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Paper	Hydraulic Structure
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Q.1 (Part a):

Culvert:

Culvert is a tunnel carring a stream under a road or railway. A culvert may act as a bridge for traffic to pass on it. They are typically found in a natural flow of water and serves the purpose of a bridge or a current flow controller.

Culvert is provided under roads and highways for a crossing of water, as road embankment cannot be allowed to obstruct the water flow. The culvert is ideally suited for a road to limit water flow in a controlled way.

Pipe, box and arch culvert are some common type of culvert.

It is based on hydraulic, water Surface elevation, and roadway height and other conditions.

While in Causeway

A causeway is of Course a raised road, it is built on an embankment. It is Supported mostly by earth or ~~Sn~~ stone, and It is not a bridge because it Supports a roadway between piers.

Culvert is a tunnel Structure constr-ucted under roadways or railways to Provide ~~cross~~ driange or take electerical or other cables from one side to another. While causeway is a road paved dip which allow the floods to pass over it. It may have or may not have opening or vent to allow low water to flow.

Q: 1 (Part b):

Cross Drainage Works:-

Cross Drainage Works is a Structure constructed when there is a crossing of cannal and natural drain, to prevent the drain water from mixing into canal water. This Type of structure is costlier one and needs to be avoided as much as possible

Cross drainage Works can be avoided in two ways:

* By changing the alignment of canal water way
* By mixing two or three streams into one and only one cross drainage work to be constructed,

making the structure economical.

Why It is Necessary:-

* It is necessary because water-shed canals do not cross natural drainages. But in actual orientation of the canal network, this ideal condition may not be available and the obstacles like natural drainages may be present across the canal. So, the cross drainage works must be provided for running the irrigation system.

* At the crossing point, the water of The canal and the drainage get intermixed so, for the smooth running of the canal with its

design discharge the cross drainage works are required.

So it is very difficult at the site ~~when~~ where natural water and drain water flow in their natural direction. without a hydraulic structure. so, the cross drainage works must be provided to maintain their natural direction of flow.

Types of Cross Drainage Works:-

Type 1 (Irrigation canal passes over the drainage)

(i) ~~Ad~~ Aqueduct:

In this the hydraulic structure in which the irrigation canal is taken over the drainage (Such as river, stream etc) is known as aqueduct. It is suitable when

When bed level of canal is above the highest flood level of drainage. In this case, the drainage water passes clearly below the canal.

