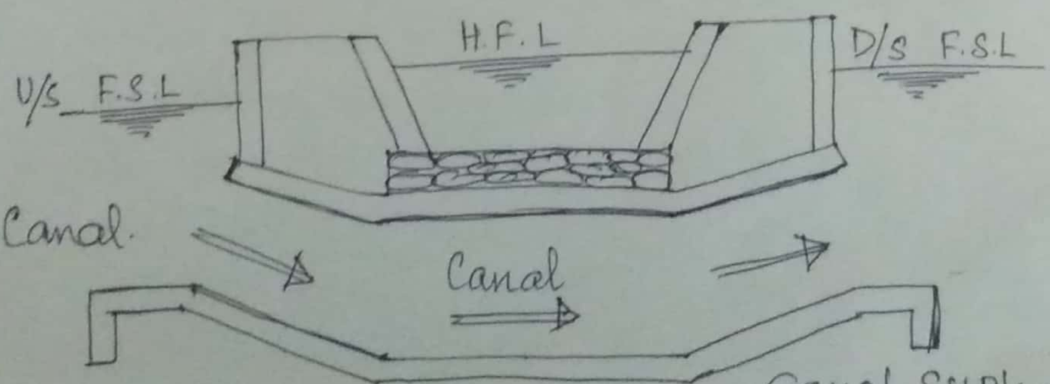
(II) C.D Works carrying drainage over the canal.

The advantage of this type is that the C.D. works themselves are less liable to damage than the earth-work of the canal.
The structures that fall under this type are.

1. Super-passage.
2. Canal system.

{Ref. Que. 4 (b)}.

A super passage is similar to an aqueduct, except. that in this case the drain is over the canal.

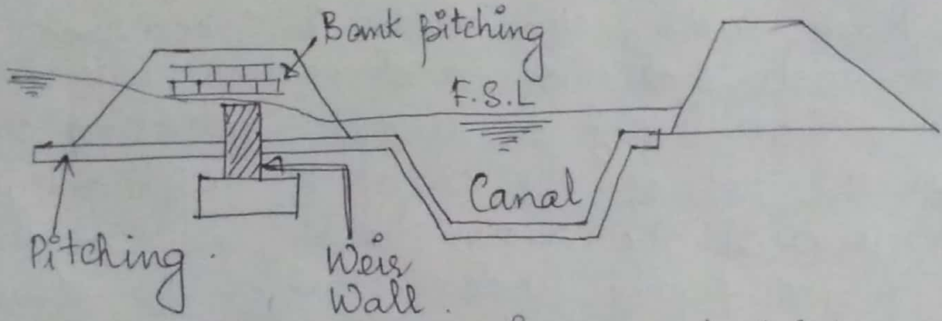


Canal Syphon.

(III) C.D works admitting the drainage water into the canal

In this canal, water and drainage water are permitted to intermingle with each other.
The advantage of this type of work is its low initial cost.
The following structures come under this type of CD:

1. Level crossing
2. Inlet and outlets.

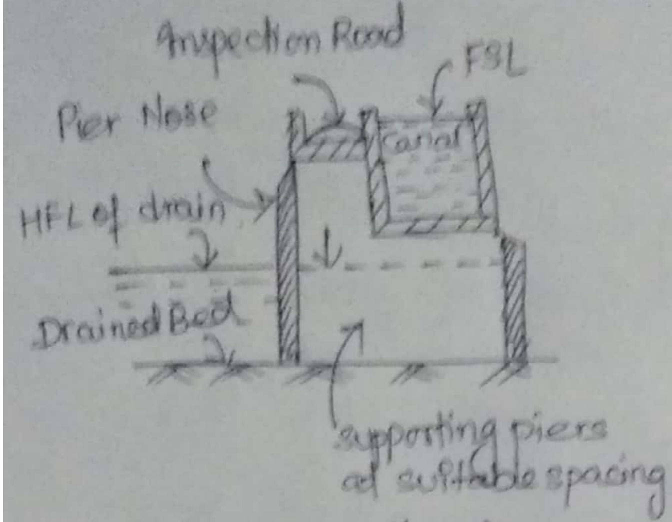


~~Lele~~ Level Crossing and inlet.

