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CMR INSTITUTE OF TECHNOLOGY

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1st Internal Test – March 2017

Sub:	Hydraulic Structures and Irrigation Design – Drawing					Code:	10CV65
Date:	30/ 03 / 2017	Duration:	90 mins	Max Marks:	50	Sem: 6	Branch: CIVIL

Note: Answer all questions. Draw neat sketches. Assume necessary data

		Marks	OBE CO	OBE RBT
1(a)	Define reservoir. Explain and classify different types of reservoir.	[7]	CIV605.1	L1
(b)	Briefly explain the procedure for determining the storage capacity and yield of the reservoir.	[8]	CIV605.1	L1

Selected

CI CCI HOD

		Marks	CO	RBT
2 (a)	Design a surplus weir with stepped apron of a tank forming a part of a chain of tanks with the following details. m) Combined catchment area – 25.89km² n) Intercepted catchment area – 20.71 km² o) Maximum water level - +12.75m p) Full tank level – +12.00 q) Ground level at proposed site – +11.00m r) Ground level below weir slopes off in a length of 6m fall to – +10.00m s) Tank bund level – +14.50m t) Top width of tank bund – 2m u) Side slope of bund on either side – 2:1 v) Hydraulic Gradient – 4:1 w) Ryve's coefficient for combined catchment – 9 x) Level of hard rock strata - +9.50m	[25]	CIV605.4	L3
(b)	Draw to a suitable scale the cross section across the weir.	[10]	CIV605.4	[illegible]

* Reservoir and types

When a barrier is constructed across some river in the form of a dam, water gets stored on the upstream side of the barrier, forming a pool of water generally called a dam reservoir/ impounding reservoir /storage reservoir.

The water stored in reservoir during rainy season can be easily used almost throughout the year, till the next rainy season.

Depending upon the purpose served by a given reservoir, the reservoirs may be broadly divided into the following three types.

1) Storage / conservation reservoir

A city water supply, irrigation water supply drawing water from a river or a stream may fail to satisfy consumers demand during low flows, & while high flows it may become difficult to carry out their operation due to devasting floods. A storage reservoir can retain such excess supplies during periods of peak flows, & can release them during low flows as & when need arises.

A reservoir can be used for controlling floods hence called flood control reservoir or single purpose flood control reservoir.

2) Flood control reservoir

A flood control reservoir / flood mitigation reservoir stores a portion of the flood flows in such a way as to minimise the flood peak @ the areas to be protected downstream.

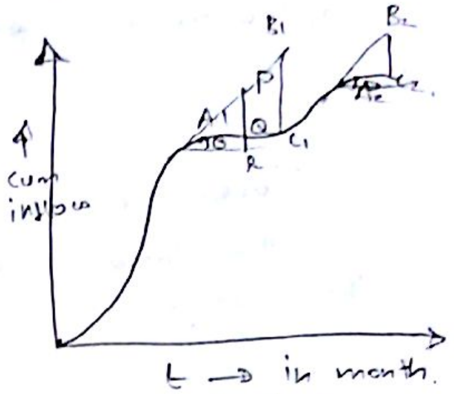
3) Multipurpose reservoirs

A reservoir planned & constructed to serve not only one purpose but various purposes together is called MR. A reservoir designed to protect the downstream areas from floods & also to conserve water for water supply, irrigation, industrial needs, hydroelectric power etc is called a MPR. Bhakra dam & Nagarjun Sagar dam are MP projects.

4) Distribution reservoir

A DR is a small storage reservoir constructed within a city water supply system. such a reservoir can be filled by pumping water at a certain rate. They are helpful in permitting the pumps or water treatment plants to work @ uniform rate & store water during hours of no demand & supply water during critical periods of max. demand.

* To find reservoir capacity by mass curve method

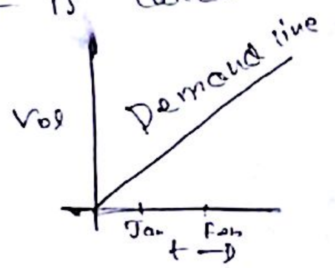


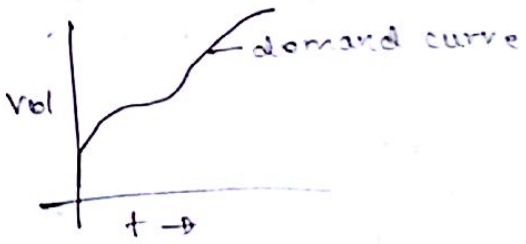
1) Based on the inflow data the cumulative inflow is calculated. The inflow can be given as runoff depth, runoff volume, discharge etc.