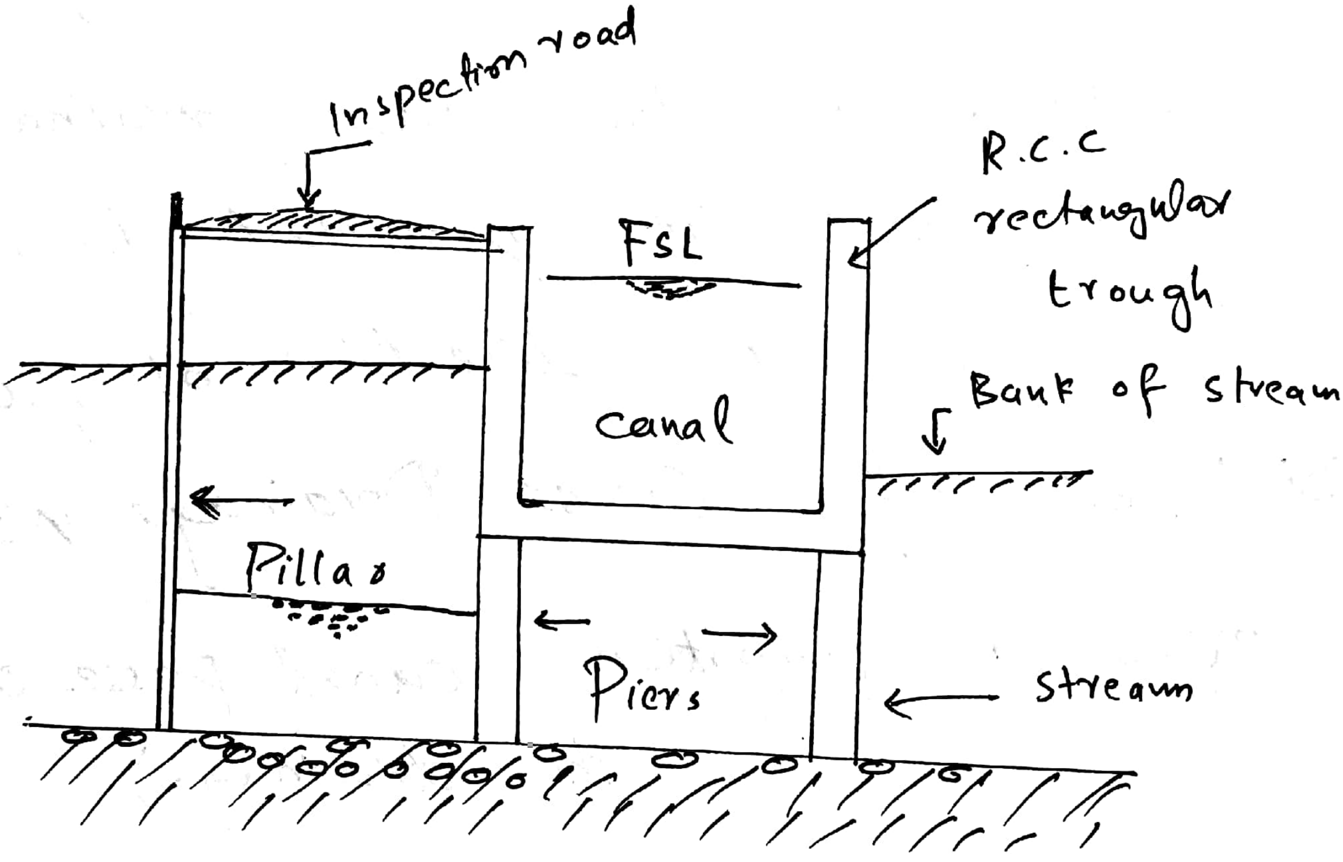


Fig Aqueduct.

(7)

Type-II Drainage Passes over the Irrigation Canal:

* Super Passage:

In this drainage is taken over the irrigation canal. It is suitable when the bed level of drainage is above the full supply level of the canal.

* Siphon Super Passage:

While this is opposite to the Super Passage it is suitable when the bed level of drainage is below the full length of the canal level.

(ii) Siphon Aqueduct:-

In this the canal is taken over the drainage, but the drainage water cannot pass clearly below the canal for this water flows under siphonic action. So it is know as siphon aqueduct. It is suitable where the bed level of canal is below the highest flood level.