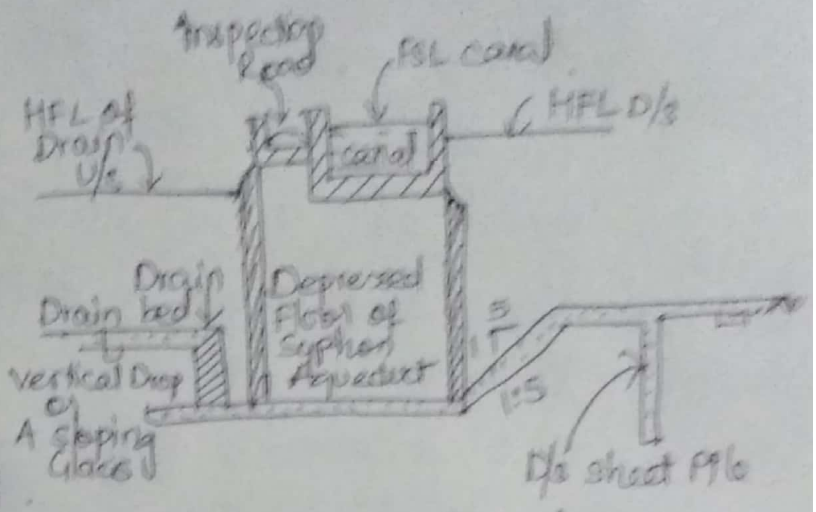
(4) Differentiate between:

(a) Aqueduct and Siphon 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.



Typical cross-section of an aqueduct

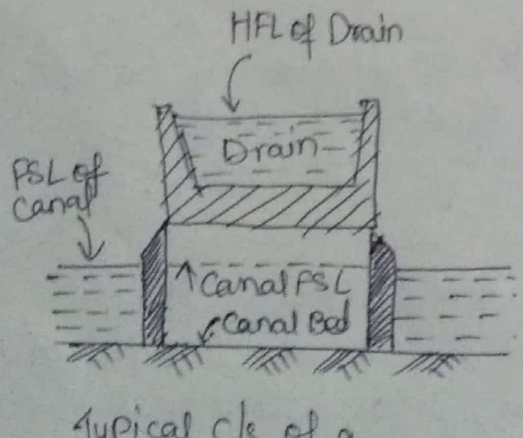


Typical cross-section of a Syphon Aqueduct

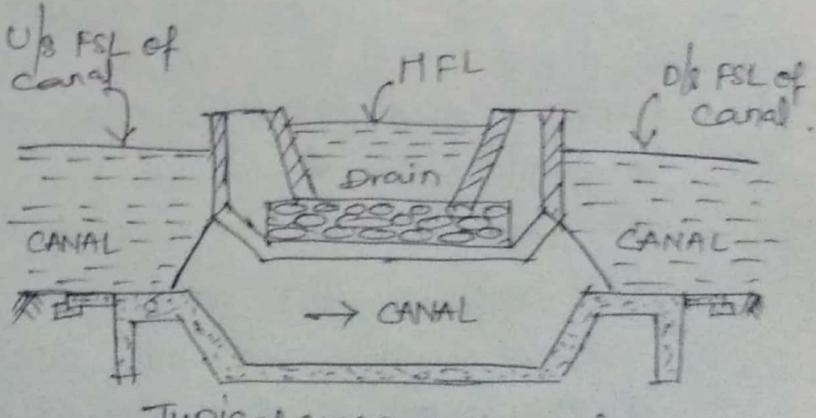
(b) Super-passage and siphon super-passage.

A: - In these works, the drain is taken over the canal such that the canal water runs below the drain either freely or under syphoning pressure.

- When the FSL of the canal is sufficiently below the bottom of the drain trough, 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 a canal syphon or a syphon.
- A superpassage is thus the reverse of an aqueduct, & similarly, a syphon is a reverse of an aqueduct syphon.



Typical C/s of a Superpassage.



