PART B

Irrigation Design –Drawing

Design of surplus weir.

Estimation of Flood discharge entering the tank

Combined catchment area of group of tanks= 25.89sq.kms
Intercepted catchment area of he upper tanks= 20.71sq.kms

Flood discharge entering the tank in question is determined by the formula
Type formula here

Where C may be assumed as 9.00 and c may be assumed an 1.50
Q= 67.45 cubic meters.

Length of the surplus weir.

Water is to be stored upto level of 12.00m. i.e FTL of tank is 12.00 and so, the crest level of the surplus weir has to be kept at 12.00m

Submersion of foreshore lands is limited to 12.75m i.e MWL of the tank is kept at 12.75m
Therefore head of discharge over the weir is 12.75- 12.00= .75m

Since temporary regulating arrangement are to be made on top of the weir, to store water at times of necessity, grooved dam stones of 15cms x 15cms, will be fixed in the centre of the crest at 1 meter intervals with top at MWL

The weir may be assumed as a broad crested weir. So the discharge per meter length of the weir is given by

Cd= $\frac{2}{3} Cdh \sqrt{2gh}$

Where Cd is 0.562 and h=0.75m
Q= 1.66 $h^{(2/3)}$
= 1.66 $h^{(2/3)}$
= 1.08 cubic meters/second

Clear length of surplus weir required = 67.45/1.08
= 63.00 meters

Since the dam stones are to be fixed on top at 1 meter clear intervals, the number of openings will be 63.

So the number of dam stones required is 62 Nos.

Size of dam stone 15cms x 15cms. And the projecting length above crest will be 75cms. Therefore the overall length of surplus weir between abutment s is 63.00+ 62x 0.15= 75.30 meters .However provide an overall length of 75.00meters.

Weir

Crest level + 12.00FTL

Top of dam stone = 12.75 MWL

Ground level =11.00

Level where hard soil at foundations is met with 9.50

Taking foundations about 0.50meters deeper into hard soil, the foundation level can be be fixed at 9.00. the foundation concrete may be usually 0.60m thick

top of the foundation concrete = 9.60

Height of weir above foundations = 12.00 – 9.60 = 2.40m

Crest width

Generally the crest width is assumed as equal to 0.55($\sqrt{H} + \sqrt{h}$) where H is the height of the weir and h is the head over the weir (both H and h expressed in meters)

A = 0.55($\sqrt{H} + \sqrt{h}$) = 0.55($\sqrt{2.40} + \sqrt{0.75}$)= 1.3m

This gives a crest width of about 1.3m. This width may be adopted.

Base width

Check the stability of the weir such that the resultant thrust due to overturning water pressure when water on the upstream side is up to the top of shutters and weight of mansory of the wier passes through the middle third. In such cases the maximum overturning moment due to wataer thrust is equal to

Mo= $(H+ S)^3/6$

Where H is the Height of weir above the foundation and S is the height of shutters.

The slope of weir on either side being the same , the restoring moment M of the weir due to the weight of masonry is

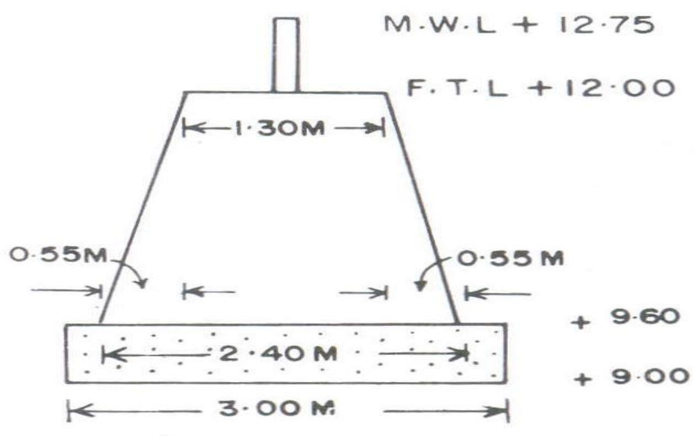
$$\mathbf{Mo} = \frac{1}{12}\left[\left\{\left(p+1\frac{1}{2}\right)H+2\frac{1}{2}S\right\}b^2 + a(pH-H-S)b-\frac{1}{2}a^2(H+3S)\right]$$