2) Plot the mass curve b/w cumulative inflow and time

3) In the graph identify the peak points A_1, A_2 etc..

4) If the demand is not given calculate the average inflow. If the demand is constant it is called as demand line, if it is varying it is called as demand curve.





5) Super impose the demand line or curve at A_1 A_2 points of mass inflow curve.

Here, PR is the demand by the people [irrig., water sy., HP]

QR is the water which is available &

PQ is the water, which is required to be stored.

6) The maximum ordinate b/w the demand & mass curve b/w A_1 & A_2 are marked as B_1C_1 & B_2C_2

7) The reservoir capacity is given by the maximum of B_1C_1, B_2C_2

2 a)

1) Weir Details

a) Length of Weir

$A_1 = 25.89\ km^2$

$A_2 = 20.71\ km^2$

$C_1 = 9$

$C_2 = \frac{9}{5} = 1.8$

$Q = C_1 A_1^{2/3} - C_2 A_2^{2/3}$

$= 9 \times 25.89^{2/3} - 1.8 \times 20.71^{2/3}$

$= \boxed{65.189\ m^3/s}$

$Q = 2 C_d \frac{2}{3} L \sqrt{2g}\ H^{3/2}$

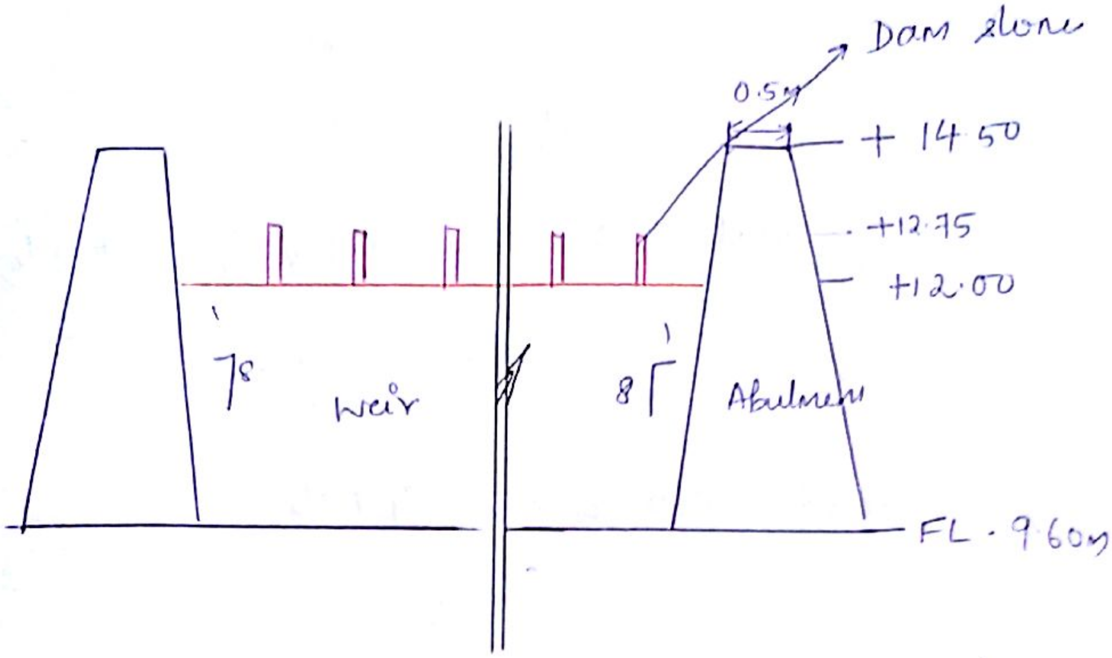
$C_d = 0.56$ (assumed)

$H = MWL - FTL = 12.75 - 12.00$

$= 0.75 M$

L = 60.69m

L' = 61M.



