FINAL TERM PAPER

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Subject:- Hydraulic Structures.

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SEMESTER:. SENIOR:-

Hydraulic Structures.

Q1) a): Differentiate between culvert and causeway?

Ans: **Culvert:**

A culvert is a structure that allows water to flow under a road, railroad, trail or similar obstruction from one side to the other. Typically embedded so as to be surrounded by soil, a culvert may be made from a pipe, reinforced concrete or other material.

Causeway:-

A causeway is a track, road or railway on the upper point of an embankment across "a low or wet place, or piece of water". It can be constructed of earth, masonry, wood or concrete. One of the earliest known wooden causeways is the Sweet Track in the Somerset levels, England, which dates from Neolithic age. Timber causeways may also be described as both boardwalks and bridges.

Q2) b):. Cross Drainage Works:.

In an irrigation project, when the network of main canals, branch canals, distributaries etc are provided, then these canals may have to cross the natural drainages like rivers, streams, nallahs etc at different points within the command area of the project. The crossing of the canals with such obstacle cannot be avoided. So, suitable structures may be constructed at the crossing point for the easy flow of water of the canal and drainage is the respective direction. These structures are known as Cross-drainage structures

* ~~[scribbled out]~~

→ **Why it is Necessary:**

* The water-shed canals do not cross natural drainages. But in actual direction/orientation of the canal network, this idea condition may not be available and obstacles like natural drainages may be present across the canal. So, the cross drainage works may 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.

Different Types of Cross-Drainage works:-

* Type I (Irrigation Canal passes over the Drainage).

a). Aqueduct

b). Siphon Aqueduct.

* Type - II (Drainage passes over the irrigation Canal)

a). Super passage.

b). Siphon Super passage.

* Type - III (Drainage and canal intersection eachother at same level).

a). level Crossing

b). Inlet and Outlet.

Type -I

Aqueduct:

The hydraulic structure in which the irrigation canal is taken over the drainage (such as river, stream etc) is known as Aqueduct.

Siphon Aqueduct:

In a hydraulic structure in which the canal is taken over the drainage, but the drainage water cannot pass clearly below the canal. It flow under Siphonic Action. So, it is known as Siphonic Aqueduct. The structure is suitable when the bed level of canal is below the highest flood level.

Type - II :.

Super Passage:.

The hydraulic structure in which the drainage is taken over the irrigation canal is known as Super Passage. This structure is suitable when the bed level of drainage is above the full supply level of the canal. The water of the canal passes clearly below the drainage.

Siphon Super Passage:.

The Hydraulic Structure in which the drainage is taken over the irrigation canal, but the canal water passes below the drainage water under siphonic action is known as siphon super passage.

Type - III.

Level Crossing:.

When the bed level of the canal and the stream are approximately the same and quality of water in canal and stream is not much different, the cross drainage work constructed is called level crossing.

Inlet and Outlet:.

When irrigation canal meets a small stream or drain at some level, drain is allowed to enter the canal as in inlet. At some distance from this inlet point, a part of water is allowed to drain as outlet which eventually meets the origional stream. Stone pitching is required at the inlet and outlet.

QNo: 2/a):. Difference Between Weir and Barrage:-

- **Weir:-**

Weir is an inpenetrable boundary which is developed over a river or waterway to raise the water level on the upstream side. In this system, the water level is raised up to the required height and the excess water is permitted to discharge over the weir. Weir is mainly constructed across an immersion river or waterway.

Barrage:

When Adjustable gates are installed in a weir to keep up the surface the water at a diverse level at various time, is called barrage.

In this system, the water level is balanced by operating the shutters or gates. The Gates are provided at different levels and operated by cables from a cabin. These gates are supported on piers at both ends. The pier to pier distance is called bay.

QNo: 2(b):. **Reynold No:.**

The Reynold Number is the ratio of inertial forces to viscous forces within a fluid which is subjected to relative internal movement due to different fluid velocities.

A region where these forces change behavior is known as boundary layer, such as the bounding surface in the interior of the pipe.

For Laminar flow:.

$$Re < 2000$$

For Turbulent:.flow:.

$$Re > 4000$$

For Transition flow:. $Re = 2000 - 4000$.