Typical cross-section of a canal syphon

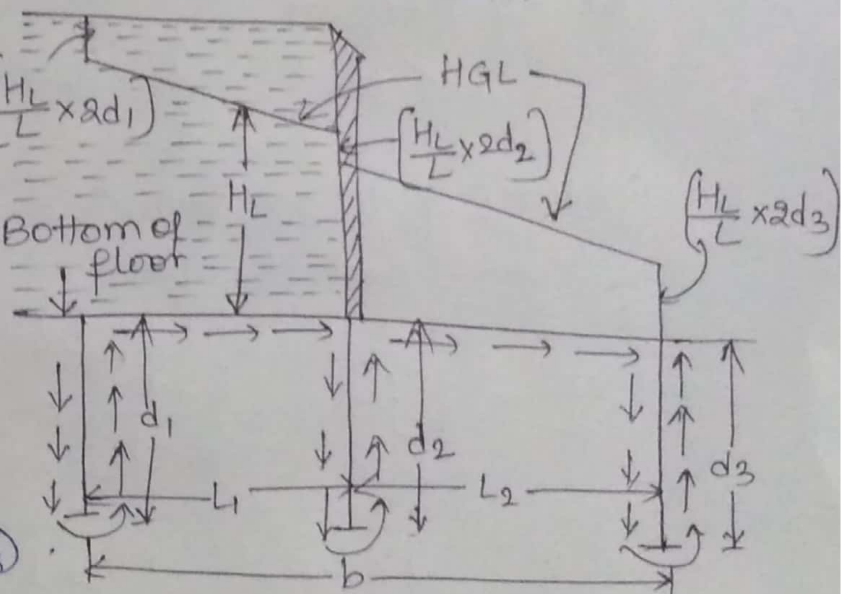
(5) Explain Bligh's creep Theory. How is the safety against piping and uplift pressure considered by this theory?

A: **Bligh's Creep Theory:**

"The percolating water follows the outline of the base of the foundation of the hydraulic structure." In other words, water creeps along the bottom contour of the structure.

- The length of the path thus traversed by water is called the length of the creep.
- The loss of head per unit of creep length (H_L/L) is called the hydraulic gradient.
- Further, Bligh makes no distinction between horizontal and vertical creep.

- Consider a section. Let H_L be the difference of water levels between upstream and downstream ends. Water will seep along the bottom contour by arrows. It starts percolating at A emerges at B. The total length of creep is given by:



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

- Head loss per unit length or hydraulic gradient,
$$= \left[\frac{H_L}{b + 2\cdot(d_1 + d_2 + d_3)}\right] = \frac{H_L}{L}.$$

- Head losses equal to $\left[\frac{H_L}{L} \times 2d_1\right]$, $\left[\frac{H_L}{L} \times 2d_2\right]$ & $\left[\frac{H_L}{L} \times 2d_3\right]$; will occur respectively, in the planes of three vertical cutoffs.

(i) **Safety against piping or Undermining:**

According to Bligh, the safety against piping can be ensured by providing sufficient creep length, given by $L = C \cdot H_L$.

where, $C \rightarrow$ Bligh's coefficient for the soil.

(ii) **Safety against uplift pressure:**

Uplift pressure caused by the seeping water $= \gamma_w h'$

where, $\gamma_w \rightarrow$ Unit weight of water.

$h' \rightarrow$ water pressure (m).

Downward pressure due to weight of the concrete floor of thickness $t = (\gamma_w \cdot G_c) \cdot t$

where, $G_c \rightarrow$ specific gravity of the floor material (i.e., concrete).

For equilibrium

$$\cancel{\gamma_w} \cdot h' = \cancel{\gamma_w} \cdot G_c \cdot t$$

$$h' = G_c \cdot t$$

Subtracting t on both sides,

$$h' - t = G_c t - t$$

$$h' - t = t(G_c - t)$$

$$\therefore \boxed{t = \left(\frac{h' - t}{G_c - 1}\right) = \frac{h}{G_c - 1}}$$

where, $(h' - t) = h$ = ordinate of the HGL above the top of the floor.

$G_c - 1$ = submerged specific gravity of the floor material.