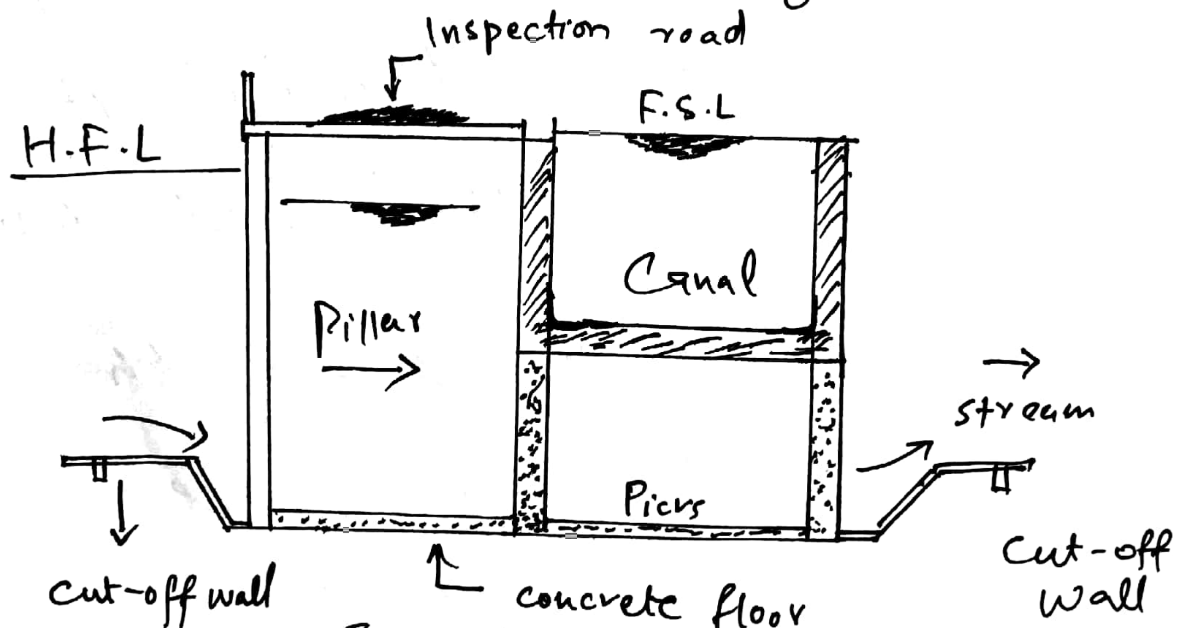


Fig Siphon Aqueduct.

Type III

Drainage and Canal Intersect each other at the same level

Level Crossings:

It is possible when the bed level of canal & ~~drainge~~ stream is approximately the same and quality of water in canal & ~~drainage~~ stream is not much different. It is called level crossing where water of canals & streams is allowed to mix.

following Components.

i) Crest wall
ii) Stream Regulator
iii) Canal Regulator.

Q: 2 part (A)

Differentiate between Weir & Barrage

Barrage	Weir
→ Low set Crest	→ High set crest
→ Ponding is done by means of Gate	→ Ponding is done against the raised crest or partly against crest & by shutters
→ Gated over entire length	→ Shutters in part length
→ Gates are of greater height	→ Shutters are of small height, 2m
→ Perfect control on river flow	→ No control of river in low floods
→ High floods can be passed with minimum afflux	→ Excessive ~~cause~~ afflux in high floods
→ Less silting upstream due to low set crest	→ Raised crest causes silting upstream.
→ Longer construction period	→ Shorter construction P.
→ Silt removal is done through under sluices	→ No means for silt disposal
→ Costly Structure	→ Relatively cheaper Structure

Q: 2 Part (b) (11)

Reynold's Number:

The Reynold's Number is the ratio of Inertial forces to Viscous force of it is dimension less number.

The product of density times length divided by viscosity coefficient.

Laminor flow:-

The flow in a pipe is laminar if the reynolds number is less than 2000.

Turbulent Flow:

If the reynolds number is greater than 4,000 then the flow in a pipe is called Turbulent.

Neither Laminor nor Turbulent flow:-

When the reynold's number is between ~~the~~ range of 2000 & ~~4000~~ ~~28~~ 4,000, the flow is neither laminar nor turbulent.

Low Critical Velocity:

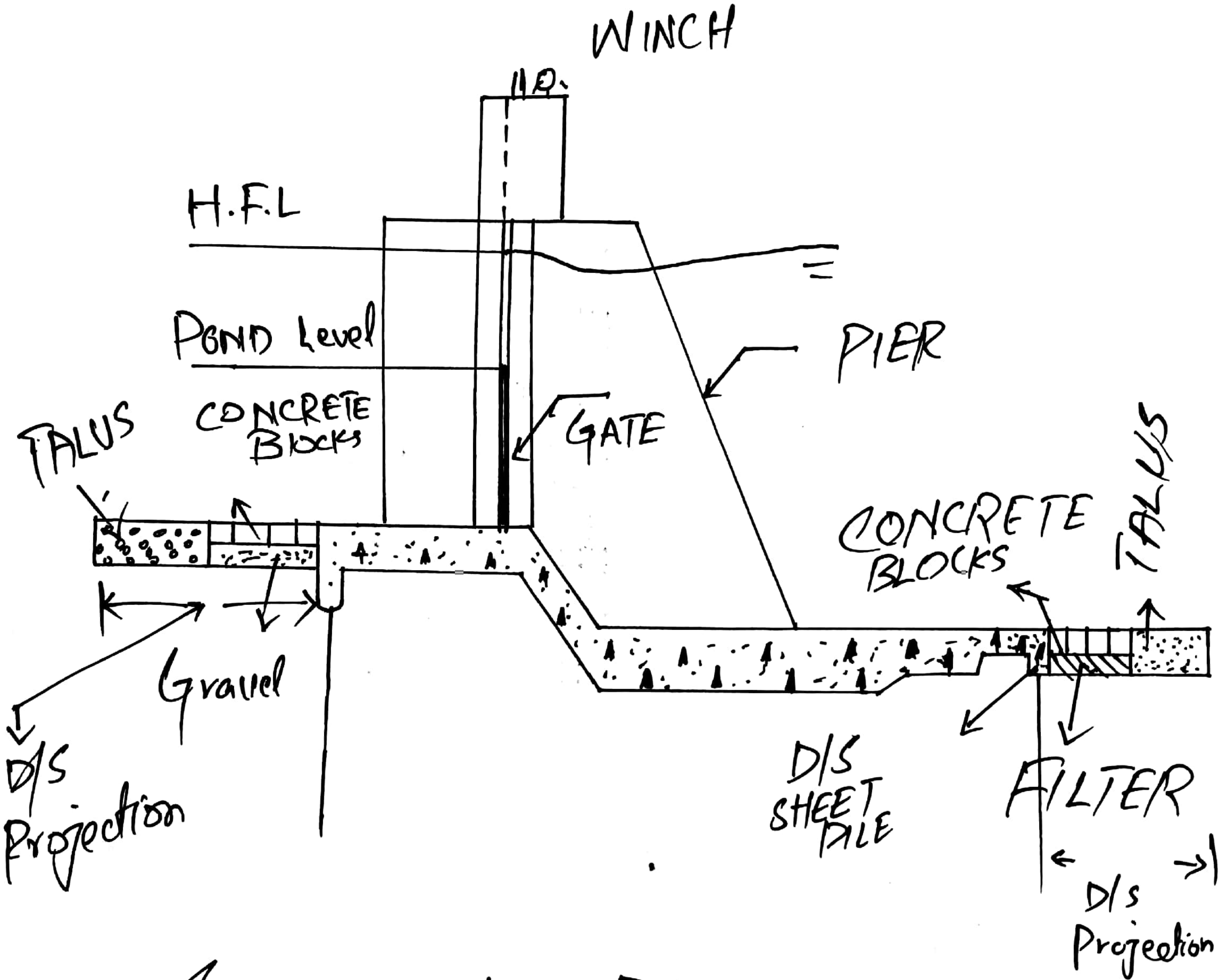
The velocity at which the flow changes from laminor to transition.

High Critical Velocity:-

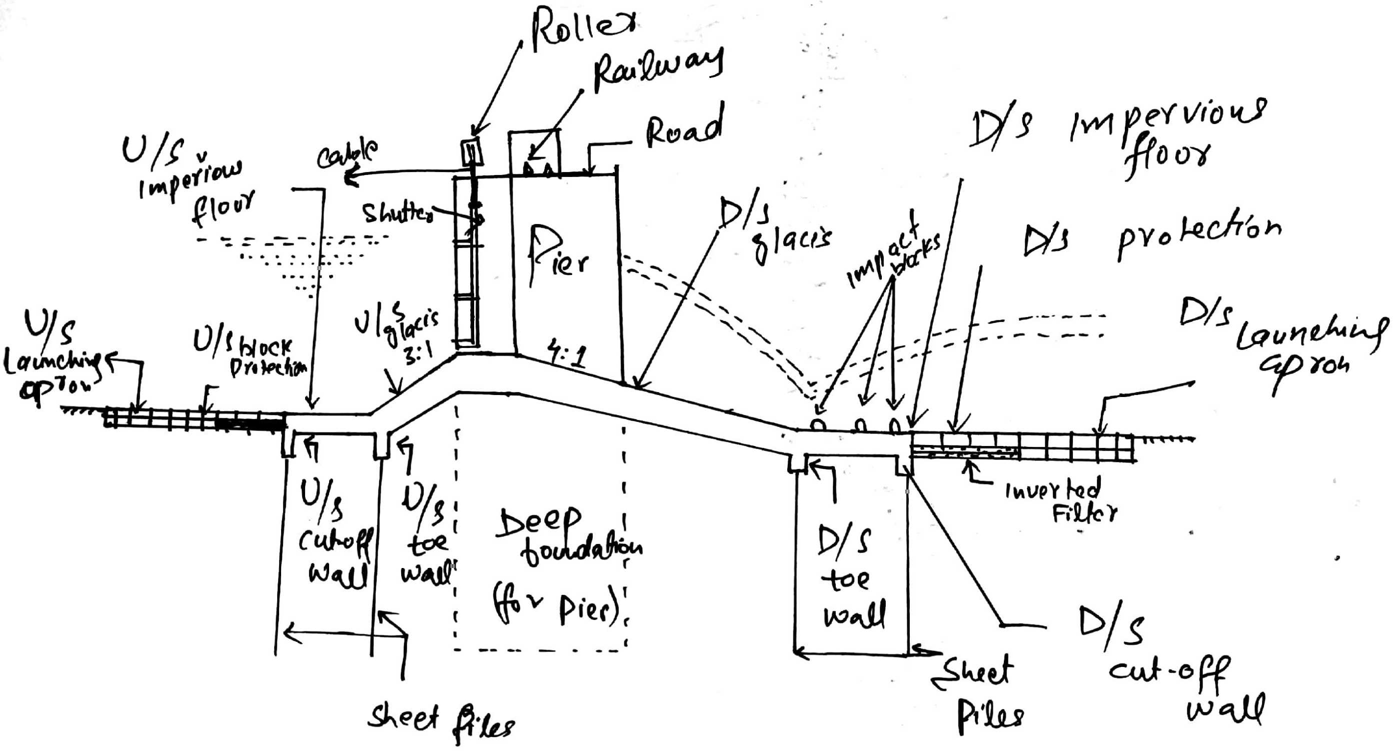
The ~~point~~ velocity at ~~the~~ which the ~~velocity~~ flow changes from transition to turbulent is called Higher critical velocity.