Where p= specific gravity of masonry
H= height of weir

a= crest of the weir
b= base of the weir

S= height of the shutters above the weir crest. i.e 1.30

S= 0.75, p may be taken as 2.25 substituting these values b will be 2.40 meters. The weir will have a trapezoidal profile as shown in figure.

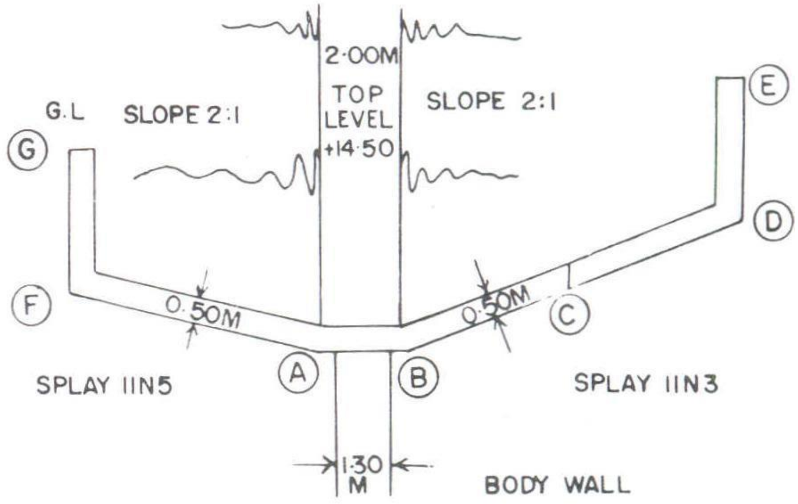


Abutments, wings, and returns

The top width of abutments, wings, and returns will all be uniformly 0.50m with a front batter of 1 in 8. Length of the wing walls must be enough to completely encase the tank bund as shown in figure**.**

Abutments

Portion AB is called the abutment. It has its top level same as that of the tank bund at 14.50 and has its length at top same as that of the top width of bund.



The height of abutment above foundation concrete = 14.50 – 9.60= 4.90m.
The bottom width required is about 4.90x 0.4 = 1.96 or say 2.00m

The section indicated in figure.

The wall BD is called upstream wing wall. The section of the wing wall at B is same as the section of the abutment.

This wing wall start sloping down from B till it reaches about 30cms. Above MWL i.e level of 12.75+0.30 = 13.05 at C.

So , the portion of wing wll BC will be having its top sloping down from 14.50 to 13.05

Section of the wing wall at C

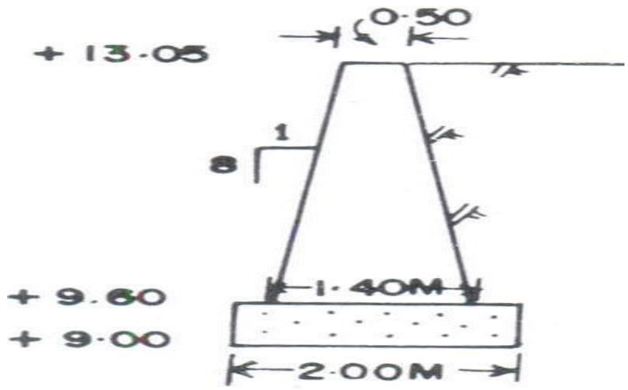
Height of wall above top of foundation 13.05- 9.60= 3.45
meters. base width is required

3.45x0.40= 1.38 or 1.40m adopt the section as given in figure 4.4

The top width from B to C is the same as 0.50 meters but the bottom width gets slowly reduced rom 2.00meters at section B to 1.40meters at section C.