- **Lower Critical Velocity:**

The velocity at which flow changes from laminar to transition is called Lower Critical Velocity.

- **Higher / Upper Critical Velocity:**

The Velocity at which flow changes from transition to Turbulent that velocity is called Higher Critical velocity.

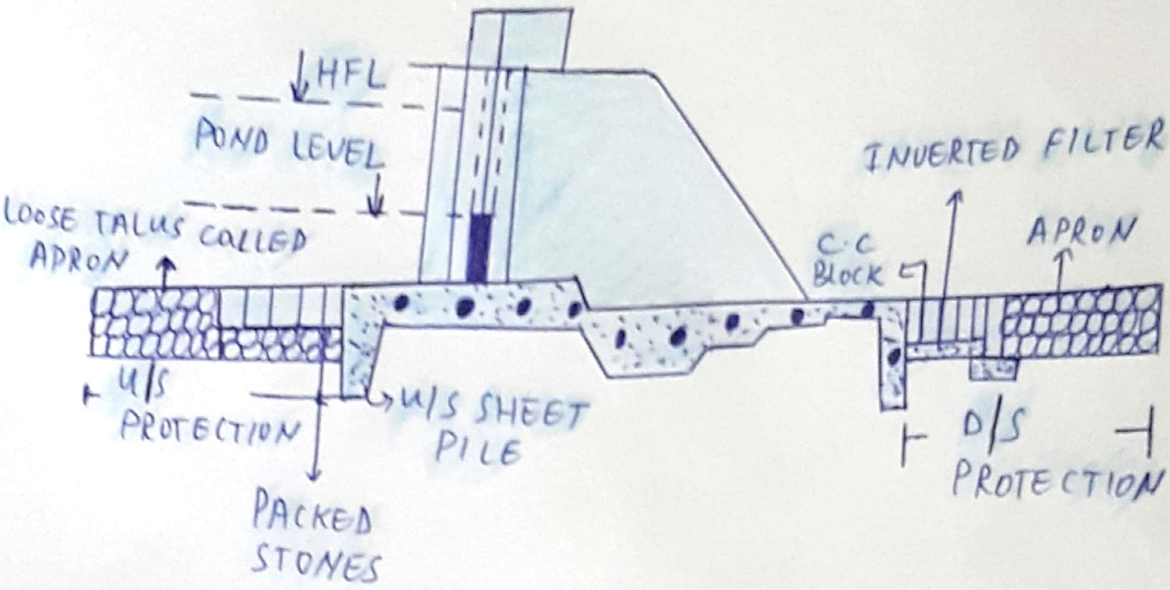
QNO:3A): Draw neat sketch of barrage showing it's different components.

BARRAGE:

The Function of barrage is similar to that of the weir, but the heading up of water is effected by the gates alone.

During the floods, the gates are raised to clear off the high flood level. when the flood recedes, the gates are lowered and the flow is obstructed, thus raising the water level at the upstream side of the barrage.

Sketch:-



U/S = Upstream Side

D/S = Downstream Side

QNo:3/b):.. How would you predict /analyze maximum or equilibrium scour depth based on experimental formulas?

Ans:. 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 assumes the relationship.

$$y_s/b' = \phi(y_o/b', F_r, d/b')$$

where b' is the pier width, y_o is the upstream flow depth, d is the sediment size, and F_r is the flow Froude number.

→ Laursen's (1962) experimental results underestimate the scour depths, compared to many Indians experiments (Inglis, 1949) which suggests the formula (approach flow is normal to the bridge piers).

$$y_s / b' = 4.2 \, (y_0 / b')^{0.78} \, F_r^{0.52}$$

→ The Indians field data also suggests that the scour depth should be taken as twice the regime scour depth.

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

$$y_s / y_0 = (B / b')^{5/7} - 1$$

predicts the maximum equilibrium scour depth.

In a relatively deep flow a first-order estimate of local (clear) local scour (around pier) may be obtained by

$$y_s = 2.3 \, K_a \, b'$$

K_a = Angularity coefficient which is a function of the pier alignment, i.e. angle of attack of approach flow.