Q: 3 Part a)

(13)(a)



Sketch of Barrage



Components Parts of barrage.

Q. No: 3 Par (b) (14)

Solution:

Several formulae based on experimental results have been proposed to Predict the 'maximum' or 'equilibrium' Scour depth (y_s, below general bed level) around bridge piers.. In general, these assume the relationship

$$Y_s/b' = \phi\,(y_0/b',\ F_r,\ d/b')$$

where b' = pier W

Y_0 = Upstream flow depth

d = Sediment size

F_r = Froud Number

Laursen's (1962) experimental results underestimate the scour depths, compared to many Indian experiments (Inglis, 1949) Which Suggest the formula (approach How is normal to the bridge piers)

$$\frac{y_s}{b'} = 4.2\left(\frac{y_o}{b'}\right)^{0.78} Fr^{0.52}$$

The indian field data also suggest that the scour depth should be taken as twice the regime scour depth.

In the case of live beds (a stream with bedload transport) the formula.

$$\frac{y_s}{y_o} = \left(\frac{B}{b'}\right)^{5/7} - 1$$

Predicts the maximum equilibrium scour depth. ~~should be taken as~~

In a relatively deep flow a first-order estimate of ~~with~~ ~~bedload~~ clear ~~transport~~) ~~the~~ ~~[illegible]~~

local Scour (around pier) may be obtained by

$$y_s = 2.3 \, K_\alpha \, b'$$

Where K_α = angularity coefficient which is a function of the pier alignment, i.e angle of attack of approach flow.

—x—x—

The End Q: 3 part (b)

Q: 4 (17)

Given DATA:

$LL = 1500\ lb/ft^2$

$D.L = 300\ lb/ft^2$

Section $= 15' \times 15'$

Thickness $= 3\ ft$

unit of soil $= 100\ lb/ft^3$

$\phi = 30^\circ$

Unit weight of concrete $= 150\ lb/ft^3$

$f_y = 60\ ksi$

Required:

Design the Culvert box?

Solution:

Self wt of slab

Thickness × unit weight of R.C.C concrete

~~× = ~~

$$3 \times 156 = 468\ lb/ft^2$$

(18)

Total load

(L.L + D.L + self wt)

= (1500 + 300 + 468)

= 2268 lb/ft²

Coefficient of Earth Pressure

$$\frac{1 - \sin\phi}{1 + \sin\phi} = \frac{1 - \sin 30^\circ}{1 + \sin 30^\circ} = 0.33$$

Letral Pressure

(i) Vertical pressure at Top

(L.L + D.L) Ka

(1500 + 300) × 0.33 = 594 lb/ft²

(ii) Pressure of soil

Ka × h × Unit weight of soil

$0.33 \times (15' + 3') \times 100$

$= 0.33 \times 18 \times 100$

$= 594 \ lb/ft^2$

(iii) Lateral pressure at top $= 594 \ lb/ft^2$

(iv) Pressure at bottom

= top + pressure of soil

$= 594 + 594$

$= 1188 \ lb/ft^2$