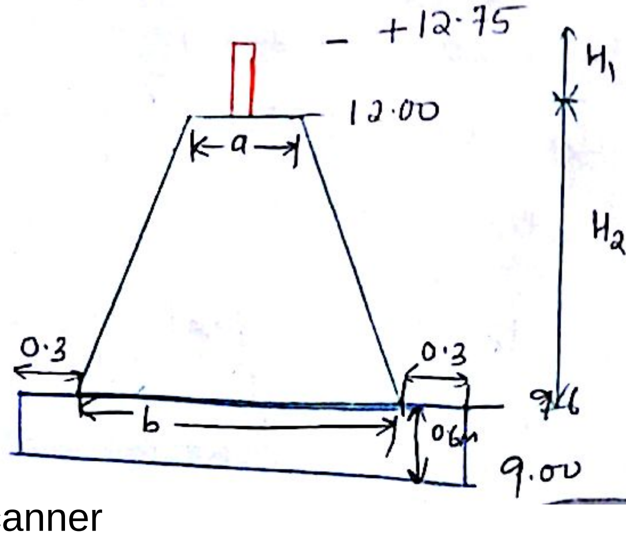
Dam stones are usually 0.2m X 0.2m in c/s.
and provided at 1m clear spacing.

No of dam stones = 61 − 1 = 60

L = L' + 60×0.2 = **73M**

b) Cross section details of weir

c/s of weir



Height of the weir, H_2 = FTL − FL

= 12 − 9.6

= 2.4M

H_1 = 0.75M

Top width, $a = 0.55\left(\sqrt{H_1} + \sqrt{H_2}\right)$

= 1.32 ≈ 1.4M

Base width, $b = \dfrac{H_1 + H_2}{\sqrt{(G-1)}}$

G = 2.3 for masonry

$= \dfrac{0.75 + 2.4}{\sqrt{(2.3-1)}}$ = 2.76M ≈ 2.8M

2) Protective works (Abutments, Wing wall & Return wall)