QNo:-4) **Given Data:**

→ Dimension of Culvert (15 ft x 15 ft).
In meters.
(4.57 m x 4.57 m)

→ L.L = 1.5 kip/ft² or 71.8203 kN/m²

1 kip/ft² = 47.8802 kN/m²

→ Super Imposed D.L = 300 lb/ft²
or
14.364 kN/m²

→ Unit wt of Soil = 100 lb/ft³
or
15.7086 kN/m³

→ 1 lb/ft³ = 0.15708 kN/m³

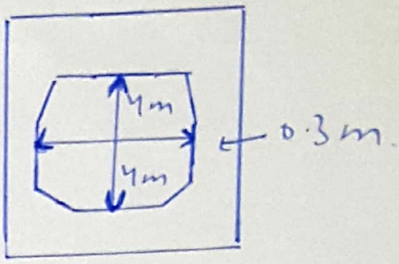
Angle of Repose = 30°

Ratio for Concrete (1:2:4)

f_y = 60 ksi

Solution:-

① Load Calculation:-



Total load carry on top slab = Self wt of slab + L.L + D.L.

Self wt of Slab = $0.3 \times 25 = 7.5 \, KN/m^2$.

W = Total Load = Self wt + D.L + L.L.

$W = 7.5 + 14.364 + 71.8203$

$W = 93.684 \, KN/m^2$.

② Coefficent of Earth Pressure (Ka).

$$Ka = \frac{1 - \sin\theta}{1 + \sin\theta} \qquad Ka = \frac{1 - \sin 300}{1 + \sin 300}$$

Ka = 13.92

- Lateral Pressure due to D.D + L.L.

Total vertical load (D.D + L.L) × Ka.

= (71.8203 + 14.364) × 13.92

= 1199.68 KN/m².

- Lateral Pressure due to soil = Ka × γh.

= 13.92 × 15.7086 × 4.87

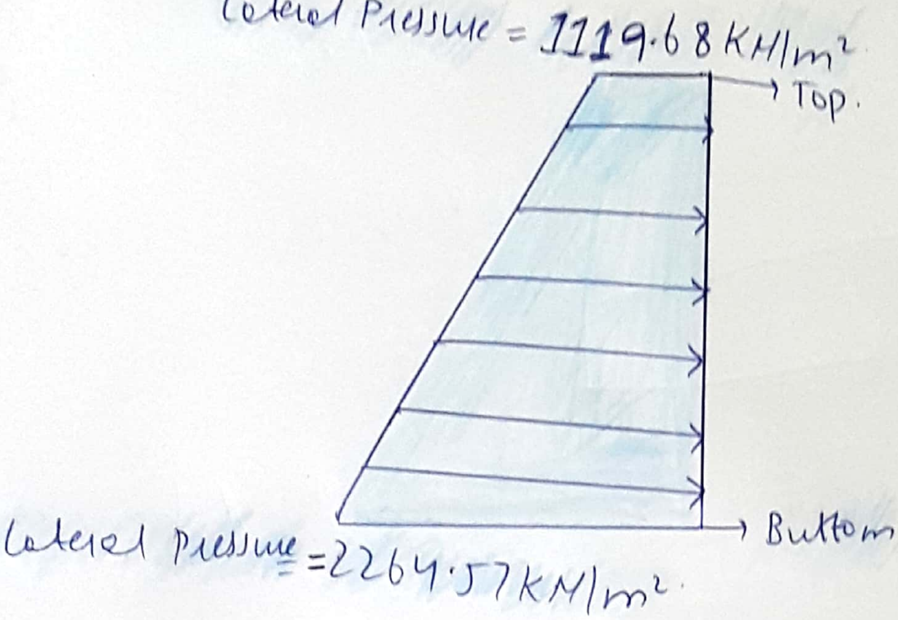
= 1064.89 KN/m².

- Lateral Pressure @ top = Lateral Pressure due to (D.D + L.L).

= 1199.68 KN/m²

- @ Buttom = Lateral Pressure due to (DL + L.L) + lateral pressure due to soil.

= 1199.68 + 1064.89 = **2264.57 KN/m²**



Sketch of Culvert Design.