Level wing and return

Since the level wing and return i.e portions CD and DE hve to be throughtout 30cms above MWL the same section of wall at C can be adopted.



Upstream side transition

In order to give an easy approach , the upstream side wing wall may be splayed as shown . i.e generally at 1 in 3.

Downstream side wings and returns.

As the water after passing over the weir goes down rapidly to normal MFL in the water course, the wings and returns need not be high as those on the upstream side. The wing wall from A to F will slope down till the top reaches the ground level at F. The section of wing wall at A will be the same as that of the abutments.

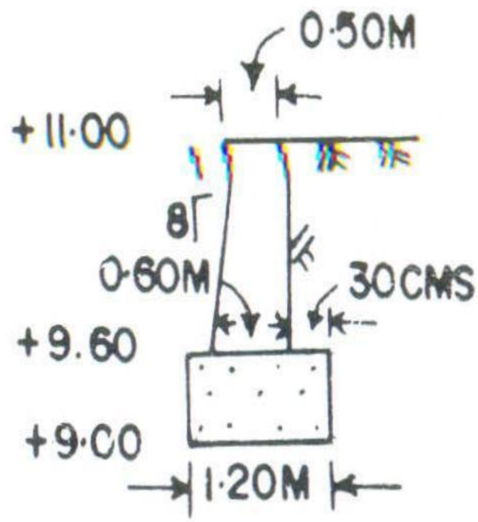
The top wing wall at F may be fixed at 11.00 same as the ground level/
So the height of wall above foundation concrete is 11.00- 9.60= 1.40 m

The base width required is 1.40x0.40= 0.56meters or adopt a minimum base width of 0.60meters. provide a section as indicated in figure 4.5

The same section is continued for the return FG also.

Downstream transition.

The downstream side wings are given a splay of 1 in 5 as shown in figure 4.2



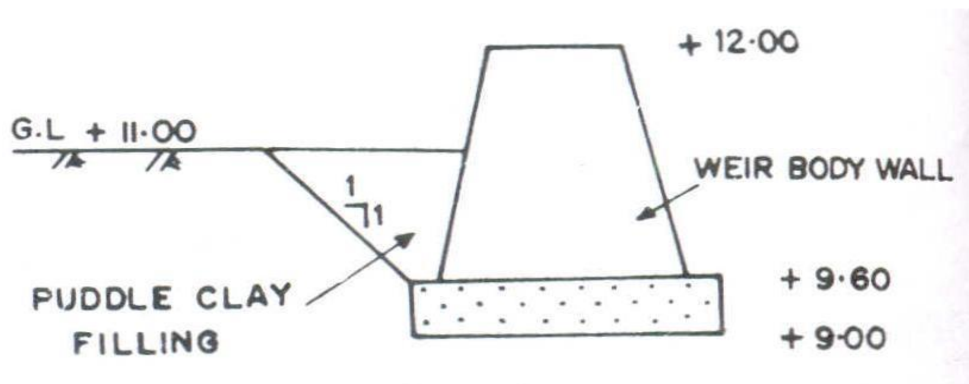
Aprons of the weir

The ground level at site of weir is 11.00

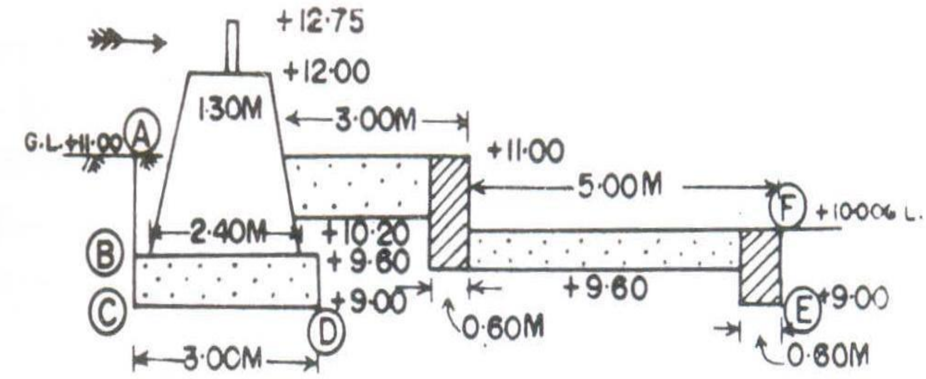
Upstream Aprons.