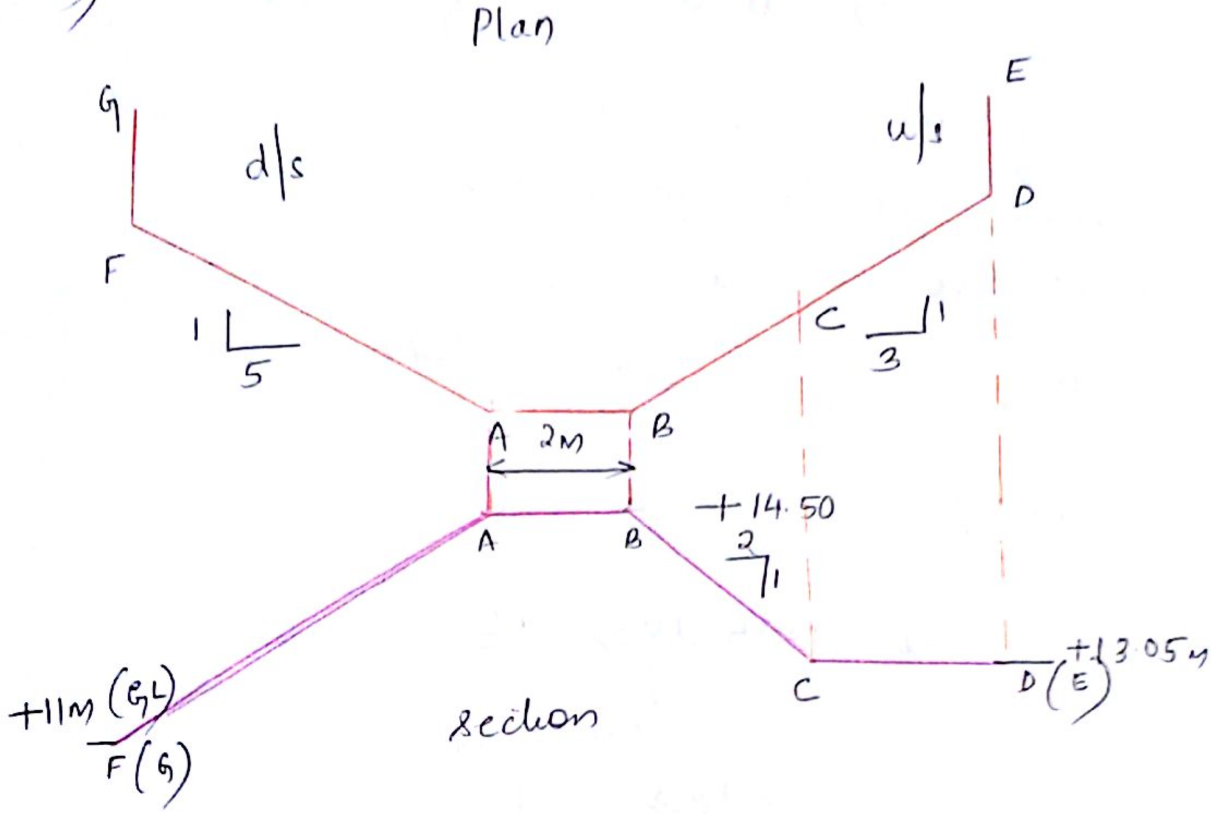
~~Ass~~ Note

a) Top width of abutment, wingwall and return wall is 0.5M

b) All walls are battered 8 : 1 on water sides

c) All concrete base offset is 0.3M from the edge of walls

Q5)



a) Abutment (AB)

Top width, $a_1 = \boxed{0.5m}$

Height, $h_1 = TBL - FL$

$= 14.50 - 9.6$

$= 4.9m$

$b_1 = 0.4h_1 = 0.4 \times 4.9 =$

$= 1.96 \approx \boxed{2m}$

b) Wingwalls and Return walls

(i) Upstream wingwall (BD) and Return wall (DE) c/s at B = c/s of abutment AB

Wingwall slopes from B(2:1) in flush with the slope of tank bund till it reaches C.

(A splay of 1 in 3 is provided).

At C

$h_2 = (MWL + 0.3) - FL$

↓ Free board

$= (12.75 + 0.3) - 9.6 = 3.45m$

Top width, $a_2 = 0.5m$

Base width, $b_2 = 0.4 \times 3.45$

$= 1.38 \approx 1.4m$

Return Wall (DE)

c/s at C = c/s at D = c/s at E

Length of return wall = 2.64m

(iii) Downstream wingwall (AF) and Return wall (FG)

c/s of A = c/s of abutment AB.

wingwall slopes ~~at 1~~ from A (2:1) in flush with the slope of tank bund till it reaches F (+GL + 11.00)

A splay of $1 \text{ in } 5$ is provided

At F

$a_3 = 0.5\text{m}$

$h_3 = 11 - 9.6 = 1.4\text{m}$

$b_3 = 0.4 \times 1.4 = 0.56$

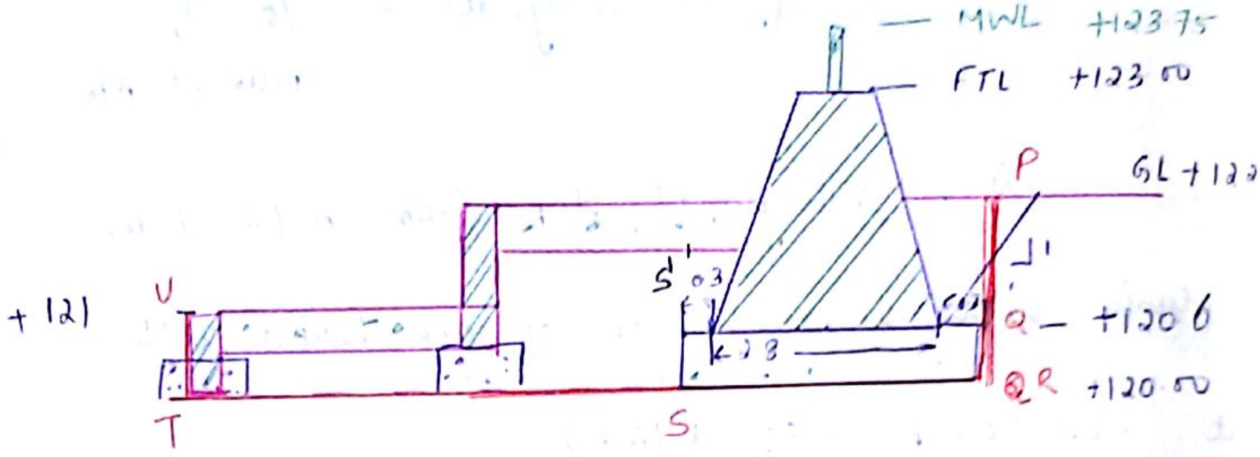
$\simeq 1\text{m}$ (should be greater than top width)

Return wall (FG)

c/s at F = c/s at G.

length of return wall = 2m

3) Design of Apron



a) Length of Apron - Using Bligh's Creep Theory

Hydraulic Gradient is 1 in 5 for flow-through soil medium

That is for 1m drop in head, the creep length is 5m

Total head through porous medium.

MWL - GL d/s

= 123.75 - 121 = 2.75m

∴ Total creep length =

$$\frac{1}{5} = \frac{\text{Total head}}{\text{Creep length}} \quad \frac{1}{5} = \frac{2.75}{L}$$

$L = 2.75 \times 5 = 13.75m$

$L = PQ + QR + RS + ST + TU = 13.75$

$= 1.4 + 0.6 + \underbrace{(2.8 + 2 \times 0.3)}_{3.4} + ST + 1 = 13.75$

$= 7.35\,m \approx \underline{\underline{8\,m}}$.

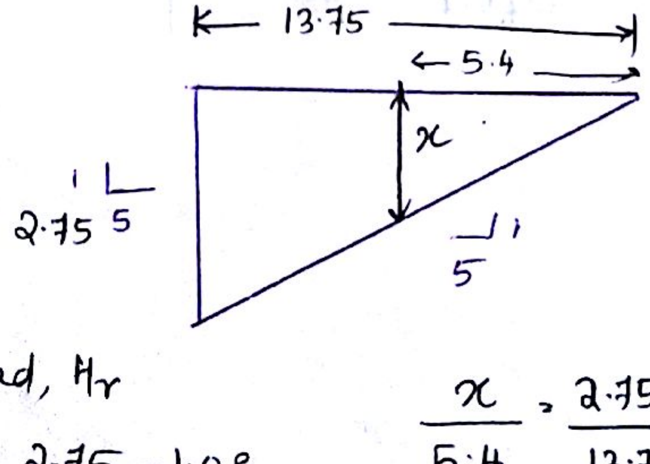
Let us provide 8 m of apron from face of weir.

Let 3 m be provided for 1st step of apron and 5 m be provided for 2nd step.

Further 3 m. 5 m of Talus can be provided

b) Thickness of apron

It is computed by the weight of the concrete required to balance the uplift pressure due to residual head.



Residual head, H_r

$2.75 - x = 2.75 - 1.08$

$= 1.67\,m$

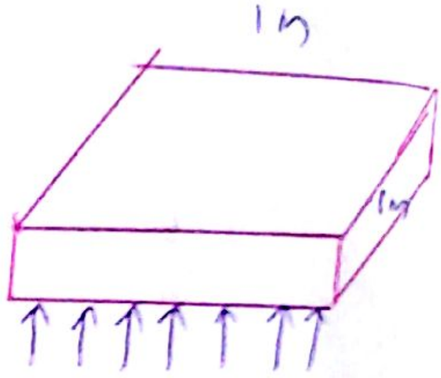
$\frac{x}{5.4} = \frac{2.75}{13.75}$

$x = 1.08\,m$

Total weight of the concrete = Total uplift pressure

Considering the dimensions as 1m x 1m

$\gamma_c \times 1 \times 1 \times t = \gamma_w \times H_r \times 1 \times 1$



$t = \frac{\gamma_w H_r}{\gamma_c}$

$t = \frac{1 \times \text{~~1.08~~}\ 1.67}{2.3} = \text{~~0.4695~~}\ 0.7260$

$\gamma_c = 2.3$ (concrete)

Factor of safety 1.25

t = ~~0.495 x 1.25~~ =

= 0.7260 x 1.25 = 0.9076 ≃ 1m

The thickness of the 2nd apron can be reduced to 0.5m ~~for~~ after the first apron

A Talus of 3-5m is provided after the apron.