Generally no apreons are required on the upstream side of the weir. Howeverit is desirable to provide puddle apron as shown in figure 4.6.

It is also sometimes provided with nominal rough stone apron 30cms. Thick packed well on puddle clay apron.



In case where the head of percolation is great, in order to reduce the length of aprons on the downstream side of the weir, it is necessary to provide upstream side solid apron. This apron is not subject to any uplifts and hence can be norminal thickness. However this acts in considerably reducing the creep length and consequently reduces th elenghts and thickness of aprons, downstream of the weir.



Downstream aprons.

Since the ground level is falling down to 10.00 in a distance of about 6 meters, it is desirable to provide a stepped apron as shown in figure.4.7. the stepping may be in two stages.

The aprons may be designed for a hydraulic gradient of 1 in 5 so that the residual gradient at the exit of aprons can be limited to 1 in 5 which is safe enough and will not start undermining the structure.

Maximum uplift pressure are experienced on the down stream aprons when the water level in the tank is upto Top of dam stone level i.e to 12.75 with no water on the downstream side.

However assume that the downstream water elevation is ta 10.00 i.e the level of the lowest solid apron.

Total uplift head acting= 12.75 – 10.00= 2.75meters.

If the residual uplift gradient is to be limited to 1/5, then we require aprons to accommodate a total creep length of 2.75 x 5= 13.75meters. The upstream water has to percolate under the foundations of the weir, if it has to establish any uplifts under the aprons. The possible path of percolation is shown in the figure. 4.7.

Assuming the puddle apron formed on the upstream of the weir to be not impervoius , the water will start percolating from A at a level of 11.00 and reach B and C . then it will follw CD under the foundation concrete. From here, it will follow the least path D to E under the end cut-off and then appear at F. ie the lower solid apron. So the total length of percolation

AB+BC+CD+DE+EF= 1.40+ 0.60+ 3.00+DE+ 1.00

= DE+ 6.00

This length must not be less than 13.75 meters , if the structures is to be safe.
DE+ 6.000= 13.75

DE= 7.75meters.

The total lengh to of solid apron from the body wall as provided in the drawing is 8 meters and this will be enough. These can be reduced if the upstream side puddle clay apron is really impervoius . To ensure safety, the whole upstream side apron can be packed with stone and well grouted with cement concrete.

At the end of the second apron retaining wall of the downstream side apron , a nominal 3 to 5 meter length of talus with a thickness of 50cms. May be provided as a safety device.

Thickness of solid apron

The maximum uplift on the apron floor is felt immediately above point D in the sketch. Assuming a thickness of 80cms of apron the bottom level of apron is 10.20creep length from D to the bottom of apron is 1.20meters.

Total creep length from point A on the upstream side upto the point above D under the solid apron is 1.40+ 0.60+3.00+1.20 = 6.20

Head lost in percolation along the path upto the point = 6.20/5 = 1.24meters.
Residual head exerting uplift under the apron= 2.75- 1.24= 1.51 meters.

Since the bottom of apron is above the assumed tail water elevation , the weight of concrete fully takes care of the uplift, as there is no loss of weight in concrete due to buoyancy.

Each meter depth of concrete can withstand a head of 2.25 meters by a self weight of apron alone. Allowing an extra 20percent thickness to withstand any variations, the thickness of apron required is (1.51/2.25) X (6/5)= 0.805 meters or say 80cms

So, provide the first solid apron as 80 cms thick . The second apron can be similarly checked and a thickness of 50cms. will be quite sufficient.

SURPLUS WEIR WITH STEPPED APRONS